THE UNIVERSITY OF CHICAGO

