

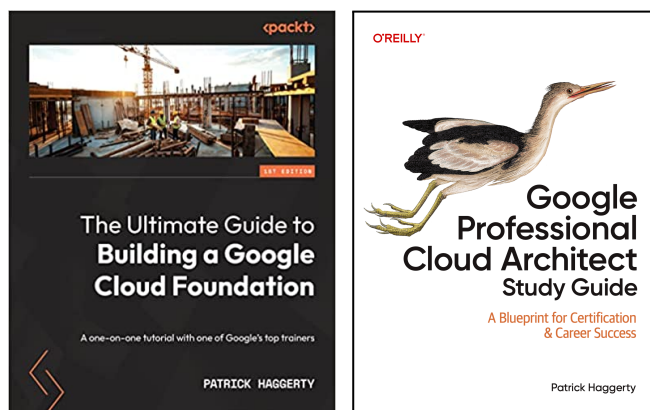
Google Cloud Helpful Resources

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My books on Google Cloud



<https://www.amazon.com/dp/B09ZV5X257>

Did you know, ROI Training offers training on a broad set of technical topics, including Google Cloud, AWS, Python, Java, JavaScript, Agile, C#, Security, and Technology Project Management?

Great ROI Training resources

- ROI YouTube Tutorials and Demos: https://www.youtube.com/channel/UC8-g09s_opdDruUjYdiuCxg
- LinkedIn Student Resource Group: <https://www.linkedin.com/groups/8620249/>
- ROI Training LinkedIn for News and Updates: <https://www.linkedin.com/company/roi-training/>
- ROI Google Certification Paths: <https://www.roitraining.com/google-cloud-training-and-certification-roadmap/>
- Full Course List: <https://www.roitraining.com/course-list/>

General

Keeping Informed

- Google Cloud Console: <https://console.cloud.google.com/>
- **GCP blog: <https://cloud.google.com/blog/>
- Google's developer blog: <https://developers.googleblog.com/>
- What's new in GCP: <https://cloud.google.com/blog/topics/inside-google-cloud/whats-new-google-cloud>
- Developer Discord channel: <https://discord.com/invite/google-dev-community>
- GCP community support: <https://docs.cloud.google.com/support/docs/community-support>
- Digital transformation with Google Cloud: <https://cloud.google.com/transform/>
- Google Research Blog: <https://ai.googleblog.com/>
- GCP newsletter: <https://cloud.google.com/newsletter>
- GCP YouTube channel: <https://www.youtube.com/user/googlecloudplatform>
- GCP Medium page: <https://medium.com/google-cloud>
- Recent GCP product changes (all release notes): <https://docs.cloud.google.com/release-notes>
- **Product specific release notes: <https://docs.cloud.google.com/release-notes/all>
- Kubernetes Podcast from Google: <https://kubernetespodcast.com/>
- **Security bulletins: <https://docs.cloud.google.com/support/bulletins>
- GCP on Reddit: <https://www.reddit.com/r/googlecloud/>

Starter information

- ****Google Cloud Architecture Center:** <https://docs.cloud.google.com/architecture>
 - What's new in the Architecture center:
<https://docs.cloud.google.com/architecture/release-notes>
- ****Google Cloud products:** <https://cloud.google.com/products>
 - Products at a glance: <https://docs.cloud.google.com/docs/product-list>
 - The Google Cloud Developer's Cheat Sheet:
<https://github.com/priyankavergadia/google-cloud-4-words>
- ****Google Regions:** <https://cloud.google.com/about/locations>
 - Google Maps: [us-east1 \(Moncks Corner, SC\)](#)
 - Google Maps: [us-central1 \(Council Bluffs, IA\)](#)
 - Google Maps: [europe-west1 \(Saint Ghislain, Belgium\)](#)
- ****Which resources are zonal, regional, multi-regional, or global:**
<https://docs.cloud.google.com/compute/docs/regions-zones/global-regional-zonal-resources>
- ****Relate Azure, AWS, and GCP service names:**
<https://cloud.google.com/free/docs/aws-azure-gcp-service-comparison>
- ****Google cloud developer's cheat sheet (GCP product list):**
 - Products: <https://cloud.google.com/products/?hl=en>
- ****Great graphics related to Google Cloud:** <https://www.thecloudgirl.dev/>
 - <https://github.com/priyankavergadia/GCPSketchnote>
- GCP Solutions: <https://cloud.google.com/solutions>
- GCP Tutorials: <https://docs.cloud.google.com/docs/tutorials>
- Google cloud design icons: <https://cloud.google.com/icons>
- General Googly (material) icons: <https://fonts.google.com/icons>
- About Google Cloud Services:
<https://cloud.google.com/docs/overview/cloud-platform-services>
- Google Cloud Well-Architected Framework guide:
<https://docs.cloud.google.com/architecture/framework>
- ****Check latency from you to every GCP Region:** <https://www.gcping.com:443/>
 - Inter-region latency and throughput:
<https://lookerstudio.google.com/u/0/reporting/fc733b10-9744-4a72-a502-92290f608571/page/70YCB>
- Google datacenter photo gallery: <https://www.google.com/about/datacenters/gallery/>

- GCP Certification: <https://cloud.google.com/certification>
- Google's "green" status: <https://cloud.google.com/sustainability/region-carbon>
- Case studies and customers: <https://cloud.google.com/customers/>
- Find a Google partner: <https://cloud.google.com/find-a-partner/>
- Google Cloud Support hub: <https://cloud.google.com/support-hub>
- Customer care packages: <https://docs.cloud.google.com/support/docs>
- Google Cloud Issue tracker: <https://docs.cloud.google.com/support/docs/issue-trackers>
- Wild and crazy cloud computing stats:
<https://www.cloudzero.com/blog/cloud-computing-statistics>
- Nice page of best practices links:
<https://ronnieroyston.com/google-cloud/google-cloud-best-practices>

Cloud Shell / SDK

- Installing the Google Cloud CLI: <https://cloud.google.com/sdk/install>
- gcloud cheat sheet:
 - The gcloud CLI cheat sheet: <https://docs.cloud.google.com/sdk/docs/cheatsheet>
 - <https://cloud.google.com/sdk/docs/images/gcloud-cheat-sheet.pdf>
 - gcp gcloud cheat sheet · GitHub:
<https://gist.github.com/pydevops/cffbd3c694d599c6ca18342d3625af97>
- gcloud reference: <https://docs.cloud.google.com/sdk/gcloud/reference>
- gsutil docs (legacy — superseded by gcloud storage):
<https://docs.cloud.google.com/storage/docs/gsutil>
 - Consider the new gcloud storage:
<https://docs.cloud.google.com/sdk/gcloud/reference/storage>
- bq command line reference:
<https://docs.cloud.google.com/bigquery/docs/reference/bq-cli-reference>
- Interactive GCP cloud SDK: <https://docs.cloud.google.com/sdk/docs/interactive-gcloud>
- How Cloud Shell works:
<https://docs.cloud.google.com/shell/docs/how-cloud-shell-works>

Compute Technologies

- **Nice "where should I run my stuff" sketch:
<https://www.thecloudgirl.dev/compute/where-should-i-run-my-stuff>
- Compute related sketches: <https://www.thecloudgirl.dev/compute>

App Engine

- App Engine: Managed app platform: <https://docs.cloud.google.com/appengine/docs/>
- Standard: <https://cloud.google.com/appengine/docs/standard>
- Supported Runtimes: <https://cloud.google.com/appengine/docs/standard/runtimes>
- Flex: <https://cloud.google.com/appengine/docs/flexible>

Cloud Run Functions

- Cloud Run functions: <https://docs.cloud.google.com/functions/docs/concepts/overview>
- Supported environments: <https://cloud.google.com/functions/docs/concepts/exec>
- Comparing Cloud Run functions: <https://cloud.google.com/functions/docs/deploy>
- Tips and tricks on using: <https://cloud.google.com/functions/docs/bestpractices/tips>

Compute Engine

- General info: <https://cloud.google.com/compute>
- GCE Overview: <https://docs.cloud.google.com/compute/docs/overview>
- Compute Engine instances overview:
<https://docs.cloud.google.com/compute/docs/instances>
- GCE Instance Groups: <https://docs.cloud.google.com/compute/docs/instance-groups>
 - Instance templates:
<https://docs.cloud.google.com/compute/docs/instance-templates/create-instance-templates>
 - Autoscaling options: <https://docs.cloud.google.com/compute/docs/autoscaler>
- GCE Machine Types: <https://docs.cloud.google.com/compute/docs/machine-resource>
- CPU platform details: <https://docs.cloud.google.com/compute/docs/cpu-platforms>
- GCE Storage (drive) types: <https://docs.cloud.google.com/compute/docs/disks>
- What is persistent disk (Cloud Disk):
<https://github.com/priyankavergadia/GCPsketchnote/blob/main/images/pd.jpg>
- Persistent disk performance:
<https://docs.cloud.google.com/compute/docs/disks/performance>
- Image management best practices:
<https://docs.cloud.google.com/compute/docs/images/image-management-best-practices>
- Migrate to Virtual Machines: <https://cloud.google.com/migrate/compute-engine/docs/>
- OS Login (leverage IAM to manage SSH access:

- Choose an access method | Compute Engine:
<https://docs.cloud.google.com/compute/docs/instances/access-overview>
- About OS Login | Compute Engine:
<https://docs.cloud.google.com/compute/docs/oslogin>
- Shielded VMs for better bootkit and rootkit protection:
<https://docs.cloud.google.com/compute/shielded-vm/docs/shielded-vm>
- TCP Forwarding through IAP (substitute for jump boxes):
<https://docs.cloud.google.com/iap/docs/tcp-forwarding-overview>
- Packer documentation: <https://www.packer.io/>
- Sole-tenancy: <https://docs.cloud.google.com/compute/docs/nodes/sole-tenant-nodes>
- Snapshots: <https://docs.cloud.google.com/compute/docs/disks/create-snapshots>
- Placement policies:
<https://cloud.google.com/compute/docs/instances/define-instance-placement>
- Geography and regions:
<https://cloud.google.com/compute/docs/regions-zones/zone-virtualization>
- Regional machine type comparison: <https://gcloud-compute.com/>

Cloud Run

- Cloud Run: <https://docs.cloud.google.com/run/docs/overview/what-is-cloud-run>
- Docs: <https://docs.cloud.google.com/run/docs>
- Deploy an app to Cloud Run with Cloud Deploy:
<https://docs.cloud.google.com/deploy/docs/deploy-app-run>
- Cloud Run service identity:
<https://docs.cloud.google.com/run/docs/securing/service-identity>
- Sample code: <https://docs.cloud.google.com/run/docs/samples>
- Secrets: <https://docs.cloud.google.com/run/docs/configuring/services/secrets>
- Knative: <https://knative.dev/>
 - Knative serving on GKE Enterprise:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/knative-serving/docs/install>
- CloudEvents: <https://cloudevents.io/>
- Eventarc (Cloud Run triggers): <https://docs.cloud.google.com/eventarc/docs/overview>
- Cloud Run ingress options: <https://docs.cloud.google.com/run/docs/securing/ingress>
- Cloud Run and Cloud Armor:
<https://docs.cloud.google.com/armor/docs/integrating-cloud-armor#serverless>

- Execution environment options:
<https://cloud.google.com/run/docs/about-execution-environments>
- How to talk to which services:
<https://docs.cloud.google.com/run/docs/integrate/using-gcp-services>
- Private Networking and Cloud Run:
<https://docs.cloud.google.com/run/docs/securing/private-networking>
- Direct VPC Egress: <https://docs.cloud.google.com/run/docs/configuring/vpc-direct-vpc>
- Compare Direct VPC egress and VPC connectors:
<https://docs.cloud.google.com/run/docs/configuring/connecting-vpc>

Kubernetes

Start here: containers and images

- What is a container: <https://www.docker.com/resources/what-container>
- Docker, getting started: <https://docs.docker.com/get-started/overview/>
- Open Container Initiative (OCI): <https://opencontainers.org/>
- Dockerfile reference: <https://docs.docker.com/engine/reference/builder/>
- Docker cheat sheet (PDF): https://docs.docker.com/get-started/docker_cheatsheet.pdf
- Docker Hub (base images): <https://hub.docker.com/search/?type=image>
- Distroless images: <https://github.com/GoogleContainerTools/distroless>
- Buildpacks: <https://buildpacks.io/>
- Google Cloud buildpacks: <https://docs.cloud.google.com/docs/buildpacks/overview>
- Buildpacks for Java: <https://docs.cloud.google.com/docs/buildpacks/java>
- Buildpacks for Node.js: <https://docs.cloud.google.com/docs/buildpacks/nodejs>
- Buildpacks for Python: <https://docs.cloud.google.com/docs/buildpacks/python>
- Docker workshop: image-building best practices:
https://docs.docker.com/get-started/workshop/09_image_best/
- Distroless example: Java:
<https://github.com/GoogleContainerTools/distroless/blob/main/examples/java/Dockerfile>
- Distroless example: Python 3:
<https://github.com/GoogleContainerTools/distroless/blob/main/examples/python3/Dockerfile>

- Distroless example: Node.js:
<https://github.com/GoogleContainerTools/distroless/blob/main/examples/nodejs/Dockerfile>
- Dockerfile best practices:
https://docs.docker.com/develop/develop-images/dockerfile_best-practices/
- Kubernetes is deprecating Docker (Don't panic!):
<https://kubernetes.io/blog/2020/12/02/dont-panic-kubernetes-and-docker/>
- The differences between Docker, containerd, CRI-O and runc:
<https://www.tutorialworks.com/difference-docker-containerd-runc-crio-oci/>
- Containerd graphic: <https://containerd.io/img/architecture.png>

Kubernetes core concepts

- What is Kubernetes: <https://kubernetes.io/docs/concepts/overview/>
- Google Kubernetes Engine overview:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/kubernetes-engine-overview>
- Kubernetes components: <https://kubernetes.io/docs/concepts/overview/components/>
- K8S glossary: <https://kubernetes.io/docs/reference/glossary/>
- Pods: <https://kubernetes.io/docs/concepts/workloads/pods/>
- Deployments: <https://kubernetes.io/docs/concepts/workloads/controllers/deployment/>
- Jobs: <https://kubernetes.io/docs/concepts/workloads/controllers/job/>
- StatefulSets: <https://kubernetes.io/docs/concepts/workloads/controllers/statefulset/>
- StatefulSets on GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/statefulset>
- Deploying workloads:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/deployment>
- GKE Cluster Architecture:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/cluster-architecture>
- Assigning Pods to nodes:
<https://kubernetes.io/docs/concepts/scheduling-eviction/assign-pod-node/>
- Taints and tolerations:
<https://kubernetes.io/docs/concepts/scheduling-eviction/taint-and-toleration/>
- Managing resources for containers:
<https://kubernetes.io/docs/concepts/configuration/manage-resources-containers/>

- Configure Liveness, Readiness and Startup Probes: <https://kubernetes.io/docs/tasks/configure-pod-container/configure-liveness-readiness-startup-probes/>
- Pod overhead: <https://kubernetes.io/docs/concepts/scheduling-eviction/pod-overhead/>
- Kubernetes custom Application resource template (Marketplace requirement): <https://github.com/kubernetes-sigs/application>
- Kubernetes best practices: resource requests and limits: <https://cloud.google.com/blog/products/gcp/kubernetes-best-practices-resource-requests-and-limits>
- Storage options: <https://docs.cloud.google.com/kubernetes-engine/docs/concepts/storage-overview>
- Nice “What is GKE” sketch: <https://github.com/priyankavergadia/GCPSketchnote/blob/main/images/GKE.jpg>
- The children's illustrated guide to Kubernetes (text): <https://www.cncf.io/the-childrens-illustrated-guide-to-kubernetes/>
- Children’s illustrated guide to Kubernetes: <https://youtu.be/4ht22ReBjno>
- <https://youtu.be/318ellq37PE>: <https://youtu.be/318ellq37PE>
- <https://youtu.be/BE77h7dmoQU>: <https://youtu.be/BE77h7dmoQU>
- Google's Kubernetes Podcast: <https://kubernetespodcast.com/>

kubectl, YAML and the toolchain

- Command line tool (kubectl): <https://kubernetes.io/docs/reference/kubectl/>
- kubectl overview: <https://kubernetes.io/docs/reference/kubectl/overview/#resource-types>
- kubectl quick reference: <https://kubernetes.io/docs/reference/kubectl/quick-reference/>
- Working with k8s yaml in VS Code / Cloud Shell: <https://docs.cloud.google.com/code/docs/vscode/yaml-editing>
- Helm package manager: <https://helm.sh/>
- Kustomize: <https://kustomize.io/>
- Skaffold: <https://skaffold.dev/>
- Cloud Deploy: <https://docs.cloud.google.com/deploy/docs/overview>

Creating and running GKE clusters

- About GKE modes of operation (Autopilot vs Standard): <https://docs.cloud.google.com/kubernetes-engine/docs/concepts/choose-cluster-mode>

- About cluster configuration choices:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/configuration-overview>
- Autopilot documentation:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/autopilot-overview>
- Comparing GKE Standard and Autopilot:
<https://docs.cloud.google.com/kubernetes-engine/docs/resources/autopilot-standard-feature-comparison>
- About Autopilot mode workloads in GKE Standard:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/about-autopilot-mode-standard-clusters>
- About custom ComputeClasses:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/about-custom-compute-classes>
- About release channels:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/release-channels>
- Autopilot resource requests and limits:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/autopilot-resource-requests>
- GKE quotas and limits: <https://docs.cloud.google.com/kubernetes-engine/quotas>
- Creating a GKE cluster in Google Cloud:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/creating-a-zonal-cluster>
- Kind: <https://kind.sigs.k8s.io/>
- Minikube: <https://minikube.sigs.k8s.io/docs/>
- Kink, a Kind helper: <https://github.com/Trendyol/kink>
- Kubernetes installation with kOps: <https://github.com/kubernetes/kops>
- Kubernetes setup options: <https://kubernetes.io/docs/setup/>
- Kubernetes production deployment tools:
<https://kubernetes.io/docs/setup/production-environment/tools/>
- Building highly available clusters:
<https://cloud.google.com/blog/products/containers-kubernetes/best-practices-for-creating-a-highly-available-gke-cluster>
- Autopilot clusters:
<https://cloud.google.com/blog/products/containers-kubernetes/introducing-gke-autopilot>

- Multi-tenant clusters:
<https://docs.cloud.google.com/kubernetes-engine/docs/best-practices/enterprise-multi-tenancy>

Scaling, storage and cost on GKE

- Horizontal Pod autoscaling:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/horizontal-pod-autoscaling>
- Vertical pod autoscaling:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/verticalpodautoscaler>
- Multidimensional autoscaling:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/multidimensional-pod-autoscaling>
- About node pool auto-creation:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/node-auto-provisioning>
- GKE Cluster autoscaling:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/cluster-autoscaler>
- Rolling updates:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/updating-apps>
- Dynamic volume (PVC) provisioning:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/persistent-volumes>
- GKE Backup:
<https://docs.cloud.google.com/kubernetes-engine/docs/add-on/backup-for-gke/concepts/backup-for-gke>
- Use image streaming to pull container images:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/image-streaming>
- Autoscaling using Cloud Monitoring metrics:
<https://docs.cloud.google.com/kubernetes-engine/docs/tutorials/autoscaling-metrics>
- Scale cluster up/down on schedule:
<https://docs.cloud.google.com/kubernetes-engine/docs/tutorials/reducing-costs-by-scaling-down-gke-off-hours>
- GKE Cost optimization:
<https://docs.cloud.google.com/architecture/best-practices-for-running-cost-effective-kubernetes-applications-on-gke>

- Introducing container image streaming in GKE:
<https://cloud.google.com/blog/products/containers-kubernetes/introducing-container-image-streaming-in-gke>

GKE networking

- Compare network models in GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/gke-compare-network-models>
- GKE network overview:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/network-overview>
- Services: <https://docs.cloud.google.com/kubernetes-engine/docs/concepts/service>
- LoadBalancer service options:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/service-load-balancer>
- GKE Ingress: <https://docs.cloud.google.com/kubernetes-engine/docs/concepts/ingress>
- GKE Gateways (a better way to do ingress):
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/gateway-api>
- GKE Dataplane V2:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/dataplane-v2>
- Using Cloud DNS for GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/cloud-dns>
- Ingress for external Application Load Balancers:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/container-native-load-balancing>
- About network isolation in GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/network-isolation>
- Kubernetes ingress: <https://kubernetes.io/docs/concepts/services-networking/ingress/>
- NetworkPolicy documentation:
<https://kubernetes.io/docs/concepts/services-networking/network-policies/>
- GKE networking best practices:
<https://docs.cloud.google.com/kubernetes-engine/docs/best-practices/networking>

GKE security

- GKE security overview:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/security-overview>
- Access control: IAM compared with Kubernetes RBAC:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/access-control>

- About Workload Identity Federation for GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/workload-identity>
- Set up Workload Identity Federation for GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/workload-identity>
- Authorize actions in clusters using RBAC:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/role-based-access-control>
- Use Google Groups for Kubernetes RBAC:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/google-groups-rbac>
- Kubernetes RBAC reference:
<https://kubernetes.io/docs/reference/access-authn-authz/rbac/>
- GKE Private clusters:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/private-cluster-concept>
- GKE Hardening your cluster (and links to other security articles):
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/hardening-your-cluster>
- Binary Auth: <https://docs.cloud.google.com/binary-authorization/docs>
- GKE Sandbox (gVisor workload isolation):
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/sandbox-pods>
- Replace Pod Security Policies with Gatekeeper:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/pod-security-policies-with-gatekeeper>
- Pod admission controllers:
<https://kubernetes.io/docs/concepts/security/pod-security-admission/>
- Pod Security Standards:
<https://kubernetes.io/docs/concepts/security/pod-security-standards/>
- Enforce Pod Security Standards with Namespace Labels:
<https://kubernetes.io/docs/tasks/configure-pod-container/enforce-standards-namespace-labels/>
- Kubernetes Secrets: <https://kubernetes.io/docs/concepts/configuration/secret/>
- Better control over Secrets: Hashicorp Vault: <https://www.vaultproject.io/>
- About the security posture dashboard:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/about-security-posture-dashboard>
- Posture management deprecations (what replaced GKE Threat Detection and the Compliance dashboard):

<https://docs.cloud.google.com/kubernetes-engine/docs/deprecations/posture-management-deprecation>

- NSA Kubernetes Hardening guide:
https://media.defense.gov/2022/Aug/29/2003066362/-1/-1/0/CTR_KUBERNETES_HARDENING_GUIDANCE_1.2_20220829.PDF

Observability and troubleshooting

- Observability for GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/observability>
- Troubleshooting Kubernetes:
<https://docs.cloud.google.com/kubernetes-engine/docs/troubleshooting>
- Monitoring, logging, and debugging: <https://kubernetes.io/docs/tasks/debug/>
- Managed Service for Prometheus:
<https://docs.cloud.google.com/stackdriver/docs/managed-prometheus>
- Configure metrics collection for GKE:
<https://docs.cloud.google.com/stackdriver/docs/solutions/gke/installing>
- Managed OpenTelemetry for GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/managed-otel-gke>
- Multi-tenant logging:
<https://docs.cloud.google.com/stackdriver/docs/solutions/gke/multi-tenant-logging>
- Troubleshooting k8s: <https://learnk8s.io/troubleshooting-deployments>
- Grafana: <https://grafana.com/>
- Managed Service for Prometheus (GMP) Customer-Sharable Deck [public]:
https://docs.google.com/presentation/d/1MbC-0Y2bA8W_kmE7qE2gEWEYluDUhmfnfdgZRV6pMBnc/edit?resourcekey=0-B_CMHCyBhi_1wxAAr5hF-Q#slide=id.p

Extending Kubernetes: CRDs, operators, Config Connector

- Custom Resources:
<https://kubernetes.io/docs/concepts/extend-kubernetes/api-extension/custom-resources/>
- Operator pattern: <https://kubernetes.io/docs/concepts/extend-kubernetes/operator/>
- Installing a CRD:
<https://kubernetes.io/docs/tasks/extend-kubernetes/custom-resources/custom-resource-definitions/>
- K8S client libraries: <https://kubernetes.io/docs/reference/using-api/client-libraries/>
- Operator SDK: <https://sdk.operatorframework.io/>

- Example creating an operator:
<https://developers.redhat.com/articles/2021/09/07/build-kubernetes-operator-six-steps>
- Java Operator SDK: <https://github.com/java-operator-sdk/java-operator-sdk>
- Third-party operators (OperatorHub): <https://operatorhub.io/>
- Config Connector overview:
<https://docs.cloud.google.com/config-connector/docs/overview>
- Config Connector installation types:
<https://docs.cloud.google.com/config-connector/docs/concepts/installation-types>
- Config Controller documentation:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/config-controller/docs>

Fleets and multi-cluster management

- Fleets are part of standard GKE - there is no separate edition to buy.
- Fleet management (start here):
<https://docs.cloud.google.com/kubernetes-engine/fleet-management/docs>
- How fleets work:
<https://docs.cloud.google.com/kubernetes-engine/fleet-management/docs/fleet-concepts>
- Fleet team management:
<https://docs.cloud.google.com/kubernetes-engine/fleet-management/docs/team-management>
- Use the GKE overview dashboard:
<https://docs.cloud.google.com/kubernetes-engine/fleet-management/docs/enterprise-overview-dashboard>
- GKE Identity Service:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/identity>
- Connect Gateway:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/multicloud-management/gateway>
- Set up the Connect gateway:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/multicloud-management/gateway/setup>
- Using the Connect gateway:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/multicloud-management/gateway/using>

- About Multi-Cluster Services (MCS):
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/multi-cluster-services>
- Configure Multi-cluster Services:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/multi-cluster-services>
- Multi Cluster Ingress:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/multi-cluster-ingress>
- Deploy Multi Cluster Ingress:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/multi-cluster-ingress>
- Deploying multi-cluster gateways:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/deploying-multi-cluster-gateways>
- Multi-cluster Services with Shared VPC:
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/msc-setup-with-shared-vpc-networks>
- Bank of Anthos demo app: <https://github.com/GoogleCloudPlatform/bank-of-anthos>

GitOps: Config Sync and Policy Controller

- Config Sync and Policy Controller are included with GKE; no separate edition or licence.
- Config Sync overview:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/config-sync/docs/overview>
- Config Sync home:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/config-sync/docs>
- Hierarchical (structured) Git repository:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/config-sync/docs/concepts/hierarchical-repo>
- Unstructured repositories:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/config-sync/docs/how-to/unstructured-repo>
- Config Sync Quickstart:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/config-sync/docs/tutorials/config-sync-multi-repo>
- GitOps best practices:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/config-sync/docs/concepts/gitops-best-practices>

- Policy Controller:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/policy-controller/docs>
- Policy Controller overview:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/policy-controller/docs/overview>
- Install Policy Controller:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/policy-controller/docs/how-to/installing-policy-controller>
- Google Policy bundles:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/policy-controller/docs/concepts/policy-controller-bundles>
- Constraints:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/policy-controller/docs/latest/reference/constraint-template-library>
- OPA Gatekeeper documentation:
<https://open-policy-agent.github.io/gatekeeper/website/docs/>

Cloud Service Mesh

- Cloud Service Mesh is the successor to Anthos Service Mesh and Traffic Director; it no longer requires a separate GKE edition.
- Cloud Service Mesh overview:
<https://docs.cloud.google.com/service-mesh/docs/overview>
- Cloud Service Mesh documentation: <https://docs.cloud.google.com/service-mesh/docs>
- Cloud Service Mesh supported features (managed control plane):
<https://docs.cloud.google.com/service-mesh/docs/managed/supported-features-mcp>
- In-cluster control plane supported features:
<https://docs.cloud.google.com/service-mesh/docs/supported-features-in-cluster>
- Provision a managed Cloud Service Mesh control plane:
<https://docs.cloud.google.com/service-mesh/docs/onboarding/provision-control-plane>
- Multi-env install (Istiod per cluster):
<https://docs.cloud.google.com/service-mesh/docs/onboarding/kubernetes-off-gcp/install/install-in-cluster-cloud-service-mesh>
- CA Service for managed Service Mesh:
<https://docs.cloud.google.com/service-mesh/docs/security/certificate-authority-service>
- Overview of proxyless Service Mesh with gRPC:
<https://docs.cloud.google.com/service-mesh/docs/service-routing/proxyless-overview>

- Setup security in proxyless gRPC:
<https://docs.cloud.google.com/service-mesh/docs/service-routing/security-proxyless-setup>

Istio and Envoy

- What is a service mesh?: <https://istio.io/latest/about/service-mesh/>
- Istio homepage: <https://istio.io/>
- Istio architecture overview: <https://istio.io/latest/docs/ops/deployment/architecture/>
- Istio deployment models: <https://istio.io/docs/ops/deployment/deployment-models/>
- Istio security concepts: <https://istio.io/latest/docs/concepts/security/>
- Istio traffic management concepts:
<https://istio.io/latest/docs/concepts/traffic-management/>
- Istio security configuration reference:
<https://istio.io/latest/docs/reference/config/security/>
- Istio installation: <https://istio.io/latest/docs/setup/install/>
- Istio traffic management tasks: <https://istio.io/latest/docs/tasks/traffic-management/>
- Circuit Breaking example:
<https://istio.io/latest/docs/tasks/traffic-management/circuit-breaking/>
- Troubleshooting multicluster:
<https://istio.io/latest/docs/ops/diagnostic-tools/multicluster/>
- Some Istio performance info:
<https://istio.io/docs/ops/deployment/performance-and-scalability/>
- Istio ambient mode overview (sidecar-less mesh):
<https://istio.io/latest/docs/ambient/overview/>
- More than you ever wanted to know about mTLS (The Illustrated TLS Connection):
<https://tls12.xargs.org/>
- Envoy proxy: <https://www.envoyproxy.io/>
- Open source mesh visualization with Kiali: <https://kiali.io/>

AI/ML on GKE

- Introduction to AI/ML workloads on GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/machine-learning>
- AI/ML orchestration on GKE documentation:
<https://docs.cloud.google.com/kubernetes-engine/docs/integrations/ai-infra>

- About AI/ML model inference on GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/machine-learning/inference>
- About GPUs in GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/gpus>
- About TPUs in GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/tpus>
- About GPU sharing strategies in GKE (MIG, time-sharing, MPS):
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/timesharing-gpus>
- About accelerator consumption options (on-demand, reservations, flex-start, Spot):
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/consumption-option>
- About GPU, TPU and H4D consumption with flex-start provisioning mode:
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/dws>
- About GKE Inference Gateway (powered by ILM-d):
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/about-gke-inference-gateway>
- Serve an LLM with GKE Inference Gateway:
<https://docs.cloud.google.com/kubernetes-engine/docs/tutorials/serve-with-gke-inference-gateway>
- Deploy a batch system using Kueue:
<https://docs.cloud.google.com/kubernetes-engine/docs/tutorials/kueue-intro>
- Overview of inference best practices on GKE:
<https://docs.cloud.google.com/kubernetes-engine/docs/best-practices/machine-learning/inference>
- About GKE Agent Sandbox (Preview):
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/machine-learning/agent-sandbox>
- About GKE Hypercluster (private access, eligible customers only):
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/hypercluster-overview>

Running Kubernetes outside Google Cloud

- Pointers only. For a full installation walk-through, go to Google's product documentation tree.
- GKE cluster options: every environment GKE runs in:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/clusters/docs>

- GKE deployment options: which features work where:
<https://docs.cloud.google.com/kubernetes-engine/enterprise/docs/deployment-options>
- Google Distributed Cloud (software only) for bare metal - overview (formerly Anthos on bare metal):
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/bare-metal/docs/concepts/about-bare-metal>
- Google Distributed Cloud (software only) for VMware - overview (formerly Anthos on VMware):
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/vmware/docs/overview>
- Google Distributed Cloud (software only) for bare metal - documentation:
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/bare-metal/docs>
- GKE attached clusters (bring an EKS, AKS or CNCF cluster under GKE management):
<https://docs.cloud.google.com/kubernetes-engine/multi-cloud/docs/attached>
- GKE on AWS deprecation announcement - end of support 17 March 2027:
<https://docs.cloud.google.com/kubernetes-engine/multi-cloud/docs/aws/deprecations/deprecation-announcement>
- GKE on Azure deprecation announcement - end of support 17 March 2027:
<https://docs.cloud.google.com/kubernetes-engine/multi-cloud/docs/azure/deprecations/deprecation-announcement>

Data — choosing a storage or analytics product

- **GCP Storage Products: <https://cloud.google.com/products/storage>
- **Which storage should I use:
<https://github.com/priyankavergadia/GCPSketchnote/blob/main/images/storageoptions.jpg>
- Designing optimal storage: <https://docs.cloud.google.com/architecture/storage-advisor>
- **Database products: <https://cloud.google.com/products/databases>
- **Which database should I use:
https://storage.googleapis.com/gweb-cloudblog-publish/images/Which-Database_v03-22-23.max-2000x2000.jpg
- **Classic data processing pipeline sketch:
<https://www.thecloudgirl.dev/data-analytics/data-analytics-pipeline>
- Database Center: <https://docs.cloud.google.com/database-center/docs/overview>

- Data center migration white paper:
https://services.google.com/fh/files/misc/google_data_center_transformation.pdf
- End to end data and analytics demo:
<https://github.com/GoogleCloudPlatform/data-analytics-golden-demo>
- Colossus:
 - Under the hood:
<https://cloud.google.com/blog/products/storage-data-transfer/how-colossus-optimizes-data-placement-for-performance/>
 - Peak behind the scenes:
<https://cloud.google.com/blog/products/storage-data-transfer/a-peek-behind-colossus-googles-file-system>
 - Google's data storage array, Colossus:
https://cloud.google.com/files/storage_architecture_and_challenges.pdf
 - Nice video overview of Google's storage infrastructure (Colossus):
https://www.youtube.com/embed/q4WC_6SzBz4

Databases

Cloud SQL, AlloyDB, and Spanner

- Cloud SQL documentation: <https://docs.cloud.google.com/sql/docs>
- Cloud SQL Maintenance: <https://docs.cloud.google.com/sql/docs/mysql/maintenance>
- Cloud SQL Backups:
<https://docs.cloud.google.com/sql/docs/mysql/backup-recovery/backups>
- Using the Cloud SQL connector:
<https://docs.cloud.google.com/sql/docs/mysql/connect-connectors>
- Connecting to Cloud SQL from GKE:
<https://docs.cloud.google.com/sql/docs/mysql/connect-kubernetes-engine>
- Cloud SQL Scalability best practices:
<https://cloud.google.com/blog/products/databases/understanding-cloud-sql-high-availability/>
- Spanner docs: <https://cloud.google.com/spanner/docs/concepts>
- Cloud Girl Spanner:
<https://github.com/priyankavergadia/GCPSketchnote/blob/main/images/Spanner.jpg>
- Spanner SQL best practices:
<https://docs.cloud.google.com/spanner/docs/sql-best-practices>

- Spanner Schema design and best practices:
<https://docs.cloud.google.com/spanner/docs/schema-design>
- Spanner white papers: <https://docs.cloud.google.com/spanner/docs/whitepapers>
- Spanner emulator: <https://docs.cloud.google.com/spanner/docs/emulator>
- Spanner compute capacity (Processing Units and Nodes):
<https://docs.cloud.google.com/spanner/docs/compute-capacity>
- Cassandra connector:
<https://docs.cloud.google.com/spanner/docs/non-relational/connect-cassandra-adapter>
- AlloyDB: <https://docs.cloud.google.com/alloydb/docs/overview>
 - Docs home: <https://docs.cloud.google.com/alloydb/docs>
 - Create and connect to a DB:
<https://docs.cloud.google.com/alloydb/docs/quickstart/create-and-connect#before-you-begin>
 - Comparison to Cloud SQL and Spanner:
<https://gist.github.com/Weiyuan-Lane/8daeabab1371221a286f0131cab3065d>

Bigtable

- Big Table docs: <https://docs.cloud.google.com/bigtable/docs/>
- Nice graphic:
<https://github.com/priyankavergadia/GCPSketchnote/blob/main/images/Bigtable.jpg>
- **Big Table schema design:
<https://docs.cloud.google.com/bigtable/docs/schema-design>
- Understanding BigTable performance:
<https://docs.cloud.google.com/bigtable/docs/performance>
- Replication: <https://docs.cloud.google.com/bigtable/docs/replication-overview>
- Application Profiles: <https://docs.cloud.google.com/bigtable/docs/app-profiles>
- Bigtable backups: <https://docs.cloud.google.com/bigtable/docs/backups>
- For development, consider using BigTable emulator:
<https://docs.cloud.google.com/bigtable/docs/emulator>

Firestore / Datastore

- Firestore docs: <https://cloud.google.com/firestore/docs>
- Firestore best practices (latency):
<https://cloud.google.com/firestore/docs/best-practices>

- Firestore graphic: <https://github.com/priyankavergadia/GCPSketchnote/blob/main/images/firestore.jpg>
- Firestore index types: <https://firebase.google.com/docs/firestore/query-data/index-overview>
- Firestore getting data: <https://cloud.google.com/firestore/docs/query-data/get-data>
- Firestore queries: <https://cloud.google.com/firestore/docs/query-data/queries>
- Firestore key visualizer: <https://cloud.google.com/firestore/docs/key-visualizer>
- Datastore docs: <https://docs.cloud.google.com/datastore/docs/concepts/overview>
- Datastore overview: <https://cloud.google.com/datastore/docs/how-to>
- Datastore queries: <https://docs.cloud.google.com/datastore/docs/concepts/queries>
- Datastore transactions: <https://docs.cloud.google.com/datastore/docs/concepts/transactions>
- GQL reference: https://docs.cloud.google.com/datastore/docs/reference/gql_reference
- Firestore native vs. Datastore mode: <https://docs.cloud.google.com/datastore/docs/firestore-or-datastore>

Memorystore

- Documentation: <https://docs.cloud.google.com/memorystore/docs/redis>
- Redis details: <https://cloud.google.com/memorystore/docs/redis/redis-overview>
- Memorystore for Memcached (deprecated — shutdown 31 Jan 2029): <https://docs.cloud.google.com/memorystore/docs/memcached>
- Memcached overview (deprecated — migrate to Memorystore for Valkey): <https://docs.cloud.google.com/memorystore/docs/memcached/memcached-overview>
- Redis vs Memcached:
 - Redis vs Memcached: Which One to Choose? (2026 Guide): <https://www.imaginarycloud.com/blog/redis-vs-memcached/>
 - Redis Vs Memcached - 2021 Comparison, Features [Infographic]: <https://scalegrid.io/blog/redis-vs-memcached-2021-comparison/>

Filestore

- Overview: <https://docs.cloud.google.com/filestore/docs/overview>
- Quickstart: <https://cloud.google.com/filestore/docs/quickstart-console>
- Overview: <https://cloud.google.com/filestore/docs/how-to>

Database Center

- Overview: <https://docs.cloud.google.com/database-center/docs/overview>
- Setup: <https://docs.cloud.google.com/database-center/docs/set-up-database-center>
- Analyze database fleet health using Gemini:
<https://docs.cloud.google.com/database-center/docs/analyze-database-using-gemini>

Data engineering and analytics

BigQuery

- What is BigQuery: <https://docs.cloud.google.com/bigquery/docs/introduction>
- Overview sketch:
<https://github.com/priyankavergadia/GCPSketchnote/blob/main/images/BigQuery.png>
- bq command line reference:
<https://docs.cloud.google.com/bigquery/docs/reference/bq-cli-reference>
- Migrating from Redshift to BQ:
<https://docs.cloud.google.com/bigquery/docs/migration/redshift-overview>

Querying

- **BigQuery SQL reference:
<https://docs.cloud.google.com/bigquery/docs/reference/standard-sql/query-syntax>
- **SQL Function one page list:
<https://cloud.google.com/bigquery/docs/reference/standard-sql/functions-and-operators>
- Querying nested repeated structures:
 - **Working with arrays and structures:
<https://docs.cloud.google.com/bigquery/docs/arrays>
 - Nice example using array_agg and structure to build a nested repeated column:
<https://medium.com/free-code-camp/exploring-a-powerful-sql-pattern-array-aggregate-struct-and-unnest-b7dcc6263e36>
 - Work with arrays and nested data in BigQuery SQL:
<https://docs.cloud.google.com/bigquery/docs/arrays>
- Queries over external data:
 - External data sources:
<https://docs.cloud.google.com/bigquery/docs/connections-api-intro>

- Federated queries:
<https://docs.cloud.google.com/bigquery/docs/federated-queries-intro>
- **Query from Cloud Storage:
<https://cloud.google.com/bigquery/external-data-cloud-storage>
- Scheduling queries: <https://docs.cloud.google.com/bigquery/docs/scheduling-queries>
- Dry run query: <https://cloud.google.com/bigquery/docs/dry-run-queries>
- User Defined Functions (UDFs):
 - User-defined functions | BigQuery:
<https://cloud.google.com/bigquery/docs/reference/standard-sql/user-defined-functions>
 - Community UDFs:
<https://github.com/GoogleCloudPlatform/bigquery-utils/tree/master/udfs/community>
- Remote Functions: <https://docs.cloud.google.com/bigquery/docs/remote-functions>
- Multi-statement transactions (scripts):
<https://cloud.google.com/bigquery/docs/reference/standard-sql/transactions>
- Multi-statement queries (scripts):
<https://docs.cloud.google.com/bigquery/docs/multi-statement-queries>
- BigQuery procedural language:
<https://docs.cloud.google.com/bigquery/docs/reference/standard-sql/procedural-language>
- Stored Procedures: <https://docs.cloud.google.com/bigquery/docs/procedures>
 - Spark: <https://docs.cloud.google.com/bigquery/docs/spark-procedures>
- BQ Sessions: <https://docs.cloud.google.com/bigquery/docs/sessions-intro>
- Example utils for BigQuery: <https://github.com/GoogleCloudPlatform/bigquery-utils>
- BigQuery ML:
 - **BigQuery ML Intro:
<https://docs.cloud.google.com/bigquery/docs/bqml-introduction>
 - **Good BigQuery logistic regression how to:
<https://docs.cloud.google.com/bigquery/docs/logistic-regression-prediction>

Performance, troubleshooting, and cost control

- **Intro to optimizing BigQuery performance:
<https://docs.cloud.google.com/bigquery/docs/best-practices-performance-overview>
- **Execution details info: <https://cloud.google.com/bigquery/query-plan-explanation>

- **Using the execution graph tab:
<https://docs.cloud.google.com/bigquery/docs/query-insights>
- Anti-pattern recognition tool:
<https://cloud.google.com/blog/products/data-analytics/bigquery-anti-pattern-recognition-tool-optimizes-performance/>
- 14 ways to tune your SQL:
<https://towardsdatascience.com/14-ways-to-optimize-bigquery-sql-for-ferrari-speed-at-honda-cost-632ec705979#38ea>
- Nice blog post on query optimization:
<https://cloud.google.com/blog/topics/developers-practitioners/bigquery-admin-reference-guide-query-optimization>
- **Getting info about BigQuery with INFORMATION_SCHEMA:
<https://docs.cloud.google.com/bigquery/docs/information-schema-intro>
- Getting job metadata (INFORMATION_SCHEMA.JOBS*):
<https://docs.cloud.google.com/bigquery/docs/information-schema-jobs>
- Couple of cool examples using job information schema:
 - ** Estimate slot usage and cost for queries:
<https://docs.cloud.google.com/bigquery/docs/information-schema-jobs#estimate-slot-usage-and-cost-for-queries>
 - **Calculate average slot utilization:
<https://docs.cloud.google.com/bigquery/docs/information-schema-jobs#calculate-average-slot-utilization>
 - The power of information schema in BigQuery:
<https://cloud.google.com/blog/topics/developers-practitioners/monitor-analyze-bigquery-performance-using-information-schema>
 - <https://medium.com/google-cloud/bigquery-slot-squeezes-896d9e0f2fc>
 - Git with the scripts: <https://github.com/monishdoshi22/BQInfoSchema>
- BQ Query Visualizer:
 - BqViz: <https://bqvisualiser.appspot.com/>
 - <https://github.com/GoogleCloudPlatform/professional-services/tree/main/tools/bq-visualizer>
- Another query plan visualizer:
https://github.com/shollyman/gcp-go-snippets/tree/main/queryplan_visualization
- How BigQuery caching works:
<https://docs.cloud.google.com/bigquery/docs/cached-results>
- Controlling costs: <https://cloud.google.com/bigquery/docs/controlling-costs>

- What is BI Engine: <https://docs.cloud.google.com/bigquery/docs/bi-engine-intro>
- Error messages: <https://docs.cloud.google.com/bigquery/docs/error-messages>
- BQ logs: <https://docs.cloud.google.com/bigquery/docs/reference/auditlogs>
- BQ monitoring:
 - **In BQ: <https://docs.cloud.google.com/bigquery/docs/admin-resource-charts>
 - Metrics for Metrics Explorer:
https://docs.cloud.google.com/monitoring/api/metrics_gcp#gcp-bigquery
- Edition pricing:
 - Overview:
<https://cloud.google.com/blog/products/data-analytics/introducing-new-bigquery-pricing-editions>
 - Details: <https://docs.cloud.google.com/bigquery/docs/editions-intro>
- Auto-scaling slots: <https://cloud.google.com/bigquery/docs/slots-autoscaling-intro>

Data ingestion and DML

- Nice blog post on ingesting data into BigQuery:
<https://cloud.google.com/blog/topics/developers-practitioners/bigquery-explained-data-ingestion>
- Batch loading data: <https://docs.cloud.google.com/bigquery/docs/batch-loading-data>
- BigQuery Transfer Service:
<https://cloud.google.com/bigquery-transfer/docs/introduction>
- Streaming into BigQuery (legacy):
<https://cloud.google.com/bigquery/streaming-data-into-bigquery>
- **Storage Write / Read API:
 - Intro: <https://cloud.google.com/bigquery/docs/write-api>
 - Streaming Java example:
<https://docs.cloud.google.com/bigquery/docs/write-api-streaming>
 - Batch load: <https://docs.cloud.google.com/bigquery/docs/write-api-batch>
 - Best practices:
<https://docs.cloud.google.com/bigquery/docs/write-api-best-practices>
- Using DML:
<https://cloud.google.com/bigquery/docs/reference/standard-sql/data-manipulation-language>

- DML and transactions:
<https://cloud.google.com/blog/products/data-analytics/dml-without-limits-now-in-bigquery>

Schema and design

- BigQuery schemas: <https://docs.cloud.google.com/bigquery/docs/schemas>
- Nested and repeated columns:
<https://docs.cloud.google.com/bigquery/docs/nested-repeated>
- **Views: <https://docs.cloud.google.com/bigquery/docs/views-intro>
- **Materialized views:
<https://docs.cloud.google.com/bigquery/docs/materialized-views-intro>
- Cross region dataset replication:
<https://docs.cloud.google.com/bigquery/docs/data-replication>
- Defining and using table constraints for join optimization:
<https://cloud.google.com/blog/products/data-analytics/join-optimizations-with-bigquery-primary-and-foreign-keys>
- Table functions:
<https://cloud.google.com/bigquery/docs/reference/standard-sql/table-functions>
- Managing and updating table schemas:
<https://docs.cloud.google.com/bigquery/docs/managing-table-schemas>
- DDL:
<https://docs.cloud.google.com/bigquery/docs/reference/standard-sql/data-definition-language>
- Getting info about table metadata:
<https://docs.cloud.google.com/bigquery/docs/information-schema-tables>
- Table partitioning: <https://docs.cloud.google.com/bigquery/docs/partitioned-tables>
- Managing partitioned tables:
<https://docs.cloud.google.com/bigquery/docs/managing-partitioned-tables>
- Table clustering: <https://docs.cloud.google.com/bigquery/docs/clustered-tables>
- BigQuery quotas and limits: <https://docs.cloud.google.com/bigquery/quotas>
- Data masking:
<https://docs.cloud.google.com/bigquery/docs/column-data-masking-intro>
- Table Cloning: <https://docs.cloud.google.com/bigquery/docs/table-clones-intro>

Security, backup, DLP

- BigQuery permissions and info on roles:
<https://docs.cloud.google.com/bigquery/docs/access-control>
- BigQuery table access control:
<https://docs.cloud.google.com/bigquery/docs/control-access-to-resources-iam>
- BigQuery column-level security:
<https://docs.cloud.google.com/bigquery/docs/column-level-security>
- Row-level security:
<https://docs.cloud.google.com/bigquery/docs/row-level-security-intro>
- Time travel (data at point in time, within last 7 days):
<https://docs.cloud.google.com/bigquery/docs/time-travel>
- Info on failsafe: <https://docs.cloud.google.com/bigquery/docs/time-travel#fail-safe>
- Table snapshots (table backup):
<https://docs.cloud.google.com/bigquery/docs/table-snapshots-intro>
- Sensitive Data Protection and BigQuery:
<https://cloud.google.com/dlp/docs/data-profiles>

Dataform

- Overview: <https://docs.cloud.google.com/dataform/docs/overview>
- Features: <https://cloud.google.com/dataform/docs/features>
- Dataform core
 - SQLx files: <https://cloud.google.com/dataform/docs/dataform-core>
 - Reference:
<https://docs.cloud.google.com/dataform/docs/reference/dataform-core-reference>
 - Samples:
<https://docs.cloud.google.com/dataform/docs/reference/sample-scripts>
 - Creating tables: <https://cloud.google.com/dataform/docs/define-table>
 - Create tables in Dataform (incremental tables):
<https://docs.cloud.google.com/dataform/docs/create-tables>
 - Assertions: <https://docs.cloud.google.com/dataform/docs/assertions>
- Quickstart: <https://docs.cloud.google.com/dataform/docs/quickstart-create-workflow>
- Intro to SQL workflows: <https://docs.cloud.google.com/dataform/docs/sql-workflows>

- CLI:
<https://docs.cloud.google.com/dataform/docs/use-dataform-cli>
- Dataform Git repos: <https://github.com/dataform-co>
- Workflow settings: <https://cloud.google.com/dataform/docs/configure-dataform>
- Dataform lifecycle: <https://cloud.google.com/dataform/docs/code-lifecycle>
- Structuring your repo: <https://cloud.google.com/dataform/docs/structure-repositories>
- Using JavaScript in Dataform:
<https://docs.cloud.google.com/dataform/docs/javascript-in-dataform>
 - Includes: <https://cloud.google.com/dataform/docs/reuse-code-includes>

How BigQuery works

- Reliability in BQ: <https://docs.cloud.google.com/bigquery/docs/reliability-intro>
- Disaster planning: <https://cloud.google.com/bigquery/docs/reliability-disaster>
- Big Query's native storage format (Capacitor):
 - Inside Capacitor, BigQuery's next-generation columnar storage format:
<https://cloud.google.com/blog/products/bigquery/inside-capacitor-bigquerys-next-generation-columnar-storage-format>
 - BigQuery Admin reference guide: Storage internals:
<https://cloud.google.com/blog/topics/developers-practitioners/bigquery-admin-reference-guide-storage>
- BigQuery under the hood:
<https://cloud.google.com/blog/products/bigquery/bigquery-under-the-hood>
- Query processing:
<https://cloud.google.com/blog/topics/developers-practitioners/bigquery-admin-reference-guide-query-processing>
- How a query works (by a Spark guy):
<https://www.waitingforcode.com/data-engineering-gcp/gcp-bigquery-by-apache-spark-guy/read>
- BigQuery turns 10: the Dremel origin story:
<https://cloud.google.com/blog/products/data-analytics/bigquery-turns-10>
- Info on Slots: <https://docs.cloud.google.com/bigquery/docs/slots>
- Shuffling data:
<https://cloud.google.com/blog/products/bigquery/in-memory-query-execution-in-google-bigquery>

DataFlow/Beam

- Getting started:
 - **Beam quickstarts:
<https://beam.apache.org/get-started/resources/learning-resources/#quickstart>
 - WordCount example: <https://beam.apache.org/get-started/wordcount-example/>
 - Beam tour: <https://tour.beam.apache.org/>
 - Dataflow documentation: <https://docs.cloud.google.com/dataflow/docs>
 - Pipeline lifecycle:
<https://docs.cloud.google.com/dataflow/docs/pipeline-lifecycle>
 - About overview: <https://docs.cloud.google.com/dataflow/docs/overview>
 - Apache Beam documentation: <https://beam.apache.org/documentation/>
 - Beam basics and terminology: <https://beam.apache.org/documentation/basics/>
- Coding/Developing and running Beam pipelines in Dataflow:
 - **Beam programming guide:
<https://beam.apache.org/documentation/programming-guide/>
 - Tips on developing and testing pipelines:
<https://docs.cloud.google.com/dataflow/docs/guides/develop-and-test-pipelines>
 - Unit-Testing your pipeline:
<https://beam.apache.org/documentation/pipelines/test-your-pipeline/>
 - Writing reusable transformations:
 - Beam Programming Guide:
<https://beam.apache.org/documentation/programming-guide/#composite-transforms>
 - PTransform Style Guide:
<https://beam.apache.org/contribute/ptransform-style-guide/>
 - Deploying a pipeline:
<https://docs.cloud.google.com/dataflow/docs/guides/deploying-a-pipeline>
 - DataFlow pipeline options:
<https://docs.cloud.google.com/dataflow/docs/reference/pipeline-options>
 - Setting example:
<https://docs.cloud.google.com/dataflow/docs/guides/setting-pipeline-options>
 - SDKs:
 - Java: <https://beam.apache.org/documentation/sdks/java/>
 - API docs: <https://beam.apache.org/releases/javadoc/>

- Python: <https://beam.apache.org/documentation/sdks/python/>
 - API docs: <https://beam.apache.org/releases/pydoc/>
- Dataflow quickstarts:
 - Java:
<https://cloud.google.com/dataflow/docs/quickstarts/create-pipeline-java>
 - Python:
<https://cloud.google.com/dataflow/docs/quickstarts/create-pipeline-python>
- Beam Transformations:
 - Java:
<https://beam.apache.org/documentation/transforms/java/overview/>
 - Python:
<https://beam.apache.org/documentation/transforms/python/overview/>
- **I/O connectors (sources and sinks):
<https://beam.apache.org/documentation/io/connectors/>
- Streaming with Pub/Sub:
<https://docs.cloud.google.com/dataflow/docs/concepts/streaming-with-cloud-pubsub>
- Working with BigQuery:
<https://beam.apache.org/documentation/io/built-in/google-bigquery/>
- Dataflow workbench (notebooks):
<https://docs.cloud.google.com/dataflow/docs/guides/interactive-pipeline-development>
- Dataflow snapshots:
<https://docs.cloud.google.com/dataflow/docs/guides/using-snapshots>
- Beam Dataframes (Python):
 - Overview:
<https://beam.apache.org/documentation/dsls/dataframes/overview/>
 - Examples:
https://github.com/apache/beam/tree/master/sdks/python/apache_beam/examples/dataframe
 - Differences from pandas:
<https://beam.apache.org/documentation/dsls/dataframes/differences-from-pandas/>
- Dataflow FlexRs: <https://docs.cloud.google.com/dataflow/docs/guides/flexrs>
- Dataflow prime (serverless)

- Dataflow Prime:
<https://docs.cloud.google.com/dataflow/docs/guides/enable-dataflow-prime>
- Right fitting:
<https://docs.cloud.google.com/dataflow/docs/guides/right-fitting>
- Resource hints:
<https://beam.apache.org/documentation/runtime/resource-hints/>
- Vertical autoscaling (mem):
<https://docs.cloud.google.com/dataflow/docs/vertical-autoscaling>
- Updating a pipeline:
<https://docs.cloud.google.com/dataflow/docs/guides/updating-a-pipeline>
- Dataflow ML:
<https://docs.cloud.google.com/dataflow/docs/machine-learning/ml-about>
- Nice example using BatchElements to batch interactions with an external API:
https://docs.cloud.google.com/dataflow/docs/notebooks/custom_remote_inference
- Creating your own I/O connector
 - Overview: <https://beam.apache.org/documentation/io/developing-io-overview/>
 - Creating Splittable DoFns:
<https://beam.apache.org/documentation/programming-guide/#sdf-basics>
 - Nice video workshop and code: <https://github.com/iht/splittable-dofns-python>
 - Workshop video: <https://youtu.be/VQdtaaWxNOY>
- Monitoring, testing, troubleshooting:
 - Pipeline testing:
<https://beam.apache.org/documentation/pipelines/test-your-pipeline/>
 - Using the monitoring interface:
<https://docs.cloud.google.com/dataflow/docs/guides/monitoring-overview>
 - Job Metrics:
<https://docs.cloud.google.com/dataflow/docs/guides/using-monitoring-intf>
 - Troubleshooting and debugging:
<https://docs.cloud.google.com/dataflow/docs/guides/troubleshooting-your-pipeline>
 - Common errors:
<https://docs.cloud.google.com/dataflow/docs/guides/common-errors>
 - Logging pipeline messages and working with logs:
<https://docs.cloud.google.com/dataflow/docs/guides/logging>

- Beam SQL in Dataflow:
 - Intro <https://cloud.google.com/dataflow/docs/guides/sql/dataflow-sql-intro>
 - Beam SQL overview:
<https://beam.apache.org/documentation/dsls/sql/overview/>
 - Windowing and triggering:
<https://beam.apache.org/documentation/dsls/sql/extensions/windowing-and-triggering/>
- Creating and using custom templates
 - Dataflow templates overview:
<https://docs.cloud.google.com/dataflow/docs/concepts/dataflow-templates>
 - Python example:
https://github.com/GoogleCloudPlatform/python-docs-samples/tree/main/dataflow/flex-templates/streaming_beam
 - Java example:
<https://github.com/GoogleCloudPlatform/java-docs-samples/tree/main/dataflow/flex-templates>
 - Classic templates:
<https://docs.cloud.google.com/dataflow/docs/guides/templates/creating-templates>
 - Google provided OSS templates:
<https://docs.cloud.google.com/dataflow/docs/guides/templates/provided-templates>
- Custom containers:
 - Using custom containers:
<https://docs.cloud.google.com/dataflow/docs/guides/using-custom-containers>
 - Beam guide on custom containers:
<https://beam.apache.org/documentation/runtime/environments/>
 - Base container images:
<https://hub.docker.com/search?q=apache%2Fbeam&type=image>
- Dataflow security and permissions:
 - Dataflow security and permissions:
<https://docs.cloud.google.com/dataflow/docs/concepts/security-and-permissions>
 - Access control with IAM | Cloud Dataflow:
<https://docs.cloud.google.com/dataflow/docs/concepts/access-control>
- Off worker data caching

- Dataflow Shuffle (batch):
<https://docs.cloud.google.com/dataflow/docs/shuffle-for-batch>
- Streaming engine:
<https://docs.cloud.google.com/dataflow/docs/streaming-engine>
- Fanouts in Beam:
<https://www.waitingforcode.com/apache-beam/fanouts-apache-beam-combine-transform/read>

Dataproc

- Managed Service for Apache Spark:
<https://cloud.google.com/dataproc/docs/concepts/overview>
- Managed Service for Apache Spark on GKE:
<https://cloud.google.com/dataproc/docs/guides/dpgke/dataproc-gke-overview>
- Managed Service for Apache Spark serverless:
<https://cloud.google.com/dataproc-serverless/docs/overview>
 - Nice quickstart demo:
<https://cloud.google.com/dataproc-serverless/docs/quickstarts/spark-batch>
 - Custom containers:
<https://cloud.google.com/dataproc-serverless/docs/guides/custom-containers>
- Nice graphic:
<https://github.com/priyankavergadia/GCPSketchnote/blob/main/images/Dataproc.jpg>
- Dataproc best practices:
<https://cloud.google.com/blog/topics/developers-practitioners/dataproc-best-practices-guide>
- Submit a job example: <https://cloud.google.com/dataproc/docs/guides/submit-job>
- Google Data Analytics blog posts: <https://cloud.google.com/blog/products/dataproc>
- Managed Service for Apache Spark components:
<https://cloud.google.com/dataproc/docs/concepts/components/overview>
- Initialization actions: <https://github.com/GoogleCloudDataproc/initialization-actions>
- Dataproc templates (archived):
<https://github.com/GoogleCloudPlatform/dataproc-templates/>
- Life of a Job: <https://cloud.google.com/dataproc/docs/concepts/jobs/life-of-a-job>
- Secondary workers and preemptible VMs:
<https://cloud.google.com/dataproc/docs/concepts/compute/secondary-vms>

- HDFS vs. Cloud Storage:
<https://cloud.google.com/blog/products/storage-data-transfer/hdfs-vs-cloud-storage-pros-cons-and-migration-tips>
- Improving Dataproc performance:
<https://cloud.google.com/blog/products/data-analytics/help-for-slow-hadoops-park-jobs-on-google-cloud-10-questions-to-ask-about-your-hadoop-and-spark-cluster-performance>
- Autoscaling clusters:
<https://cloud.google.com/dataproc/docs/concepts/configuring-clusters/autoscaling>
- Workflow templates:
<https://cloud.google.com/dataproc/docs/concepts/workflows/overview>

Data Fusion

- Data Fusion: <https://docs.cloud.google.com/data-fusion/docs>
- What is Data Fusion:
<https://docs.cloud.google.com/data-fusion/docs/concepts/overview>
- Nice Cloud Girl sketch:
<https://github.com/priyankavergadia/GCPsketchnote/blob/main/images/datafusion.jpg>
- Architecture and terminology:
<https://cloud.google.com/data-fusion/docs/concepts/architecture>
- Quickstart: <https://cloud.google.com/data-fusion/docs/quickstart>
- Overview: <https://cloud.google.com/data-fusion/docs/how-to>
- Editions and pricing: <https://cloud.google.com/data-fusion/pricing>
- Cask Data Application Platform info: <https://cdap.io/>
- CDAP GitHub repository: <https://github.com/cdapio>
- CDAP blog (Medium): <https://medium.com/cdapio>
- CDAP documentation: <https://cdap.atlassian.net/wiki/spaces/DOCS/overview>
- **CDAP user guides: <https://cdap.atlassian.net/wiki/spaces/DOCS/pages/614891521/>
- Data pipeline user guide:
<https://cdap.atlassian.net/wiki/spaces/DOCS/pages/517406816/>
- **Wrangler user guide: <https://cdap.atlassian.net/wiki/spaces/DOCS/pages/515211781>
- Plugins (connectors): <https://cloud.google.com/data-fusion/plugins>
- Using Sensitive Data Protection with Data Fusion:
<https://docs.cloud.google.com/data-fusion/docs/how-to/using-dlp>

- Wrangler command line:
<https://cdap.atlassian.net/wiki/spaces/DOCS/pages/379748488>
- Performance tuning: <https://cdap.atlassian.net/wiki/spaces/DOCS/pages/818511873/>
- Working with logs:
 - Cloud Data Fusion audit logging:
<https://docs.cloud.google.com/data-fusion/docs/how-to/audit-logging>
 - View advanced pipeline logs in Cloud Logging:
<https://docs.cloud.google.com/data-fusion/docs/how-to/viewing-stackdriver-logs>

Dataplex

- Intro:
<https://cloud.google.com/blog/products/data-analytics/introducing-google-cloud-dataplex>
- Knowledge Catalog overview:
<https://docs.cloud.google.com/dataplex/docs/introduction>
- Overview: <https://cloud.google.com/dataplex/docs/guides>
- Overview: <https://cloud.google.com/dataplex/docs/quickstart-guide>
- Data profiling: <https://docs.cloud.google.com/dataplex/docs/data-profiling-overview>
- Auto data quality:
<https://docs.cloud.google.com/dataplex/docs/auto-data-quality-overview>

Datastream

- Overview: <https://docs.cloud.google.com/datastream/docs/overview>
- Quickstart:
<https://docs.cloud.google.com/datastream/docs/quickstart-replication-to-bigquery>
- Sources: <https://docs.cloud.google.com/datastream/docs/sources>
- Destinations: <https://docs.cloud.google.com/datastream/docs/destinations>
- Unified types: <https://docs.cloud.google.com/datastream/docs/unified-types>

Managed Airflow (formerly Cloud Composer)

- What is Airflow? <https://airflow.apache.org/docs/apache-airflow/stable/index.html>
- Airflow on GitHub: <https://github.com/apache/airflow>
- Architecture overview:
<https://airflow.apache.org/docs/apache-airflow/stable/core-concepts/overview.html>

- Airflow concepts:
<https://airflow.apache.org/docs/apache-airflow/stable/core-concepts/index.html>
- What is Managed Airflow: <https://cloud.google.com/composer/docs/concepts/overview>
- Managed Airflow versions:
<https://docs.cloud.google.com/composer/docs/composer-versioning-overview>
- Run an example DAG in Managed Airflow:
<https://cloud.google.com/composer/docs/run-apache-airflow-dag>
- Creating a Managed Airflow environment:
<https://cloud.google.com/composer/docs/how-to/managing/creating>
- Writing DAGs: <https://docs.cloud.google.com/composer/docs/composer-3/write-dags>
- Test DAGs: <https://docs.cloud.google.com/composer/docs/composer-3/test-dags>
- Managed Airflow local development CLI:
<https://docs.cloud.google.com/composer/docs/composer-3/run-local-airflow-environments>
- Troubleshooting DAGs:
<https://docs.cloud.google.com/composer/docs/composer-3/troubleshooting-dags>
- Airflow tutorials: <https://airflow.apache.org/docs/apache-airflow/stable/tutorial/>
- Airflow documentation home: <https://airflow.apache.org/docs/>
- Airflow template (Jinja) reference:
<https://airflow.apache.org/docs/apache-airflow/stable/templates-ref.html>
- Airflow Google providers:
<https://airflow.apache.org/docs/apache-airflow-providers-google/stable/index.html>
- Airflow operators for Google products:
<https://airflow.apache.org/docs/apache-airflow-providers-google/stable/operators/index.html>
- GCP transfer operators:
<https://airflow.apache.org/docs/apache-airflow-providers-google/stable/operators/transfer/index.html>
- Airflow Examples:
<https://github.com/GoogleCloudPlatform/python-docs-samples/tree/main/composer>
- Managing Airflow Connections:
<https://cloud.google.com/composer/docs/how-to/managing/connections>
- Cleaning up the Airflow database:
<https://docs.cloud.google.com/composer/docs/composer-3/cleanup-airflow-database>
- Optimizing Managed Airflow for scaling and cost:
<https://docs.cloud.google.com/composer/docs/composer-3/optimize-environments>

- CI/CD and Github:
<https://docs.cloud.google.com/composer/docs/composer-3/dag-cicd-github>

Pub/Sub

- Pub/Sub documentation home page: <https://docs.cloud.google.com/pubsub/docs>
- Pub/Sub graphic:
<https://github.com/priyankavergadia/GCPSketchnote/blob/main/images/pubsub.jpg>
- Subscriber info: <https://docs.cloud.google.com/pubsub/docs/subscriber>
- Schemas: <https://docs.cloud.google.com/pubsub/docs/schemas>
- Single Message Transforms (SMTs):
<https://docs.cloud.google.com/pubsub/docs/smts/smts-overview>
- Subscriber message filtering: <https://cloud.google.com/pubsub/docs/filtering>
- Exactly once messages:
<https://docs.cloud.google.com/pubsub/docs/exactly-once-delivery>
- Message ordering: <https://docs.cloud.google.com/pubsub/docs/ordering>
- Local emulator: <https://docs.cloud.google.com/pubsub/docs/emulator>
- Performance testing:
<https://cloud.google.com/blog/products/data-analytics/testing-cloud-pubsub-clients-to-maximize-streaming-performance>
- Monitoring:
 - Monitor Pub/Sub in Cloud Monitoring:
<https://docs.cloud.google.com/pubsub/docs/monitoring>
 - Google Cloud metrics overview | Cloud Monitoring:
https://docs.cloud.google.com/monitoring/api/metrics_gcp#gcp-pubsub
- Message Replay: <https://docs.cloud.google.com/pubsub/docs/replay-overview>

Cloud Storage

- Google Cloud Storage: <https://docs.cloud.google.com/storage/docs/introduction>
- Nice graphic:
<https://github.com/priyankavergadia/GCPSketchnote/blob/main/images/GCS.png>
- Best practices: <https://docs.cloud.google.com/storage/docs/best-practices>
- Using versioning: <https://docs.cloud.google.com/storage/docs/using-object-versioning>
- Retention policies and locks:
<https://docs.cloud.google.com/storage/docs/using-bucket-lock>
- Object lifecycle management: <https://docs.cloud.google.com/storage/docs/lifecycle>

- Access control: <https://docs.cloud.google.com/storage/docs/access-control>
- Encryption options: <https://docs.cloud.google.com/storage/docs/encryption>
- Storage Transfer Service Docs: <https://cloud.google.com/storage-transfer/docs>
- On-prem transfer service:
<https://cloud.google.com/storage-transfer/docs/on-prem-overview>
- CDN caching overview:
 - Setup: <https://docs.cloud.google.com/cdn/docs/using-cdn>
 - Details: <https://docs.cloud.google.com/cdn/docs/caching>
- Cloud CDN: <https://docs.cloud.google.com/cdn/docs>
- gsutil docs (legacy — superseded by gcloud storage):
<https://docs.cloud.google.com/storage/docs/gsutil>
- Info on gcloud storage
 - New gcloud storage CLI for your data transfers:
<https://cloud.google.com/blog/products/storage-data-transfer/new-gcloud-storage-cli-for-your-data-transfers>
 - gcloud storage: <https://docs.cloud.google.com/sdk/gcloud/reference/storage>
- Host website out of cloud storage:
<https://docs.cloud.google.com/storage/docs/hosting-static-website>
- Autoclass: <https://docs.cloud.google.com/storage/docs/autoclass>
- Managed folders (folder level permissions):
<https://docs.cloud.google.com/storage/docs/managed-folders>

DataPrep

- BigQuery data preparation overview:
<https://docs.cloud.google.com/bigquery/docs/data-prep-introduction>

Business intelligence, AI and ML

Looker

Looker essentials

- Looker (BI): <https://cloud.google.com/looker>
- Looker documentation home: <https://docs.cloud.google.com/looker/docs>
- Looker Community (forums):
<https://www.googlecloudcommunity.com/gc/Looker/ct-p/looker>

- **Best Practices: <https://docs.cloud.google.com/looker/docs/best-practices/home>
- **Exploring data: <https://cloud.google.com/looker/docs/exploring-data>
- **Filtering data:
 - Filtering and limiting data | Looker:
<https://docs.cloud.google.com/looker/docs/filtering-and-limiting>
 - Looker filter expressions:
<https://docs.cloud.google.com/looker/docs/filter-expressions>
- Create and edit dashboards and Looks:
<https://docs.cloud.google.com/looker/docs/dashboards-and-looks-intro>
- **Creating visualizations:
<https://docs.cloud.google.com/looker/docs/creating-visualizations>
- **Visualization types: <https://docs.cloud.google.com/looker/docs/visualization-types>
- Looker glossary: <https://docs.cloud.google.com/looker/docs/glossary>
- Keyboard shortcuts: <https://docs.cloud.google.com/looker/docs/keyboard-shortcuts>
- **Looker/LookML terms and concepts:
<https://docs.cloud.google.com/looker/docs/lookml-terms-and-concepts>
- Retrieving and charting data (good high-level set of other links):
<https://docs.cloud.google.com/looker/docs/retrieve-and-chart-data>
- Delivering Looks and Explorers:
<https://docs.cloud.google.com/looker/docs/delivering-looks-explores>
- **Creating custom fields (using the UI):
<https://docs.cloud.google.com/looker/docs/custom-fields>
- **Using table calculations:
<https://docs.cloud.google.com/looker/docs/table-calculations>
- **Looker expressions (table calculations, tests, custom fields and filters):
<https://docs.cloud.google.com/looker/docs/creating-looker-expressions>
- **Looker functions and operators:
<https://docs.cloud.google.com/looker/docs/functions-and-operators>
 - Calculating percent of previous and percent change with table calculations:
<https://docs.cloud.google.com/looker/docs/best-practices/how-to-calculate-percent-change-percent-previous>
 - Moving averages:
<https://community.looker.com/technical-tips-tricks-1021/calculating-moving-averages-30817>
- Working with dashboards:
<https://docs.cloud.google.com/looker/docs/viewing-dashboards>

- Visualizing data effectively:
<https://docs.cloud.google.com/looker/docs/visualization-guide>
- Boards: <https://docs.cloud.google.com/looker/docs/presenting-content>
- Scheduling and sending dashboards:
<https://docs.cloud.google.com/looker/docs/scheduling-and-sending-dashboards>
- Organizing and securing content (folders, permissions):
<https://docs.cloud.google.com/looker/docs/organizing-spaces>
- Creating and using alerts: <https://docs.cloud.google.com/looker/docs/alerts-overview>

LookML

- LookML reference overview:
<https://docs.cloud.google.com/looker/docs/reference/lookml-quick-reference>
- LookML development basics:
 - Know before you start writing LookML (page of links):
<https://docs.cloud.google.com/looker/docs/data-modeling>
 - ** Intro to LookML (page of links):
<https://docs.cloud.google.com/looker/docs/write-lookml-intro>
 - Looker/LookML terms and concepts:
<https://docs.cloud.google.com/looker/docs/lookml-terms-and-concepts>
 - **What is Looker Modeling Language (LookML):
<https://docs.cloud.google.com/looker/docs/what-is-lookml>
 - Validating LookML:
<https://docs.cloud.google.com/looker/docs/lookml-validation>
 - Project file types:
<https://docs.cloud.google.com/looker/docs/lookml-project-files>
 - Managing LookML files and folders:
<https://docs.cloud.google.com/looker/docs/creating-project-files>
 - Best Practices: <https://docs.cloud.google.com/looker/docs/best-practices/home>
- Field types:
<https://docs.cloud.google.com/looker/docs/reference/param-dimension-filter-parameter-types>
- Generating initial Model files from the database:
<https://docs.cloud.google.com/looker/docs/generating-a-model>
- Using SQL in LookML objects:
<https://docs.cloud.google.com/looker/docs/sql-and-referring-to-lookml>

- How Looker generates SQL:
<https://docs.cloud.google.com/looker/docs/how-looker-generates-sql>
- How Looker does joins: <https://docs.cloud.google.com/looker/docs/working-with-joins>
- Modular LookML
 - LAMS Style Guide:
<https://looker-open-source.github.io/look-at-me-sideways/rules.html>
 - Why and how to create modular LookML (blog post):
<https://cloud.google.com/blog/products/data-analytics/create-modular-lookml-models>
 - Reusing code with extends:
<https://docs.cloud.google.com/looker/docs/reusing-code-with-extends>
 - Extending Explores:
<https://docs.cloud.google.com/looker/docs/reference/param-explore-extends>
 - Extending views:
<https://docs.cloud.google.com/looker/docs/reference/param-view-extends>
 - Refinements: <https://docs.cloud.google.com/looker/docs/lookml-refinements>
 - Importing from another project:
<https://docs.cloud.google.com/looker/docs/importing-projects>
- Understanding symmetric aggregates:
<https://docs.cloud.google.com/looker/docs/best-practices/understanding-symmetric-aggregates>
- **Derived tables: <https://docs.cloud.google.com/looker/docs/derived-tables>
 - explore_source:
<https://docs.cloud.google.com/looker/docs/reference/param-view-explore-source>
 - Creating native derived tables:
<https://docs.cloud.google.com/looker/docs/creating-ndts>
 - Incremental PDTs: <https://docs.cloud.google.com/looker/docs/incremental-pdts>
 - Aggregate awareness / aggregate tables:
 - Aggregate awareness | Looker:
https://docs.cloud.google.com/looker/docs/aggregate_awareness
 - Tutorial:
<https://docs.cloud.google.com/looker/docs/best-practices/aggregate-awareness-tutorial>
- Looker Git integration, version control, and deploying changes:
<https://docs.cloud.google.com/looker/docs/version-control-and-deploying-changes>

- Multi-stage development options:
 - <https://www.googlecloudcommunity.com/gc/Technical-Tips-Tricks/Looker-Multistage-Development-Framework-Dev-gt-QA-gt-Prod/ta-p/587798>
 - Moving Looker objects (Looks, dashboards, boards, and connections):
https://github.com/looker-open-source/looker_deployer
- LookML validators/linters:
 - Spectacles: <https://github.com/spectacles-ci/spectacles>
 - Look At Me Sideways (LAMS):
<https://github.com/looker-open-source/look-at-me-sideways>
- Optimizing performance
 - Looker performance:
<https://docs.cloud.google.com/looker/docs/best-practices/how-to-optimize-looker-server-performance>
 - Hitchhiker's guide to performance:
<https://community.looker.com/sql-10/a-hitchhiker-s-guide-to-query-performance-in-looker-25586>
 - Dashboard performance:
<https://docs.cloud.google.com/looker/docs/best-practices/considerations-when-building-performant-dashboards>
- Working with BigQuery nested repeated structures:
<https://docs.cloud.google.com/looker/docs/best-practices/how-to-model-nested-bigquery-data-in-looker>
- Writing LookML best practices:
<https://docs.cloud.google.com/looker/docs/best-practices/how-to-write-sustainable-maintainable-lookml>
- LookML dashboards:
 - Overview (several helpful links):
<https://docs.cloud.google.com/looker/docs/reference/lookml-dashboard-overview>
 - Building:
<https://docs.cloud.google.com/looker/docs/building-lookml-dashboards>
 - User defined vs LookML dashboards:
<https://docs.cloud.google.com/looker/docs/types-of-dashboards>
- Liquid:
 - **Liquid in LookML syntax reference:
<https://docs.cloud.google.com/looker/docs/liquid-variable-reference>

- Templated filters and Liquid parameters:
<https://docs.cloud.google.com/looker/docs/templated-filters>
- **Liquid templating language (101 level general reference):
<https://shopify.github.io/liquid/>
- **Liquid guide: <https://github.com/Shopify/liquid/wiki/Liquid-for-Designers>
- Dynamic descriptions (via lookup) with liquid variables:
https://docs.cloud.google.com/looker/docs/liquid-variable-reference#usage_of_liquid_variables_with_the_description_parameter
- Easy date formatting with Liquid:
<https://docs.cloud.google.com/looker/docs/best-practices/how-to-use-liquid-to-format-dates>
- Internationalization (model localization):
<https://docs.cloud.google.com/looker/docs/model-localization>
- Changing the Explore menu and field picker:
<https://docs.cloud.google.com/looker/docs/changing-explore-menu-and-field-picker>
- Errors and troubleshooting:
 - Error catalog: <https://docs.cloud.google.com/looker/docs/error-catalog>
 - Some nice examples, start here (see other options in left menu):
<https://docs.cloud.google.com/looker/docs/best-practices/how-to-change-the-model-or-explore-of-a-look>
- Content validation: <https://docs.cloud.google.com/looker/docs/content-validation>
- Looker tests
 - test | Looker:
<https://docs.cloud.google.com/looker/docs/reference/param-model-test>
 - Testing best practices:
<https://community.looker.com/lookml-5/lookml-data-tests-recommendations-and-best-practices-20815>
- Looker API: <https://docs.cloud.google.com/looker/docs/api-getting-started>
 - Client SDK: <https://docs.cloud.google.com/looker/docs/api-sdk>
 - Reference: <https://developers.looker.com/api/explorer/4.0?sdk=ts>
- Embedding Looker in web pages:
 - Best practices:
<https://docs.cloud.google.com/looker/docs/security-best-practices-embedded-analytics>
 - Signed embedding and URL parameters:
<https://cloud.google.com/looker/docs/single-sign-on-embedding>

- Embedded SDK (intro, demo, reference):
<https://docs.cloud.google.com/looker/docs/embed-sdk>
- Creating and applying themes:
<https://docs.cloud.google.com/looker/docs/themes-for-embedded-dashboards-and-explores>
- Creating a positive user experience:
<https://docs.cloud.google.com/looker/docs/best-practices/how-to-create-a-positive-experience-for-looker-users>
- LookML do's and don'ts:
<https://docs.cloud.google.com/looker/docs/best-practices/best-practices-lookml-dos-and-donts>

Looker Admin

- **Setup and administer Looker (page of links):
<https://docs.cloud.google.com/looker/docs/set-up-and-administer-looker>
- Setting up and testing Git connection:
<https://docs.cloud.google.com/looker/docs/setting-up-git-connection>
- Looker database dialects and connection instructions:
<https://docs.cloud.google.com/looker/docs/dialects>
 - List of database configurations:
https://docs.cloud.google.com/looker/docs/dialects#database_configuration_instructions
 - Connecting Looker to your DB:
<https://docs.cloud.google.com/looker/docs/connecting-to-your-db>
 - BigQuery: <https://docs.cloud.google.com/looker/docs/db-config-google-bigquery>
 - Cloud SQL:
<https://docs.cloud.google.com/looker/docs/db-config-google-cloud-sql>
 - With Cloud SQL don't allowlist the IP, use the Cloud SQL Proxy and access via SSH: <https://docs.cloud.google.com/looker/docs/using-an-ssh-tunnel>
 - Spanner: <https://docs.cloud.google.com/looker/docs/db-config-cloud-spanner>
- Connecting to Google Sheets:
<https://docs.cloud.google.com/looker/docs/connected-sheets>
- Access control and permissions management:
 - Authentication configurations:
<https://docs.cloud.google.com/looker/docs/admin-panel-authentication-pages>

- Permissions management:
<https://docs.cloud.google.com/looker/docs/access-control-and-permission-management>
- Roles, permission sets, model sets:
<https://docs.cloud.google.com/looker/docs/admin-panel-users-roles>
- User attributes:
<https://docs.cloud.google.com/looker/docs/admin-panel-users-user-attributes>
- System activity, Explores and pre-created dashboards:
<https://docs.cloud.google.com/looker/docs/system-activity-pages>

Looker Studio

- Looker Studio: <https://lookerstudio.google.com/>
- About Looker Studio (BI): <https://cloud.google.com/looker-studio?hl=en>
- About Looker Studio Pro: <https://support.google.com/looker-studio/answer/13715508>
- Looker Studio documentation: <https://support.google.com/looker-studio>
- Looker Studio quick start guide:
<https://cloud.google.com/looker/docs/studio/find-your-way-around-looker-studio>
- How to use Looker Studio (guide overview):
<https://docs.cloud.google.com/looker/docs/studio/about-the-how-to-guide>
- Welcome to Looker Studio: <https://cloud.google.com/looker/docs/studio>
- Report tutorials: <https://cloud.google.com/looker/docs/studio/tutorial-report-intro>
- Visualizing BigQuery data with Looker Studio:
<https://docs.cloud.google.com/bigquery/docs/visualize-looker-studio>
- Chart type reference: <https://support.google.com/looker-studio/topic/7059081>
- Creating custom visualization:
 - Lab:
<https://codelabs.developers.google.com/codelabs/community-visualization#0>
 - Docs: <https://developers.google.com/looker-studio/visualization>
- Forums:
<https://www.googlecloudcommunity.com/gc/Looker-Studio/bd-p/looker-studio-pro>
- About data sources: <https://cloud.google.com/looker/docs/studio/about-data-sources>
- Extracted datasources for better performance:
<https://cloud.google.com/looker/docs/studio/extract-data-for-faster-performance>
- Blending Datasources:
<https://cloud.google.com/looker/docs/studio/how-blends-work-in-looker-studio>

- Calculated fields: <https://cloud.google.com/looker/docs/studio/about-calculated-fields>
- Functions:
 - List: <https://support.google.com/looker-studio/table/6379764>
 - Reference: <https://support.google.com/looker-studio/topic/7019880>
- Working with parameters: <https://cloud.google.com/looker/docs/studio/parameters>
- Looker vs Looker Studio: <https://docs.cloud.google.com/looker/docs>
- Looker Studio API: <https://developers.google.com/looker-studio/integrate/api>
- Linking API: <https://developers.google.com/looker-studio/integrate/linking-api>
- Dashboard performance:
<https://cloud.google.com/looker/docs/studio/improve-looker-studio-performance>
- Adding drilldowns to charts:
<https://cloud.google.com/looker/docs/studio/add-drill-actions-to-charts>

Machine Learning / AI / Gemini Enterprise (formerly Vertex AI)

Start here - what changed in 2026, and the fundamentals

- Orientation. Vertex AI was renamed Gemini Enterprise Agent Platform on 22 Apr 2026; the services did not go away. Read the name-changes page first.
- Vertex AI to Agent Platform: the official name-change map:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/vertex-ai-name-changes>
- Announcing Gemini Enterprise Agent Platform (22 Apr 2026):
<https://cloud.google.com/blog/products/ai-machine-learning/introducing-gemini-enterprise-agent-platform>
- Intro to Gemini Enterprise Agent Platform (formerly Vertex AI):
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/overview>
- Agent Platform release notes:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/release-notes>
- Google Cloud AI and ML products: <https://cloud.google.com/products/ai>
- All Google Cloud products: <https://cloud.google.com/products/>
- Machine Learning Crash Course (Google):
<https://developers.google.com/machine-learning/crash-course>
- ML Glossary: <https://developers.google.com/machine-learning/glossary>
- Understanding Neural Networks (video): <https://youtu.be/aircAruvnKk>
- Cool ML example, the Teachable Machine: <https://teachablemachine.withgoogle.com/>
- Kaggle Learn: hands-on ML tutorials: <https://www.kaggle.com/learn>

- Introduction to Generative AI (video):
<https://www.youtube.com/watch?v=G2fqAlgmoPo>
- ROI of GenAI (PDF):
https://services.google.com/fh/files/misc/the_roi_of_generative_ai.pdf

Notebooks - Colab Enterprise and Agent Platform Workbench

- The two ways to run a notebook on the platform. Colab Enterprise for collaboration and zero infra; Workbench for custom environments and scheduling.
- Notebooks overview - the two ways to run them:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/notebooks/overview>
- Choose a notebook solution: Colab Enterprise vs Workbench:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/notebooks/workbench/notebook-solution>
- Colab Enterprise quickstart:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/notebooks/colab/create-console-quickstart>
- Introduction to Agent Platform Workbench (formerly Vertex AI Workbench):
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/notebooks/workbench/introduction>
- Agent Platform notebook tutorials:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/tutorials/jupyter-notebooks>

Models - finding and understanding them

- Model Garden and the model catalogue, plus the transformer/LLM theory you need to read a model card.
- Models and Model Garden index:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/models>
- Explore models in Model Garden:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/model-garden/explore-models>
- Google Gen AI SDK overview (Python, Go, Java, Node.js, C#):
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/sdks/overview>
- Available generative AI models:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/available-models>

- Generative AI beginner's guide: <https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/introduction>
- Overview of models on Agent Platform: <https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/overview>
- Gemini API model reference: <https://docs.cloud.google.com/gemini-enterprise-agent-platform/reference/models/gemini>
- Quickstart: try the Gemini API: <https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/quickstart-multimodal>
- Gemini API docs (Google AI for Developers - the non-Cloud path): <https://ai.google.dev/docs>
- Gemini API example code (Google AI for Developers): <https://ai.google.dev/examples?keywords=googleai>
- Cloud Natural Language API (legacy pre-trained API): <https://cloud.google.com/natural-language>
- Cloud Natural Language: how-to guides: <https://docs.cloud.google.com/natural-language/docs/how-to>
- Cloud Natural Language: content category taxonomy: <https://docs.cloud.google.com/natural-language/docs/categories>
- Intro to LLMs: <https://developers.google.com/machine-learning/resources/intro-llms>
- Attention Is All You Need - the original transformer paper (PDF): <https://arxiv.org/pdf/1706.03762.pdf>
- Transformers, an illustrated guide: <https://jalammar.github.io/illustrated-transformer/>
- Transformer Explainer (interactive): <https://poloclub.github.io/transformer-explainer/>
- Visual view of Generative AI transformers (FT): <https://ig.ft.com/generative-ai/>
- Example tokenizer (OpenAI): <https://platform.openai.com/tokenizer>
- Token Visualizer: <https://token3d.netlify.app/>
- Understanding temperature: <https://docs.cohere.com/docs/temperature>
- Understanding Top-k, Top-p: <https://docs.cohere.com/docs/controlling-generation-with-top-k-top-p>

Models - customizing them: prompting, tuning, grounding and RAG

- Everything between 'pick a model' and 'train your own': prompting, fine-tuning, grounding, RAG and vector search.

- Agent Studio - prompt design and model comparison workspace:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/agent-studio>
- Overview of prompting strategies:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/prompts/prompt-design-strategies>
- Introduction to prompt design:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/prompts/introduction-prompt-design>
- Generative AI cookbook (Gen AI SDK recipes):
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/cookbook>
- Prompt engineering, overview and guide:
<https://cloud.google.com/discover/what-is-prompt-engineering>
- Prompt engineering techniques: <https://www.promptingguide.ai/>
- Fine tuning and model tuning:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/tune-models>
- Function calling:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/function-calling>
- Codelab on function calling:
<https://codelabs.developers.google.com/codelabs/how-to-cloud-run-gemini-function-calling?hl=en#0>
- Nice function calling example (Java):
<https://glaforge.dev/posts/2023/12/22/gemini-function-calling/>
- Grounding overview:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/grounding/overview>
- RAG Engine overview:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/build/rag-engine/rag-overview>
- Vector Search overview:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/vector-search/overview>
- Vector Search quickstart:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/vector-search/quickstart>

- BigQuery vector search tutorial:
<https://docs.cloud.google.com/bigquery/docs/vector-search>
- BigQuery semantic search and RAG tutorial:
<https://docs.cloud.google.com/bigquery/docs/vector-index-text-search-tutorial>
- Understanding vector text embeddings:
<https://cloud.google.com/blog/topics/developers-practitioners/meet-ais-multitool-vector-embeddings>
- Generative AI on Google Cloud: sample code (GitHub):
<https://github.com/GoogleCloudPlatform/generative-ai>

Models - building your own: training, AutoML and pipelines

- Custom training, AutoML, hyperparameter tuning and MLOps. AutoML, NAS and Vizier are all still supported under the new name.
- Vertex AI SDK migration guide - GenAI modules removed 24 Jun 2026:
<https://docs.cloud.google.com/vertex-ai/generative-ai/docs/deprecations/genai-vertexai-sdk>
- Training overview: AutoML, custom training, Ray:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/training-overview>
- AutoML beginner's guide:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/beginners-guide>
- Prebuilt training containers:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/training/pre-built-containers>
- Custom training containers:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/training/create-custom-container>
- Hyperparameter tuning overview:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/training/hyperparameter-tuning-overview>
- Vizier - black-box hyperparameter optimization:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/vizier/overview>

- Neural Architecture Search:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/training/neural-architecture-search/overview>
- Agent Platform Pipelines:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/pipelines/introduction>
- Build a pipeline (KFP SDK v2):
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/pipelines/build-pipeline>
- BigQuery ML: introduction:
<https://docs.cloud.google.com/bigquery/docs/bqml-introduction>
- BigQuery ML logistic regression tutorial:
<https://docs.cloud.google.com/bigquery/docs/logistic-regression-prediction>
- Choosing the right ML approach for your application:
<https://cloud.google.com/blog/products/ai-machine-learning/get-the-right-ml-model-for-your-application>
- Agent Platform tutorials:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/tutorials>
- Agent Platform notebook samples (GitHub, still named vertex-ai-samples):
<https://github.com/GoogleCloudPlatform/vertex-ai-samples>
- Using the Agent Platform SDK for Python:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/machine-learning/python-sdk/use-vertex-ai-python-sdk>
- google-cloud-aiplatform client library reference (platform/MLOps only - not GenAI):
<https://docs.cloud.google.com/python/docs/reference/aiplatform/latest/google.cloud.aiplatform>
- google-cloud-aiplatform on GitHub (GenAI modules removed 24 Jun 2026 - use google-genai): <https://github.com/googleapis/python-aiplatform/>
- Rules of ML: <https://developers.google.com/machine-learning/guides/rules-of-ml>
- Precision vs. Recall:
<https://developers.google.com/machine-learning/crash-course/classification/precision-and-recall>
- 11 model evaluation and error metrics:
<https://www.analyticsvidhya.com/blog/2019/08/11-important-model-evaluation-error-metrics/>

- A tour of ML algorithms: <https://machinelearningmastery.com/a-tour-of-machine-learning-algorithms/>
- ML Cheat Sheet: <https://ml-cheatsheet.readthedocs.io/en/latest/index.html>
- TensorFlow tutorials: <https://www.tensorflow.org/tutorials>
- GCP and Bioinformatics: <https://github.com/lynnlangit/gcp-for-bioinformatics>

Agents - building them: ADK, Agent Studio and A2A

- The Build pillar of the console. ADK is the code-first path, Agent Studio the low-code path, A2A the interop standard.
- Agents overview - Build, Scale, Govern, Optimize: <https://docs.cloud.google.com/gemini-enterprise-agent-platform/agents>
- Agent Development Kit on Agent Platform: <https://docs.cloud.google.com/gemini-enterprise-agent-platform/build/adk>
- ADK documentation home (adk.dev, ADK 2.0): <https://adk.dev/>
- ADK get started - Python, TypeScript, Go, Java, Kotlin: <https://adk.dev/get-started/>
- adk-python on GitHub: <https://github.com/google/adk-python>
- Agent Garden - prebuilt agent templates: <https://docs.cloud.google.com/gemini-enterprise-agent-platform/build/agent-garden>
- Design agents in Agent Studio (low-code): <https://docs.cloud.google.com/gemini-enterprise-agent-platform/agent-studio/design-agents>
- Agent2Agent (A2A) protocol docs - Linux Foundation, spec v1.0: <https://a2a-protocol.org/latest/>
- What is A2A?: <https://a2a-protocol.org/latest/topics/what-is-a2a/>
- Create an A2A agent on Agent Runtime: <https://docs.cloud.google.com/gemini-enterprise-agent-platform/build/runtime/create-an-a2a-agent>
- Skill Registry - tools and connectors for agents: <https://docs.cloud.google.com/gemini-enterprise-agent-platform/build/skill-registry>
- Agent Platform code samples and tutorials (GitHub): <https://github.com/Google-Cloud-AI/agent-platform>
- Generative vs deterministic (Conversational Agents / Dialogflow CX): <https://docs.cloud.google.com/dialogflow/cx/docs/generative-deterministic>
- Build using flows (Conversational Agents / Dialogflow CX): <https://docs.cloud.google.com/dialogflow/cx/docs/quick/build-agent>

- Build using playbooks (Conversational Agents / Dialogflow CX):
<https://docs.cloud.google.com/dialogflow/cx/docs/quick/build-agent-playbook>
- Data stores in Conversational Agents (Dialogflow CX):
<https://docs.cloud.google.com/generative-ai-app-builder/docs/agent-data-store>

Agents - running and scaling them: Agent Runtime, sessions and memory

- The Scale pillar. Agent Runtime is the managed deployment target formerly called Vertex AI Agent Engine.
- Scale your agents - pillar overview:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/scale>
- Agent Runtime (formerly Vertex AI Agent Engine):
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/build/runtime>
- Quickstart: deploy an ADK agent to Agent Runtime:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/build/runtime/quickstart-adk>
- Sessions - conversation state:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/scale/sessions>
- Memory Bank - long-term agent memory:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/scale/memory-bank>

Agents - governing and evaluating them

- The Govern and Optimize pillars: registry, identity, gateway, evaluation and observability.
- Govern your agents - pillar overview:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/govern>
- Agent Registry - catalogue of agents, tools and MCP servers:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/govern/agent-registry>
- Agent Identity (SPIFFE-based):
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/govern/agent-identity-overview>
- Agent Gateway - securing agent connectivity:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/govern/gateways/agent-gateway-overview>
- Agent evaluation:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/optimize/evaluation/agent-evaluation>

- Agent observability - metrics, traces, logs:
<https://docs.cloud.google.com/gemini-enterprise-agent-platform/optimize/observability/overview>
- LLM evaluation metrics explained:
<https://www.confident-ai.com/blog/llm-evaluation-metrics-everything-you-need-for-llm-evaluation>

Gemini Enterprise and Agent Search (the knowledge-worker side)

- The other product called Gemini Enterprise: the intranet search / AI assistant app, formerly Agentspace. Agent Search is the search engine underneath.
- Introduction to Gemini Enterprise:
<https://docs.cloud.google.com/gemini/enterprise/docs>
- Gemini Enterprise quickstart:
<https://docs.cloud.google.com/gemini/enterprise/docs/quickstart-gemini-enterprise>
- Gemini Enterprise editions and pricing tiers:
<https://docs.cloud.google.com/gemini/enterprise/docs/editions>
- Gemini Notebook Enterprise (formerly NotebookLM Enterprise):
<https://docs.cloud.google.com/gemini/enterprise/notebooklm-enterprise/docs/overview>
- What is Agent Search: <https://docs.cloud.google.com/generative-ai-app-builder/docs>
- Getting started with Agent Search:
<https://docs.cloud.google.com/generative-ai-app-builder/docs/try-enterprise-search>
- About apps and data stores (Agent Search):
<https://docs.cloud.google.com/generative-ai-app-builder/docs/create-datastore-ingest>
- About user events (Agent Search):
<https://docs.cloud.google.com/generative-ai-app-builder/docs/user-events>
- Record real-time user events:
<https://docs.cloud.google.com/generative-ai-app-builder/docs/record-user-events>
- Import historical user events:
<https://docs.cloud.google.com/generative-ai-app-builder/docs/import-user-events>
- Agent Search quotas and limits:
<https://docs.cloud.google.com/generative-ai-app-builder/quotas>

Responsible AI, safety and data protection

- Principles, safety filters, Model Armor and Sensitive Data Protection.
- Google's AI Principles: <https://ai.google/responsibility/principles/>

- Responsible AI on Google Cloud: <https://cloud.google.com/responsible-ai>
- Responsible AI for generative AI: safety filters and model limits: <https://docs.cloud.google.com/gemini-enterprise-agent-platform/models/responsible-ai>
- Responsible AI with TensorFlow: https://www.tensorflow.org/responsible_ai
- NIST SP 1270: managing bias in AI (PDF): <https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1270.pdf>
- Model Armor overview: <https://docs.cloud.google.com/security-command-center/docs/model-armor-overview>
- Sensitive Data Protection documentation: <https://docs.cloud.google.com/sensitive-data-protection/docs>
- De-identifying with Sensitive Data Protection: <https://docs.cloud.google.com/dlp/docs/deidentify-sensitive-data>
- Auto-scan a bucket with Sensitive Data Protection, send results to Security Command Center: <https://docs.cloud.google.com/dlp/docs/sending-results-to-scc>

Gemini for Google Workspace

- End-user Gemini in Docs, Sheets, Gmail. Different SKU from everything above.
- Gemini in Google Workspace: <https://workspace.google.com/solutions/ai/>
- Gemini for Workspace handbook (PDF): https://services.google.com/fh/files/misc/gws_gemini_handbook.pdf
- Gemini for Workspace cheat sheet: <https://support.google.com/a/users/answer/14143478>
- Prompting 101: <https://workspace.google.com/resources/ai/writing-effective-prompts/>
- Workspace with Gemini prompting guide (PDF): https://services.google.com/fh/files/misc/workspace_with_gemini_prompting_guide.pdf

Operations/Observability

- Cloud Observability graphic: <https://github.com/priyankavergadia/GCPSketchnote/blob/main/images/CloudOps.jpg>
- Google Cloud Observability doc homepage: <https://docs.cloud.google.com/stackdriver/docs>
- Google microservice demo: <https://github.com/GoogleCloudPlatform/microservices-demo>
- Operations pricing: <https://cloud.google.com/stackdriver/pricing>

- Ops unified Logging/Monitoring OpsAgent:
<https://docs.cloud.google.com/stackdriver/docs/solutions/agents/ops-agent>
 - Configuration options:
<https://docs.cloud.google.com/stackdriver/docs/solutions/agents/ops-agent/configuration>
- SRE
 - GCP Current status information: <https://status.cloud.google.com/>
 - Google SRE info: <https://sre.google/>
 - **Google's SRE books: <https://sre.google/books/>
 - The art of SLOs:
<https://landing.google.com/sre/resources/practicesandprocesses/art-of-slos/>
 - SLI/SLO handout: <https://cre.page.link/art-of-slos-handbook-pdf-letter>
 - Starter SLI menu:
<https://sre.google/workbook/implementing-slos/#slis-for-different-types-of-services>
 - High Availability: https://en.wikipedia.org/wiki/High_availability
 - SLA & Uptime calculator: How much downtime corresponds to 99.9 % uptime: <https://uptime.is/>
 - Postmortem examples:
 - Google SRE: Incident Postmortem Example for Outage Resolution:
<https://landing.google.com/sre/sre-book/chapters/postmortem/>
 - A Guide to the Incident Postmortem Process | Atlassian:
<https://www.atlassian.com/incident-management/postmortem/templates>
 - Postmortem Template - PagerDuty Incident Response Documentation:
https://response.pagerduty.com/after/post_mortem_template/
 - Disaster Recovery scenarios planning guide:
<https://cloud.google.com/solutions/dr-scenarios-planning-guide>
- Monitoring
 - **GCP available metrics: <https://docs.cloud.google.com/monitoring/api/metrics>
 - Metric kinds and types:
<https://docs.cloud.google.com/monitoring/api/v3/kinds-and-types>
 - **Using the Metrics Explorer:
<https://docs.cloud.google.com/monitoring/charts/metrics-explorer>
 - Monitoring documentation: <https://docs.cloud.google.com/monitoring/docs>

- Understanding Metric Scopes:
<https://docs.cloud.google.com/monitoring/settings>
- Monarch, the time series DB:
 - <https://medium.com/geekculture/understanding-monarch-googles-planet-scale-monitoring-system-60e59b63ac0c>
 - Monarch: Google's Planet-Scale In-Memory Time Series Database:
<https://research.google/pubs/pub50652/>
- How monitoring works:
<https://docs.cloud.google.com/monitoring/api/v3/metrics>
- Components of the metric model:
<https://docs.cloud.google.com/monitoring/api/v3/metric-model>
- Alerting in GCP: <https://docs.cloud.google.com/monitoring/alerts>
- Alerting behavior: <https://docs.cloud.google.com/monitoring/alerts/concepts-indepth>
- Log based alerts:
<https://docs.cloud.google.com/logging/docs/alerting/log-based-alerts>
- SLO Monitoring:
<https://docs.cloud.google.com/stackdriver/docs/solutions/slo-monitoring>
- Monitoring official resource names (monitored resources):
<https://docs.cloud.google.com/monitoring/api/resources>
- Uptime checks: <https://docs.cloud.google.com/monitoring/uptime-checks>
- Synthetic monitoring:
 - Overview:
<https://docs.cloud.google.com/monitoring/uptime-checks/introduction>
 - Creating:
<https://docs.cloud.google.com/monitoring/synthetic-monitors/create>
 - Scanning for broken links:
<https://docs.cloud.google.com/monitoring/synthetic-monitors/broken-links>
- Custom metrics: <https://docs.cloud.google.com/monitoring/custom-metrics>
- Monitoring Query Language (not recommended):
<https://docs.cloud.google.com/monitoring/mql>
- MQL example queries: <https://docs.cloud.google.com/monitoring/mql/examples>
- PromQL in GCP: <https://docs.cloud.google.com/monitoring/promql>
- VM Monitoring Agent(legacy):
<https://cloud.google.com/monitoring/agent/install-agent>

- Ops unified Logging/Monitoring agent:
<https://cloud.google.com/stackdriver/docs/solutions/ops-agent>
- Managing agents across multiple VMs:
<https://docs.cloud.google.com/monitoring/agent/monitoring/fleet-installation>
- Automating logging and monitoring agent installation with Agent Policies:
<https://cloud.google.com/stackdriver/docs/solutions/managing-agent-policies>
- Building custom dashboards:
<https://docs.cloud.google.com/monitoring/charts/dashboards>
- Exporting metric data to BigQuery:
<https://cloud.google.com/architecture/stackdriver-monitoring-metric-export>
- Metric data retention:
https://docs.cloud.google.com/monitoring/quotas#data_retention_policy
- Logging
 - **Logging overview and info on available logs:
<https://docs.cloud.google.com/logging/docs/overview#categories>
 - **Cloud Audit Logs: <https://docs.cloud.google.com/logging/docs/audit>
 - **Platform (product specific) logs:
<https://docs.cloud.google.com/logging/docs/api/platform-logs>
 - Using Logs Explorer:
<https://docs.cloud.google.com/logging/docs/view/logs-explorer-interface>
 - Observability Analytics:
<https://docs.cloud.google.com/logging/docs/log-analytics>
 - Cloud Logging documentation: <https://docs.cloud.google.com/logging/docs>
 - Logging concepts: <https://cloud.google.com/logging/docs/basic-concepts>
 - Logging libraries: <https://docs.cloud.google.com/logging/docs/setup>
 - Using Log Queries:
<https://docs.cloud.google.com/logging/docs/view/building-queries>
 - Log query language ref:
<https://docs.cloud.google.com/logging/docs/view/logging-query-language>
 - Log query examples:
<https://cloud.google.com/logging/docs/view/query-library-preview>
 - Correlate log entries:
<https://docs.cloud.google.com/logging/docs/view/correlate-logs>
 - **LogEntry type docs:
<https://docs.cloud.google.com/logging/docs/reference/v2/rest/v2/LogEntry>

- Custom indexing:
<https://docs.cloud.google.com/logging/docs/analyze/custom-index>
- Network telemetry, VPC Flow logs:
 - Using: <https://docs.cloud.google.com/vpc/docs/using-flow-logs>
 - Flow log overview and details:
<https://docs.cloud.google.com/vpc/docs/flow-logs>
 - Record format:
<https://docs.cloud.google.com/vpc/docs/about-flow-logs-records>
- VM Logging Agent: <https://cloud.google.com/logging/docs/agent/installation>
- Customizing agent (fluentd):
<https://cloud.google.com/logging/docs/agent/configuration#configure>
- Load Balancer logging:
<https://docs.cloud.google.com/load-balancing/docs/https/https-logging-monitoring>
- Central log storage:
<https://docs.cloud.google.com/logging/docs/central-log-storage>
- Info on Access Transparency Logs:
<https://cloud.google.com/logging/docs/audit/access-transparency-overview>
- Log Router: <https://docs.cloud.google.com/logging/docs/routing/overview>
- Exporting log data to Splunk:
<https://cloud.google.com/solutions/exporting-stackdriver-logging-for-splunk>
- Aggregated sinks:
https://docs.cloud.google.com/logging/docs/export/aggregated_sinks
- Managing logging and monitoring agent policies:
<https://cloud.google.com/stackdriver/docs/solutions/managing-agent-policies>
- Controlling log access with Log Views:
<https://docs.cloud.google.com/logging/docs/logs-views>
- Log based alerts:
<https://docs.cloud.google.com/logging/docs/alerting/log-based-alerts>
- Error Reporting
 - Error Reporting: <https://docs.cloud.google.com/error-reporting/docs>
 - Setting up: <https://docs.cloud.google.com/error-reporting/docs/setup>
 - ReportedErrorEvent:
<https://docs.cloud.google.com/error-reporting/docs/formatting-error-messages>

- Trace
 - Trace: <https://docs.cloud.google.com/trace/docs>
 - Trace setup: <https://docs.cloud.google.com/trace/docs/setup>
 - Trace filters: <https://docs.cloud.google.com/trace/docs/trace-filters>
 - Trace quick start: <https://docs.cloud.google.com/trace/docs/trace-app-latency>
- Profiler
 - Profiler: <https://docs.cloud.google.com/profiler/docs>
 - About Profiler: <https://docs.cloud.google.com/profiler/docs/about-profiler>
 - Overview:
https://docs.cloud.google.com/profiler/docs/about-profiler#profiling_agent
 - Reading Flame graphs:
<https://docs.cloud.google.com/profiler/docs/concepts-flame>
 - Filtering flame graphs:
<https://docs.cloud.google.com/profiler/docs/filtering-profiles>

Networking

- Networking 101
 - CIDR explained: https://en.wikipedia.org/wiki/Classless_Inter-Domain_Routing
 - CIDR table: <http://www.rjsmith.com/CIDR-Table.html>
 - CIDR calculator: <https://www.ipaddressguide.com/cidr>
 - Info on Private networking (RFC 1918):
https://en.wikipedia.org/wiki/Private_network
- Google Cloud VPCs
 - Networking (VPC) in GCP: <https://docs.cloud.google.com/vpc/docs/overview>
 - GCP networking overview:
<https://cloud.google.com/blog/topics/developers-practitioners/google-cloud-net-working-overview>
 - Cloud Girl network graphic:
https://storage.googleapis.com/gweb-cloudblog-publish/images/image3_oUMNvdq.max-2000x2000.jpg
 - IP Ranges for all GCP services:
<https://support.google.com/a/answer/10026322?hl=en>
 - IP addresses: <https://docs.cloud.google.com/vpc/docs/ip-addresses>

- Valid subnet IP ranges:
<https://docs.cloud.google.com/vpc/docs/subnets#valid-ranges>
- Network Connectivity Center:
<https://docs.cloud.google.com/network-connectivity/docs/network-connectivity-center>
 - About:
<https://docs.cloud.google.com/network-connectivity/docs/network-connectivity-center/concepts/overview>
- Peering VPC networks: <https://docs.cloud.google.com/vpc/docs/vpc-peering>
- Cloud DNS: <https://docs.cloud.google.com/dns/docs/overview/>
- Internal DNS: <https://docs.cloud.google.com/compute/docs/internal-dns>
- Cloud NAT: <https://docs.cloud.google.com/nat/docs/overview>
- Network bandwidth:
<https://docs.cloud.google.com/compute/docs/network-bandwidth>
- Network best practices
 - VPC design best practices and reference architectures:
<https://docs.cloud.google.com/architecture/best-practices-vpc-design>
 - Shared VPC Network docs: <https://docs.cloud.google.com/vpc/docs/shared-vpc>
 - VPC limits and quotas: <https://docs.cloud.google.com/vpc/docs/quota>
 - Hybrid connectivity options: <https://cloud.google.com/hybrid-connectivity/>
 - Interconnect providers:
<https://docs.cloud.google.com/network-connectivity/docs/interconnect/concepts/service-providers>
 - Serverless VPC access (put Cloud Run, App Engine, and Cloud Functions on VPC):
<https://docs.cloud.google.com/vpc/docs/serverless-vpc-access>
 - CDN caching overview: <https://docs.cloud.google.com/cdn/docs/caching>
 - Cloud CDN: <https://docs.cloud.google.com/cdn/docs>
- Network monitoring
 - VPC Flow Logs: <https://docs.cloud.google.com/vpc/docs/using-flow-logs>
 - Details: <https://docs.cloud.google.com/vpc/docs/flow-logs>
 - Log content:
<https://docs.cloud.google.com/vpc/docs/about-flow-logs-records>
 - Network Intelligence Center:
<https://docs.cloud.google.com/network-intelligence-center/docs>
 - Packet Mirroring:

- Packet Mirroring | Virtual Private Cloud:
<https://docs.cloud.google.com/vpc/docs/packet-mirroring>
- Using (demo?):
<https://docs.cloud.google.com/vpc/docs/using-packet-mirroring>
- Firewall logs: <https://cloud.google.com/vpc/docs/firewall-rules-logging>
- Load Balancing
 - **Choosing a Load Balancer:
<https://docs.cloud.google.com/load-balancing/docs/choosing-load-balancer>
 - Load Balancer sketch:
<https://github.com/priyankavergadia/GCPSketchnote/blob/main/images/CLB.jpg>
 - Load Balancer logging:
<https://docs.cloud.google.com/load-balancing/docs/https/https-logging-monitoring>
 - Load Balancer IPs for firewall rules:
<https://docs.cloud.google.com/load-balancing/docs/https#firewall-rules>
- Network Security
 - Firewall rule overview: <https://cloud.google.com/vpc/docs/firewalls>
 - Hierarchical firewall policies: <https://cloud.google.com/vpc/docs/firewall-policies>
 - VPC Service Controls:
 - Overview:
<https://docs.cloud.google.com/vpc-service-controls/docs/overview>
 - Creating a VPC Service Control access level:
<https://docs.cloud.google.com/access-context-manager/docs/create-basic-access-level>
 - Supported VPC Service control products
<https://docs.cloud.google.com/vpc-service-controls/docs/supported-products>
 - Cloud VPN:
<https://docs.cloud.google.com/network-connectivity/docs/vpn/concepts/overview>
 - Identity Aware Proxy (IAP) docs:
<https://docs.cloud.google.com/iap/docs/concepts-overview>
 - Choosing a network connectivity product:
<https://docs.cloud.google.com/network-connectivity/docs/how-to/choose-product>

- TCP Forwarding through IAP (substitute for jump boxes):
<https://docs.cloud.google.com/iap/docs/tcp-forwarding-overview>
- Cloud Armor: <https://docs.cloud.google.com/armor/docs/cloud-armor-overview>
- Private Service Connect:
<https://docs.cloud.google.com/vpc/docs/private-service-connect>

Development / Terraform / Tools

Start here - developing on Google Cloud

- Orientation: what the Google Cloud developer surface looks like in 2026.
- Developing apps in Google Cloud:
<https://docs.cloud.google.com/docs/application-development>
- Google Cloud developer tools: <https://cloud.google.com/products/tools>
- CNCF Cloud Native Landscape, a map of the cloud native tool ecosystem:
<https://landscape.cncf.io/>
- The Google Cloud "Going to Production" song:
<https://www.youtube.com/watch?v=NaR8WltPwO>

Client libraries, APIs and authentication

- The libraries you import and how your code proves who it is.
- Google Client Libraries: <https://docs.cloud.google.com/apis/docs/cloud-client-libraries>
- Authenticating to Google Cloud with service accounts:
<https://docs.cloud.google.com/docs/authentication#service-accounts>
- .NET client library reference: <https://docs.cloud.google.com/dotnet/docs/reference>
- Go client library reference: <https://docs.cloud.google.com/go/docs/reference>
- Java client library reference: <https://docs.cloud.google.com/java/docs/reference>
- Node.js client library reference: <https://docs.cloud.google.com/nodejs/docs/reference>
- Python client library reference: <https://docs.cloud.google.com/python/docs/reference>
- Cloud Logging client libraries: <https://docs.cloud.google.com/logging/docs/setup>
- API Explorer: <https://developers.google.com/apis-explorer>

APIs, microservices and application design

- The Twelve-Factor App methodology: <https://12factor.net/>
- API Gateway: <https://docs.cloud.google.com/api-gateway/docs/about-api-gateway>
- Apigee overview: <https://cloud.google.com/apigee>
- Cloud Endpoints:
<https://docs.cloud.google.com/endpoints/docs/openapi/architecture-overview>

- Google API error handling: <https://google.aip.dev/193>
- gRPC: <https://grpc.io/>
- OpenAPI Initiative: <https://www.openapis.org/>

AI coding assistants and agentic development

- Gemini CLI stopped serving free and AI Pro/Ultra users on 18 June 2026; Antigravity is the successor. Building your own agents with ADK is in the ML/AI branch, not here.
- Google Antigravity, the agent-first development platform: <https://antigravity.google/>
- Antigravity, getting started: <https://antigravity.google/docs/getting-started>
- Gemini Code Assist, the licensed in-IDE assistant:
<https://docs.cloud.google.com/gemini/docs/codeassist/overview>
- Antigravity IDE overview: <https://antigravity.google/docs/ide/overview>
- Antigravity CLI overview: <https://antigravity.google/docs/cli/overview>
- Antigravity CLI installation and authentication: <https://antigravity.google/docs/cli/install>
- Antigravity SDK overview: <https://antigravity.google/docs/sdk/overview>
- Antigravity CLI, first steps in the terminal:
<https://antigravity.google/docs/cli/getting-started>
- Hands-on with Antigravity CLI (Google codelab):
<https://codelabs.developers.google.com/antigravity-cli-hands-on>
- Migrating from Gemini CLI to Antigravity CLI:
<https://antigravity.google/docs/cli/gcli-migration>
- Google's Gemini CLI transition announcement:
<https://github.com/google-gemini/gemini-cli/discussions/27274>
- Introducing the Antigravity CLI (announcement):
<https://antigravity.google/blog/introducing-google-antigravity-cli>

IDEs, editors and managed development environments

- Google Cloud Code (IDE Plugin): <https://cloud.google.com/code>
- General Cloud Code docs: <https://docs.cloud.google.com/code/docs>
- Cloud Code for VS Code: <https://docs.cloud.google.com/code/docs/vscode/how-to>
- Cloud Code for IntelliJ: <https://docs.cloud.google.com/code/docs/intellij/how-to>
- Cloud Code for Cloud Shell: <https://docs.cloud.google.com/code/docs/shell/how-to>
- Cloud Workstations, Google managed development environments:
<https://docs.cloud.google.com/workstations/docs/overview>

Sample code and demo applications

- GCP code samples: <https://docs.cloud.google.com/docs/samples>

- Python code samples: <https://github.com/GoogleCloudPlatform/python-docs-samples/>
- Java code samples: <https://github.com/GoogleCloudPlatform/java-docs-samples>
- Node.js code samples: <https://github.com/GoogleCloudPlatform/nodejs-docs-samples>
- .NET code samples: <https://github.com/GoogleCloudPlatform/dotnet-docs-samples>
- Generative AI on Google Cloud samples:
<https://github.com/GoogleCloudPlatform/generative-ai/tree/main>
- GKE sample applications:
<https://github.com/GoogleCloudPlatform/kubernetes-engine-samples>
- Online Boutique, Google's microservices demo app:
<https://github.com/GoogleCloudPlatform/microservices-demo>
- Bank of Anthos demo app: <https://github.com/GoogleCloudPlatform/bank-of-anthos>
- Simple Hello World app: <https://github.com/haggman/HelloWorldNodeJs>
- Small Node.js app demonstrating operations suite features:
<https://github.com/haggman/HelloLoggingNodeJS>

Source control and Git

- Cloud Source Repositories is end of sale - Secure Source Manager and Developer Connect are the Google-hosted answers.
- Secure Source Manager, Google's managed Git hosting:
<https://docs.cloud.google.com/secure-source-manager/docs/overview>
- Developer Connect, connecting Google Cloud to GitHub, GitLab and Bitbucket:
<https://docs.cloud.google.com/developer-connect/docs/overview>
- Git tutorial, the official git-scm walkthrough: <https://git-scm.com/docs/gittutorial>
- Setting up a Git repository:
<https://www.atlassian.com/git/tutorials/setting-up-a-repository>
- Git remote, fetch, push and pull: <https://www.atlassian.com/git/tutorials/syncing>
- Git branching workflows compared:
<https://www.atlassian.com/git/tutorials/comparing-workflows>
- GitHub Git cheat sheet (PDF):
<https://training.github.com/downloads/github-git-cheat-sheet.pdf>

Cloud Build and CI/CD

- Cloud Build documentation: <https://docs.cloud.google.com/build/docs>
- DevOps in Google Cloud (DORA capabilities):
<https://docs.cloud.google.com/architecture/devops>
- Creating a basic cloudbuild.yaml:
<https://docs.cloud.google.com/build/docs/configuring-builds/create-basic-configuration>

- Cloud Build builders: <https://docs.cloud.google.com/build/docs/cloud-builders>
- Community and custom builders: <https://docs.cloud.google.com/build/docs/configuring-builds/use-community-and-custom-builders>
- Creating and managing Cloud Build triggers: <https://docs.cloud.google.com/build/docs/automating-builds/create-manage-triggers>
- Cloud Build private pools: <https://docs.cloud.google.com/build/docs/private-pools/private-pools-overview>
- Build and push a Docker image with Cloud Build: <https://docs.cloud.google.com/build/docs/build-push-docker-image>
- Google's GitHub Actions: <https://github.com/google-github-actions>
- Set up gcloud in GitHub Actions: <https://github.com/google-github-actions/setup-gcloud>
- Example GitHub Actions workflows for Google Cloud: <https://github.com/google-github-actions/setup-gcloud#example-workflows>
- Cloud Build community builders repo: <https://github.com/GoogleCloudPlatform/cloud-builders-community>

Artifact Registry and software supply chain security

- Container Registry shut down on 18 March 2025; everything here is Artifact Registry.
- Artifact Registry overview: <https://docs.cloud.google.com/artifact-registry/docs/overview>
- Moving from Container Registry to Artifact Registry: <https://docs.cloud.google.com/artifact-registry/docs/transition/transition-from-gcr>
- Store Docker container images in Artifact Registry: <https://docs.cloud.google.com/artifact-registry/docs/docker/store-docker-container-images>
- Software supply chain security overview: <https://docs.cloud.google.com/software-supply-chain-security/docs/overview>
- Artifact Analysis, vulnerability scanning and metadata: <https://docs.cloud.google.com/artifact-analysis/docs/artifact-analysis>
- Binary Authorization: <https://docs.cloud.google.com/binary-authorization/docs>
- Binary Authorization end-to-end example: <https://docs.cloud.google.com/binary-authorization/docs/getting-started-console>
- Assured Open Source Software: <https://docs.cloud.google.com/assured-open-source-software/docs/overview>

Cloud Deploy and release management

- Cloud Deploy overview: <https://docs.cloud.google.com/deploy/docs/overview>
- Cloud Deploy architecture: <https://docs.cloud.google.com/deploy/docs/architecture>
- Cloud Deploy terminology: <https://docs.cloud.google.com/deploy/docs/terminology>
- Deploy an app to GKE with Cloud Deploy:
<https://docs.cloud.google.com/deploy/docs/deploy-app-gke>
- Deploy an app to Cloud Run with Cloud Deploy:
<https://docs.cloud.google.com/deploy/docs/deploy-app-run>
- Cloud Deploy to GKE Enterprise and attached clusters:
<https://docs.cloud.google.com/deploy/docs/anthos-targets>
- Scaffold, the build and deploy loop under Cloud Deploy: <https://skaffold.dev/>

Terraform on Google Cloud

- Google's own Terraform guidance, blueprints and validation tooling.
- Terraform on Google Cloud: <https://docs.cloud.google.com/docs/terraform>
- Create a VM with Terraform (quickstart):
<https://docs.cloud.google.com/docs/terraform/create-vm-instance>
- Store Terraform state in a Cloud Storage bucket:
<https://docs.cloud.google.com/docs/terraform/resource-management/store-state>
- Best practices for using Terraform on Google Cloud:
<https://docs.cloud.google.com/docs/terraform/best-practices/general-style-structure>
- Google's Terraform blueprint modules:
<https://docs.cloud.google.com/docs/terraform/blueprints/terraform-blueprints>
- terraform-google-modules, Google's Terraform module org:
<https://github.com/terraform-google-modules>
- Terraform policy validation with gcloud terraform vet:
<https://docs.cloud.google.com/docs/terraform/policy-validation>
- Managing infrastructure as code with Terraform, Cloud Build and GitOps:
<https://docs.cloud.google.com/docs/terraform/resource-management/managing-infrastructure-as-code>
- terraform-example-foundation, the enterprise foundations blueprint code:
<https://github.com/terraform-google-modules/terraform-example-foundation>

Terraform language and HashiCorp reference

- Installing the Terraform CLI:
<https://developer.hashicorp.com/terraform/tutorials/gcp-get-started/install-cli>

- Getting started with Terraform on Google Cloud (HashiCorp tutorial):
<https://developer.hashicorp.com/terraform/tutorials/gcp-get-started>
- Terraform language reference: <https://developer.hashicorp.com/terraform/language>
- Terraform built-in functions:
<https://developer.hashicorp.com/terraform/language/functions>
- Terraform version constraints:
<https://developer.hashicorp.com/terraform/language/expressions/version-constraints>
- Terraform style conventions: <https://developer.hashicorp.com/terraform/language/style>
- Google Cloud Terraform provider reference:
<https://registry.terraform.io/providers/hashicorp/google/latest/docs>
- Terraform Registry: <https://registry.terraform.io/>
- The Terraform test framework (.tftest.hcl):
<https://developer.hashicorp.com/terraform/language/tests>
- Refactoring Terraform modules with moved blocks:
<https://developer.hashicorp.com/terraform/language/modules/develop/refactoring>
- Testing Terraform (HashiCorp blog):
<https://www.hashicorp.com/blog/testing-hashicorp-terraform>

Infrastructure as code beyond Terraform

- Infrastructure Manager, Config Connector and the export tools that bootstrap config from what you already run.
- Infrastructure Manager, Google's managed Terraform service:
<https://docs.cloud.google.com/infrastructure-manager/docs/overview>
- Deploy a VPC with Infrastructure Manager (quickstart):
<https://docs.cloud.google.com/infrastructure-manager/docs/deploy-vpc-with-terraform>
- Config Connector, managing Google Cloud from Kubernetes:
<https://docs.cloud.google.com/config-connector/docs/overview>
- gcloud resource-config bulk-export, generate Terraform from existing resources:
<https://docs.cloud.google.com/sdk/gcloud/reference/alpha/resource-config/bulk-export>
- Cloud Asset Inventory asset types:
<https://docs.cloud.google.com/asset-inventory/docs/asset-types>

Marketplace and Service Catalog

- Private Catalog was renamed Service Catalog.
- Offering software through Google Cloud Marketplace:
<https://docs.cloud.google.com/marketplace/docs/partners/get-started>

- Service Catalog, a private app store for your org:
<https://docs.cloud.google.com/service-catalog/docs>
- Example open source Marketplace Kubernetes apps:
<https://github.com/GoogleCloudPlatform/click-to-deploy/tree/master/k8s>
- Kubernetes Application custom resource (a Marketplace requirement):
<https://github.com/kubernetes-sigs/application>

Command line and everyday cheat sheets

- gcpdiag, diagnostics for Google Cloud: <https://github.com/GoogleCloudPlatform/gcpdiag>
- Bash scripting cheat sheet: <https://devhints.io/bash>
- sed cheat sheet: <http://eriklievaart.com/cheat/linux/shell/sed.html>
- vi cheat sheet (PDF):
https://www.atmos.albany.edu/daes/atmclasses/atm350/vi_cheat_sheet.pdf
- The Art of Command Line: <https://github.com/jlevy/the-art-of-command-line>
- crontab.guru, check your cron schedule spec: <https://crontab.guru/>
- regex101, regex tester and explainer: <https://regex101.com/>
- RegExr, regex tester and reference: <https://regexr.com/>
- Regex quick start cheat sheet: <https://www.rexegg.com/regex-quickstart.php>
- Markdown cheat sheet: <https://www.markdownguide.org/cheat-sheet/>
- Markdown quick reference:
<https://wordpress.com/support/markdown-quick-reference/>
- Maven in five minutes:
<https://maven.apache.org/guides/getting-started/maven-in-five-minutes.html>
- Mockaroo, fake test data generator: <https://mockaroo.com/>

Security

Start here - security on Google Cloud

- How Google secures the platform, and where to start on your side of the shared responsibility line.
- Google's trusted infrastructure: <https://cloud.google.com/security/infrastructure>
- How Google designs security into its infrastructure:
<https://docs.cloud.google.com/docs/security/infrastructure/design>
- Google infrastructure security design whitepaper (PDF):
https://docs.cloud.google.com/docs/security/infrastructure/design/resources/google_in_frastructure_whitepaper_fa.pdf

- Google Cloud security best practices center: <https://cloud.google.com/security/best-practices>
- Google Cloud reference architectures: <https://docs.cloud.google.com/architecture>
- Google Cloud Well-Architected Framework guide: <https://docs.cloud.google.com/architecture/framework>
- BeyondCorp, Google's zero trust model: <https://cloud.google.com/beyondcorp>
- OWASP Top Ten: <https://owasp.org/www-project-top-ten/>
- Five pillars of protection against ransomware attacks: <https://cloud.google.com/blog/products/identity-security/5-pillars-of-protection-to-prevent-ransomware-attacks>
- Video, what it takes to get into a Google data center: <https://www.youtube.com/watch?v=kd33UVZhAA>

IAM roles, policies and permissions

- Allow policies, deny policies and the newer principal access boundary layer.
- IAM basics: <https://docs.cloud.google.com/iam/docs/overview>
- The three types of IAM roles: <https://docs.cloud.google.com/iam/docs/roles-overview>
- Every predefined role and its permissions: <https://docs.cloud.google.com/iam/docs/roles-permissions>
- Full resource names: <https://docs.cloud.google.com/iam/docs/full-resource-names>
- IAM conditions: <https://docs.cloud.google.com/iam/docs/conditions-overview>
- Tags and conditional access control: <https://docs.cloud.google.com/iam/docs/tags-access-control>
- IAM deny policies: <https://docs.cloud.google.com/iam/docs/deny-access>
- Principal access boundary policies: <https://docs.cloud.google.com/iam/docs/principal-access-boundary-policies>
- Common Expression Language (CEL) definition: <https://github.com/cel-expr/cel-spec/blob/master/doc/langdef.md>
- Policy Analyzer, who can do what to which resource: <https://docs.cloud.google.com/policy-intelligence/docs/analyze-iam-policies>
- Troubleshooting access with Policy Troubleshooter: <https://docs.cloud.google.com/policy-intelligence/docs/troubleshoot-access>
- Policy Intelligence, the full set of IAM analysis tools: <https://docs.cloud.google.com/policy-intelligence/docs>

Service accounts and workload identity

- Google's position is unambiguous in 2026: federate, impersonate, do not create keys.

- Service accounts overview:
<https://docs.cloud.google.com/iam/docs/service-account-overview>
- Workload Identity Federation:
<https://docs.cloud.google.com/iam/docs/workload-identity-federation>
- Creating short-lived service account credentials:
<https://docs.cloud.google.com/iam/docs/create-short-lived-credentials-direct>
- Service account keys, creating and deleting:
<https://docs.cloud.google.com/iam/docs/keys-create-delete>
- Best practices for service accounts:
<https://docs.cloud.google.com/iam/docs/best-practices-service-accounts>

Identity providers and workforce identity

- Cloud Identity: <https://docs.cloud.google.com/identity/docs/overview>
- Workforce Identity Federation:
<https://docs.cloud.google.com/iam/docs/workforce-identity-federation>
- Identity Platform, customer identity for your apps:
<https://docs.cloud.google.com/identity-platform/docs/how-to>
- Firebase Authentication compared with Identity Platform:
<https://docs.cloud.google.com/identity-platform/docs/product-comparison>
- Managed Service for Microsoft Active Directory, creating a domain:
<https://docs.cloud.google.com/managed-microsoft-ad/docs/create-domain>
- Google Cloud Directory Sync (GCDS):
<https://knowledge.workspace.google.com/admin/users/about-google-cloud-directory-sync>
- Single sign-on with an external identity provider:
<https://docs.cloud.google.com/architecture/identity/single-sign-on>
- Best practices for federating Google Cloud with an external identity provider:
<https://docs.cloud.google.com/architecture/identity/best-practices-for-federating>
- Federating with Active Directory and Microsoft Entra ID:
<https://docs.cloud.google.com/architecture/identity/federating-gcp-with-active-directory-introduction>
- Identity reference architectures:
<https://docs.cloud.google.com/architecture/identity/reference-architectures>

Organization policy and guardrails

- Introduction to Organization Policy:
<https://docs.cloud.google.com/organization-policy/overview>

- Organization policy constraints reference:
<https://docs.cloud.google.com/organization-policy/reference/org-policy-constraints>
- Restrict service usage:
<https://docs.cloud.google.com/organization-policy/restrict-services>
- Scoping organization policies with tags:
<https://docs.cloud.google.com/organization-policy/scope-policies>
- Creating custom constraints:
<https://docs.cloud.google.com/organization-policy/create-custom-constraints>

Resource hierarchy, labels and tags

- Creating and managing organization resources:
<https://docs.cloud.google.com/resource-manager/docs/creating-managing-organization>
- Best practices for planning accounts and organizations:
<https://docs.cloud.google.com/architecture/identity/best-practices-for-planning>
- Google Cloud Setup, the guided onboarding flow:
<https://docs.cloud.google.com/docs/enterprise/cloud-setup>
- Managing multiple organizations:
<https://docs.cloud.google.com/resource-manager/docs/managing-multiple-orgs>
- Creating and managing tags:
<https://docs.cloud.google.com/resource-manager/docs/tags/tags-creating-and-managing>
- Creating and managing labels:
<https://docs.cloud.google.com/resource-manager/docs/creating-managing-labels>
- Products that support labels:
<https://docs.cloud.google.com/resource-manager/docs/labels-supported-services>
- Cloud Asset Inventory resource name format:
<https://docs.cloud.google.com/asset-inventory/docs/asset-names>
- Essential Contacts:
<https://docs.cloud.google.com/resource-manager/docs/managing-notification-contacts>

Data protection and confidential computing

- Cloud DLP is now Sensitive Data Protection.
- Default encryption at rest:
<https://docs.cloud.google.com/docs/security/encryption/default-encryption>
- Encryption in transit: <https://docs.cloud.google.com/docs/security/encryption-in-transit>

- Customer-supplied encryption keys (CSEK):
<https://docs.cloud.google.com/docs/security/encryption/customer-supplied-encryption-keys>
- Sensitive Data Protection, formerly Cloud DLP:
<https://docs.cloud.google.com/sensitive-data-protection/docs/sensitive-data-protection-overview>
- Confidential Computing overview:
<https://docs.cloud.google.com/confidential-computing/docs/confidential-computing-overview>

Key management and secrets

- Cloud Key Management Service (KMS): <https://docs.cloud.google.com/kms/docs>
- Cloud KMS overview:
<https://docs.cloud.google.com/kms/docs/key-management-service>
- Products that support customer-managed encryption keys (CMEK):
<https://docs.cloud.google.com/kms/docs/use-keys-google-cloud>
- External Key Manager (EKM), keys you hold outside Google:
<https://docs.cloud.google.com/kms/docs/ekm>
- Cloud HSM (hardware security module): <https://docs.cloud.google.com/kms/docs/hsm>
- Cloud KMS Autokey: <https://docs.cloud.google.com/kms/docs/autokey-overview>
- Key rotation: <https://docs.cloud.google.com/kms/docs/key-rotation>
- Cloud KMS IAM permissions and roles:
<https://docs.cloud.google.com/kms/docs/reference/permissions-and-roles>
- Secret Manager overview:
<https://docs.cloud.google.com/secret-manager/docs/overview>
- Creating a secret (Secret Manager quickstart):
<https://docs.cloud.google.com/secret-manager/docs/create-secret-quickstart>
- Secret Manager best practices:
<https://docs.cloud.google.com/secret-manager/docs/best-practices>
- Certificate Authority Service, running a private CA:
<https://docs.cloud.google.com/certificate-authority-service/docs/ca-service-overview>

Security Command Center and threat detection

- The Enterprise tier is being retired - Premium is the landing spot.
- Security Command Center overview:
<https://docs.cloud.google.com/security-command-center/docs/security-command-center-overview>

- Security Command Center documentation:
<https://docs.cloud.google.com/security-command-center/docs>
- Security Command Center service tier comparison:
<https://docs.cloud.google.com/security-command-center/docs/service-tiers>
- Web Security Scanner:
<https://docs.cloud.google.com/security-command-center/docs/concepts-web-security-scanner-overview>
- Google Security Operations (SecOps), formerly Chronicle:
<https://docs.cloud.google.com/chronicle/docs/secops/secops-overview>

Compliance, sovereignty and foundations blueprints

- Enterprise foundations blueprint guide:
<https://docs.cloud.google.com/architecture/blueprints/security-foundations>
- Security, privacy and compliance pillar of the Well-Architected Framework:
<https://docs.cloud.google.com/architecture/framework/security>
- Assured Workloads, sovereignty and compliance boundaries:
<https://docs.cloud.google.com/assured-workloads/docs/overview>
- Google Cloud compliance offerings: <https://cloud.google.com/compliance>
- Security partners: <https://cloud.google.com/security/partners>

Pricing/Cost

- **Price list for all resources: <https://cloud.google.com/pricing/list>
- **GCP Pricing Calculator: <https://cloud.google.com/products/calculator>
- Gemini pricing:
<https://cloud.google.com/gemini-enterprise-agent-platform/generative-ai/pricing>
- What is FinOps: <https://www.finops.org/introduction/what-is-finops/>
- GCP Billing: <https://docs.cloud.google.com/billing/docs>
- Guide to Cloud Billing Resource Organization and Access Management:
<https://docs.cloud.google.com/billing/docs/onboarding-checklist>
- Committed use discounts: <https://docs.cloud.google.com/docs/cuds>
- Well-Architected Framework: cost optimization pillar:
<https://docs.cloud.google.com/architecture/framework/cost-optimization>
- **Cost optimization for developers and operators:
<https://cloud.google.com/architecture/cost-efficiency-on-google-cloud>
- Visualizing GCP billing using Looker:
<https://medium.com/google-cloud/visualize-gcp-billing-using-looker-99a90a462868>

- Setting budgets and alerts: <https://docs.cloud.google.com/billing/docs/how-to/budgets>
- Using BigQuery to analyze exported billing data: <https://docs.cloud.google.com/billing/docs/how-to/export-data-bigquery>
- Lots of good Cloud Billing account how to's: <https://docs.cloud.google.com/billing/docs/how-to/account-management-overview>
- "Cloud Computing Isn't as Cost Effective as Hoped": <https://youtu.be/Vqgg-0fl4Co>
- Was moving to cloud a mistake? <https://www.infoworld.com/article/3676597/was-moving-to-cloud-a-mistake.html>

Other

- OpenAI/Claude
 - GenAI model cost comparison: <https://docsbot.ai/tools/gpt-openai-api-pricing-calculator>
 - But what is GPT (3 Blue, 1 Brown): <https://youtu.be/wjZofJX0v4M?si=TQPnW1YS3fEhhy1j>
 - ChatGPT: <https://chat.openai.com/>
 - OpenAI Playground: <https://platform.openai.com/playground>
 - OpenAI documentation: <https://platform.openai.com/docs/introduction>
 - OpenAI API docs: <https://platform.openai.com/docs/api-reference>
 - Claude: <https://claude.ai/chats>
 - Anthropic courses: <https://github.com/anthropics/courses>
 - Anthropic developer dashboard: <https://console.anthropic.com/dashboard>
 - Workbench: <https://console.anthropic.com/workbench>
- Databricks on GCP
 - Getting started: <https://docs.gcp.databricks.com/en/getting-started/index.html>
 - Main Admin/Account console: <https://accounts.gcp.databricks.com/>
 - Documentation: <https://docs.gcp.databricks.com/en/index.html>
 - SQL:
 - Getting started: <https://docs.gcp.databricks.com/en/sql/get-started/index.html>
 - Ref: <https://docs.gcp.databricks.com/en/sql/language-manual/index.html>
 - Terraform provider: <https://registry.terraform.io/providers/databricks/databricks/latest/docs>
 - Spark on Databricks:

- Spark overview: <https://docs.gcp.databricks.com/en/spark/index.html>
- Spark Streaming:
 - Streaming tutorial:
<https://docs.gcp.databricks.com/en/structured-streaming/tutorial.html>
 - Delta lake streaming:
<https://docs.gcp.databricks.com/en/structured-streaming/delta-lake.html>
- LangChain
 - Home page: <https://www.langchain.com/>
 - Docs: <https://python.langchain.com/docs/introduction/>
 - API reference: https://python.langchain.com/api_reference/
 - Python user's guide: <https://python.langchain.com/docs/introduction/>
 - GitHub: <https://github.com/langchain-ai/langchain>
 - Providers: <https://python.langchain.com/docs/integrations/providers/>
 - Building agents: <https://python.langchain.com/docs/tutorials/agents/>
 - Google provider page:
<https://python.langchain.com/docs/integrations/providers/google/>
 - LangChain ChatGoogleGenerativeAI (Gemini) integration:
https://docs.langchain.com/oss/python/integrations/chat/google_generative_ai
 - Free 1hr class (uses OpenAI but would also work same for GCP):
<https://www.deeplearning.ai/short-courses/langchain-for-llm-application-development/>

Retired links (removed 2026-08-09)

- Removed during the August 2026 update. Kept here so nothing disappears silently — each entry says why it went.
- [Kubernetes] <https://dockerlabs.collabnix.com/docker/cheatsheet/> — <https://dockerlabs.collabnix.com/docker/cheatsheet/> — DEAD - dockerlabs cheat sheet is unreachable and the label was only the raw URL.
- [Kubernetes] Python — <https://github.com/GoogleContainerTools/distroless/blob/main/examples/java/Dockerfile> — Labelled 'Python' but points at the Java distroless Dockerfile - a duplicate of the previous row. The Python example it promised is added as a new link.
- [Kubernetes] Example creating a CRD — <https://developer.ibm.com/tutorials/kubernetes-custom-resource-definitions/> — UNREADABLE - IBM developer tutorial has been reorganised away.

- [Kubernetes] Java example —
<https://medium.com/xgeeks/kubernetes-dummy-operator-in-java-6b2f26198a55> — Medium paywall. The Java Operator SDK repo in this subsection covers the same ground.
- [Kubernetes] Network requirements —
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/bare-metal/docs/concepts/network-reqs> — Installation detail. Subsection 15 is a pointer, not a treatment.
- [Kubernetes] Prerequisite guides —
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/bare-metal/docs/installing/install-prereq> — Installation detail. Subsection 15 is a pointer, not a treatment.
- [Kubernetes] Load balancer options and configurations —
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/bare-metal/docs/installing/load-balance> — Installation detail. Subsection 15 is a pointer, not a treatment.
- [Kubernetes] Plan a basic installation —
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/bare-metal/docs/installing/minimal-infrastructure> — Installation detail. Subsection 15 is a pointer, not a treatment.
- [Kubernetes] Config file samples —
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/bare-metal/docs/reference/config-samples> — Installation detail. Subsection 15 is a pointer, not a treatment.
- [Kubernetes] Building a demo bare metal env on GCP Compute Engine —
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/bare-metal/docs/try/admin-user-gce-vms> — Installation detail. Subsection 15 is a pointer, not a treatment.
- [Kubernetes] Try ABM on GCE using Terraform —
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/bare-metal/docs/try/gce-vms-tf> — Hands-on Terraform lab for bare metal. Good page, but subsection 15 is a pointer only; label also still said 'ABM'.
- [Kubernetes] Installation —
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/vmware/docs/how-to/install-overview> — Installation detail. Subsection 15 is a pointer, not a treatment.
- [Kubernetes] Hierarchical namespaces —
<https://github.com/kubernetes-sigs/hierarchical-namespaces> — Flagged RETIRED. Hierarchical namespaces are not part of the current Config Sync story.
- [Kubernetes] Doc homepage —
<https://docs.cloud.google.com/kubernetes-engine/enterprise/docs> — 'Doc homepage'

for GKE Enterprise now 302s to the generic GKE docs home - the enterprise content is gone. Replaced by 'GKE cluster options'.

- [Kubernetes] Technical overview — <https://docs.cloud.google.com/kubernetes-engine/enterprise/docs/concepts/overview> — 'Technical overview' now 302s to the GKE overview page, which this branch already links.
- [Kubernetes] Setting up GKE-E — <https://docs.cloud.google.com/kubernetes-engine/enterprise/docs/setup/overview> — 'Setting up GKE-E' - GKE Enterprise onboarding flow. GKE has had no editions since 23 Sep 2025.
- [Kubernetes] Knative, about — <https://docs.cloud.google.com/kubernetes-engine/enterprise/knative-serving/docs/architecture-overview> — Still live, but Knative on GKE belongs in the Serverless branch, not Kubernetes. Move, do not delete.
- [Kubernetes] Knative serving — <https://docs.cloud.google.com/kubernetes-engine/enterprise/knative-serving/docs/setup> — Still live, but Knative on GKE belongs in the Serverless branch, not Kubernetes. Move, do not delete.
- [Kubernetes] Overview — <https://docs.cloud.google.com/migrate/containers/docs/getting-started> — Migrate to Containers is a migration topic, and it lost its console UI, migctl and CRDs in May 2024. Move to the Migration branch.
- [Kubernetes] Architecture — <https://docs.cloud.google.com/migrate/containers/docs/m2c-cli/architecture> — Migrate to Containers is a migration topic. Move to the Migration branch.
- [Kubernetes] Example VM move — <https://docs.cloud.google.com/migrate/containers/docs/migrate-vm> — Migrate to Containers is a migration topic. Move to the Migration branch.
- [Kubernetes] Migration docs — <https://docs.cloud.google.com/migration-center/docs> — Migration Center is not a Kubernetes topic. Move to the Migration branch.
- [Kubernetes] Migration Center overview — <https://docs.cloud.google.com/migration-center/docs/migration-center-overview> — Migration Center is not a Kubernetes topic. Move to the Migration branch.
- [Kubernetes] Manage Identity with GKE Identity Service — <https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/vmware/docs/conc>

epts/authentication — GDC on VMware operational detail. Subsection 15 is a pointer only.

- [Kubernetes] Hardening on-prem (VMware) clusters —
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/vmware/docs/how-to/hardening-your-cluster> — GDC on VMware operational detail. Subsection 15 is a pointer only.
- [Kubernetes] Load Balancer configuration options (on-prem VM Ware) —
<https://docs.cloud.google.com/kubernetes-engine/distributed-cloud/vmware/docs/how-to/setup-load-balance> — GDC on VMware operational detail. Subsection 15 is a pointer only.
- [Kubernetes] Setup (start here) —
<https://docs.cloud.google.com/kubernetes-engine/enterprise/docs/setup/on-premises> — On-premises setup flow under the retired GKE Enterprise framing. Subsection 15 is a pointer only.
- [Kubernetes] AWS —
<https://docs.cloud.google.com/kubernetes-engine/multi-cloud/docs/aws/concepts/gcp-managed-regions> — CONTENT_OUTDATED region list for GKE on AWS, which enters end of support 17 Mar 2027. Replaced by the deprecation announcement.
- [Kubernetes] Azure —
<https://docs.cloud.google.com/kubernetes-engine/multi-cloud/docs/azure/reference/supported-regions> — CONTENT_OUTDATED region list for GKE on Azure, which enters end of support 17 Mar 2027. Replaced by the deprecation announcement.
- [Kubernetes]
<https://cloud.google.com/service-mesh/docs/security/certificate-authority-service> —
<https://docs.cloud.google.com/service-mesh/docs/security/certificate-authority-service> — Exact duplicate of the CA Service link above it, and its label was only the raw URL.
- [Kubernetes] In cluster —
<https://docs.cloud.google.com/service-mesh/docs/supported-features> — Labelled 'In cluster' but this URL resolves to the managed control plane feature page, duplicating the Managed CSM row. The real in-cluster page is added as a new link.
- [Kubernetes] Overview —
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/multi-cluster-services> — Duplicate of the Multi-cluster Services concept link now in Fleets and multi-cluster management.
- [Kubernetes] Configuring —
<https://docs.cloud.google.com/kubernetes-engine/docs/how-to/multi-cluster-services>

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- Duplicate of the Multi-cluster Services how-to link now in Fleets and multi-cluster management.
 - [Kubernetes] GKE related IAM roles —
<https://docs.cloud.google.com/iam/docs/understanding-roles#kubernetes-engine-roles>
— WRONG_PAGE - the #kubernetes-engine-roles anchor no longer resolves. Replaced by the GKE Access control page.
 - [Kubernetes] GKE editions (Standard vs Enterprise) —
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/gke-editions> — Page retired. GKE has had no editions or tiers since 23 Sep 2025 and clusters no longer carry a tier attribute.
 - [Kubernetes] Pod concepts —
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/pod> — The GKE Pod concept page is gone. Replaced by the [kubernetes.io](https://kubernetes.io/docs/concepts/pods/) Pods page.
 - [Kubernetes] Pods —
<https://docs.cloud.google.com/kubernetes-engine/docs/concepts/pod> — Duplicate of the row above, same retired GKE Pod concept page.
 - [Kubernetes] Create and manage multiple similar clusters — <https://gardener.cloud/> — Gardener is SAP's Kubernetes-as-a-service. Out of scope for a Google Cloud course.
 - [Kubernetes]
<https://kubernetes.io/docs/reference/generated/kubect/kubectl-commands> —
<https://kubernetes.io/docs/reference/generated/kubect/kubectl-commands> —
CONTENT_OUTDATED generated command dump. Replaced by the [kubectl](https://kubernetes.io/docs/reference/kubectl/) reference hub.
 - [Kubernetes] Cool instance calculator —
<https://learnk8s.io/kubernetes-instance-calculator> — UNREADABLE - the interactive instance calculator no longer renders.
 - [Kubernetes] YAML cheat sheet — <https://lzone.de/cheat-sheet/YAML> — UNREADABLE - lzone YAML cheat sheet.
 - [Kubernetes]
<https://unofficial-kubernetes.readthedocs.io/en/latest/user-guide/kubectl-cheatsheet/>
—
<https://unofficial-kubernetes.readthedocs.io/en/latest/user-guide/kubectl-cheatsheet/>
— CONTENT_OUTDATED unofficial cheat sheet that duplicates the official [kubectl](https://kubernetes.io/docs/reference/kubectl/) quick reference in this subsection.

- [Kubernetes] Using Envoy as a front proxy — <https://medium.com/cloudx-at-fidelity/using-envoy-as-a-front-proxy-c7b49cc6d4cf> — Medium paywall.
- [Kubernetes] Envoy proxy 101 — <https://www.getambassador.io/learn/envoy-proxy/> — Flagged RETIRED.
- [Kubernetes] (legacy fluentd) — <https://docs.cloud.google.com/architecture/customizing-stackdriver-logs-fluentd> — Flagged RETIRED - legacy Stackdriver plus fluentd logging customisation.
- [Kubernetes] <https://cloud.google.com/community/tutorials/kubernetes-engine-customize-fluentbit> — <https://docs.cloud.google.com/community/tutorials/kubernetes-engine-customize-fluentbit> — Flagged RETIRED - the Cloud community tutorials programme is wound down.
- [Kubernetes] Open source Istio mesh visualization with Kiali — <https://kiali.io/> — Duplicate of the Kiali link in Istio and Envoy.
- [Kubernetes] Configure Liveness, Readiness and Startup Probes — <https://kubernetes.io/docs/tasks/configure-pod-container/configure-liveness-readiness-startup-probes/> — Duplicate of the probes link in Kubernetes core concepts.
- [Kubernetes] Info on deploying Windows pods — <https://cloud.google.com/blog/products/containers-kubernetes/how-to-deploy-a-windows-container-on-google-kubernetes-engine> — Windows on GKE - dropped per Patrick.
- [Kubernetes] GKE docs on Windows Applications — <https://docs.cloud.google.com/kubernetes-engine/docs/how-to/deploying-windows-app> — Windows on GKE - dropped per Patrick.
- [ML/AI] Getting started with AgentSpace Enterprise — <https://cloud.google.com/agentspace/agentspace-enterprise/docs/quickstart-agentspace> — Dead. AgentSpace brand retired; replaced by the Gemini Enterprise quickstart added below.
- [ML/AI] NotebookLM Enterprise — <https://cloud.google.com/agentspace/notebooklm-enterprise/docs/overview> — Dead. NotebookLM Enterprise is now Gemini Notebook Enterprise; replacement added below.
- [ML/AI] Demo — <https://cloud.google.com/dlp/demo/#/> — Unreadable JS-only demo behind a URL fragment; no stable target. Sensitive Data Protection docs cover it.
- [ML/AI] Quickstarts — <https://cloud.google.com/natural-language/docs/quickstarts> — Redundant with the Natural Language how-to guides, and the pre-trained NL API is largely superseded by Gemini. Three NL API links is enough shelf space.

- [ML/AI] Vertex AI code samples — <https://cloud.google.com/vertex-ai/docs/samples> — Audit verdict RETIRED - frozen page carrying the 'no longer being updated' banner. The vertex-ai-samples GitHub repo is the live equivalent and is kept.
- [ML/AI] (GenAI) — <https://github.com/GoogleCloudPlatform/generative-ai/tree/main> — Exact duplicate of the generative-ai repo root, and it appeared twice in the source file.
- [ML/AI] Kubeflow on GCP — <https://googlecloudplatform.github.io/kubeflow-gke-docs/docs/> — Community GitHub Pages site for Kubeflow on GKE, effectively unmaintained. Agent Platform Pipelines is the supported managed path and is kept.
- [ML/AI] Perspectives on issues in AI governance — <https://ai.google/static/documents/perspectives-on-issues-in-ai-governance.pdf> — Dead. 2019 whitepaper pulled by Google; NIST SP 1270 covers the same ground and is live.
- [ML/AI] <https://neptune.ai/blog/performance-metrics-in-machine-learning-complete-guide> — <https://neptune.ai/blog/performance-metrics-in-machine-learning-complete-guide> — Now redirects to an OpenAI acquisition announcement - the metrics guide is gone. Analytics Vidhya metrics article is kept in its place.
- [ML/AI] Overview — <https://cloud.google.com/vertex-ai/docs/generative-ai/image/overview> — Frozen Vertex AI page carrying the 'no longer being updated' banner. Imagen and the media models now live under Model Garden, added below.
- [ML/AI] Distilling purpose-built models — <https://cloud.google.com/vertex-ai/docs/generative-ai/models/distill-text-models> — Dead. Model distillation docs removed in the Agent Platform migration; no successor page.
- [ML/AI] Large Language Models (LLMs) concepts guide — <https://developers.generativeai.google/guide/concepts> — Dead host. Folded into ai.google.dev, which is already linked.
- [ML/AI] Understanding ReAct — <https://generativeai.pub/understand-react-and-how-it-works-in-three-minutes-f5f57a404a82> — HTTP 403 / Medium paywall. ReAct is now better taught from the ADK multi-agent docs, added below.
- [ML/AI] (GenAI) — <https://github.com/GoogleCloudPlatform/generative-ai/tree/main> — Exact duplicate of the generative-ai repo root, and it appeared twice in the source file.

- [Data] Data Catalog overview:
<https://docs.cloud.google.com/data-catalog/docs/concepts/overview> —
<https://docs.cloud.google.com/data-catalog/docs/concepts/overview> — Data Catalog discontinued 1 June 2026 — superseded by Dataplex Universal Catalog
- [Data] How-to guides: <https://cloud.google.com/data-catalog/docs/how-to> —
<https://cloud.google.com/data-catalog/docs/how-to> — Data Catalog discontinued 1 June 2026 — superseded by Dataplex Universal Catalog
- [Data] Tagging BigQuery tables example:
<https://cloud.google.com/data-catalog/docs/quickstart-tagging> —
<https://cloud.google.com/data-catalog/docs/quickstart-tagging> — Data Catalog discontinued 1 June 2026 — superseded by Dataplex Universal Catalog
- [Data] DataPrep: <https://cloud.google.com/dataprep/docs> —
<https://cloud.google.com/dataprep/docs> — Cloud Dataprep is no longer a Google-hosted product
- [Dev/Security] Vertex AI — <https://cloud.google.com/vertex-ai/docs/samples> — The Vertex AI sample browser now carries a banner saying the Vertex AI documentation is no longer updated and the services have moved to the Gemini Enterprise Agent Platform. Samples for that platform belong in the ML/AI branch, not here.
- [Dev/Security] BigQuery BigFrame (DataFrame) notebook examples —
<https://github.com/googleapis/python-bigquery-dataframes/tree/main/notebooks> — Repository archived by the owner and now read-only. BigFrames belongs in the Data/BigQuery branch anyway.
- [Dev/Security] AI Notebooks —
<https://cloud.google.com/ai-platform/notebooks/docs/introduction> — Redirects to the Vertex AI deprecations page - AI Platform Notebooks / user-managed notebooks are shut down. Colab Enterprise and Workbench instances are covered in the ML/AI branch.
- [Dev/Security] Git cheat sheet —
<https://about.gitlab.com/images/press/git-cheat-sheet.pdf> — HTTP 404. GitLab pulled the PDF. This URL appeared twice (Code/Development and General Tools, the second time with the raw URL as its label); both copies go. The GitHub Git cheat sheet PDF covers the same ground.
- [Dev/Security] Artifact Management —
<https://cloud.google.com/artifact-management/docs/overview> — HTTP 404. The 'Artifact Management' product page no longer exists; replaced by the new Software supply chain security overview.

- [Dev/Security] Container Registry — <https://cloud.google.com/container-registry/docs/quickstart> — HTTP 404, and Container Registry itself was shut down on 18 March 2025. Replaced by the Artifact Registry overview and the transition guide.
- [Dev/Security] Spinnaker for GCP — <https://github.com/GoogleCloudPlatform/spinnaker-for-gcp> — Repository archived by the owner and read-only. Cloud Deploy is Google's answer here now.
- [Dev/Security] Useful Medium articles — <https://medium.com/tag/cloud-build> — An uncurated Medium tag feed, not a resource. Returns 403 to anything but a browser and the top posts are years out of date.
- [Dev/Security] nano keyboard commands: — <https://staffwww.fullcoll.edu/sedwards/Nano/NanoKeyboardCommands.html> — Host no longer resolves (DNS failure).
- [Dev/Security] Free Formatter (JSON, YAML, CRON, etc) — <https://www.freeformatter.com/> — The site now displays a notice that FreeFormatter is retired and no longer offers formatting services.
- [Dev/Security] GCP Policy library — <https://github.com/GoogleCloudPlatform/policy-library> — Repository archived by the owner on 20 August 2025. The gcloud terraform vet page and Organization Policy custom constraints cover this now.
- [Dev/Security] Terraformer — <https://github.com/GoogleCloudPlatform/terraformer> — The README states Terraformer is deprecated and no longer maintained, and the repo is archived read-only. gcloud resource-config bulk-export is the supported path.
- [Dev/Security] Managing IaC with Terraform, Cloud Build, and GitOps — <https://cloud.google.com/architecture/managing-infrastructure-as-code> — Redirects to docs.cloud.google.com/docs/terraform/resource-management/managing-infrastructure-as-code, which was already listed separately in the same subsection. Kept the canonical copy.
- [Dev/Security] Secure foundations blueprint guide (how Google thinks you should build your org) — <https://services.google.com/fh/files/misc/google-cloud-security-foundations-guide.pdf> — Stale PDF snapshot of a guide that has since been renamed the enterprise foundations blueprint and moved to a maintained web page. This URL appeared twice (Terraform and Resource Management); both copies go, replaced by the live blueprint guide in the Security branch.

- [Dev/Security] Integrating Cloud Identity with 3rd-party user or IdPs — <https://support.google.com/cloudidentity/topic/7558767> — Now redirects to the generic Cloud Identity how-to index, which has nothing about third-party IdP integration. Replaced by the single sign-on with an external identity provider architecture guide.
- [Dev/Security] Understanding constraints — <https://cloud.google.com/resource-manager/docs/organization-policy/understanding-constraints> — Redirects to the Organization Policy overview, which is already listed in the same subsection.
- [Dev/Security] Best practices for enterprises — <https://cloud.google.com/docs/enterprise/best-practices-for-enterprise-organizations> — Redirects to the Well-Architected Framework, already listed under 'Start here'.
- [Dev/Security] Forseti (security scanner) tutorials — <https://cloud.google.com/community/tutorials/private-forseti-with-scc-integration> — Redirects into the archived Google Cloud Community tutorials repo. Forseti Security is retired and its function was absorbed by Security Command Center.
- [Dev/Security] Forseti home page — <https://forsetisecurity.org/> — Forseti Security is retired; Google folded its scanning into Security Command Center. The site returns intermittent 503s and has not been updated in years.
- [Dev/Security] Best practices for DDOS protection — <https://cloud.google.com/files/GCPDDoSprotection-04122016.pdf> — A 2016 PDF whitepaper that predates Cloud Armor Enterprise, Adaptive Protection and the current network edge policies. DDoS and Cloud Armor are covered in the Networking > Network Security branch.
- [Dev/Security] Architecture diagram tool — <https://googlecloudcheatsheet.withgoogle.com/architecture> — The architecture diagram tool is gone; the URL now dumps you on the generic Google Cloud products catalog.
- [Dev/Security] Operations suite cost optimization: <https://cloud.google.com/solutions/stackdriver-cost-optimization> — <https://cloud.google.com/solutions/stackdriver-cost-optimization> — guide retired; redirects to the generic Well-Architected Framework
- [Dev/Security] Operations suite cost optimization: <https://cloud.google.com/solutions/stackdriver-cost-optimization> — <https://cloud.google.com/solutions/stackdriver-cost-optimization> — guide retired; redirects to the generic Well-Architected Framework

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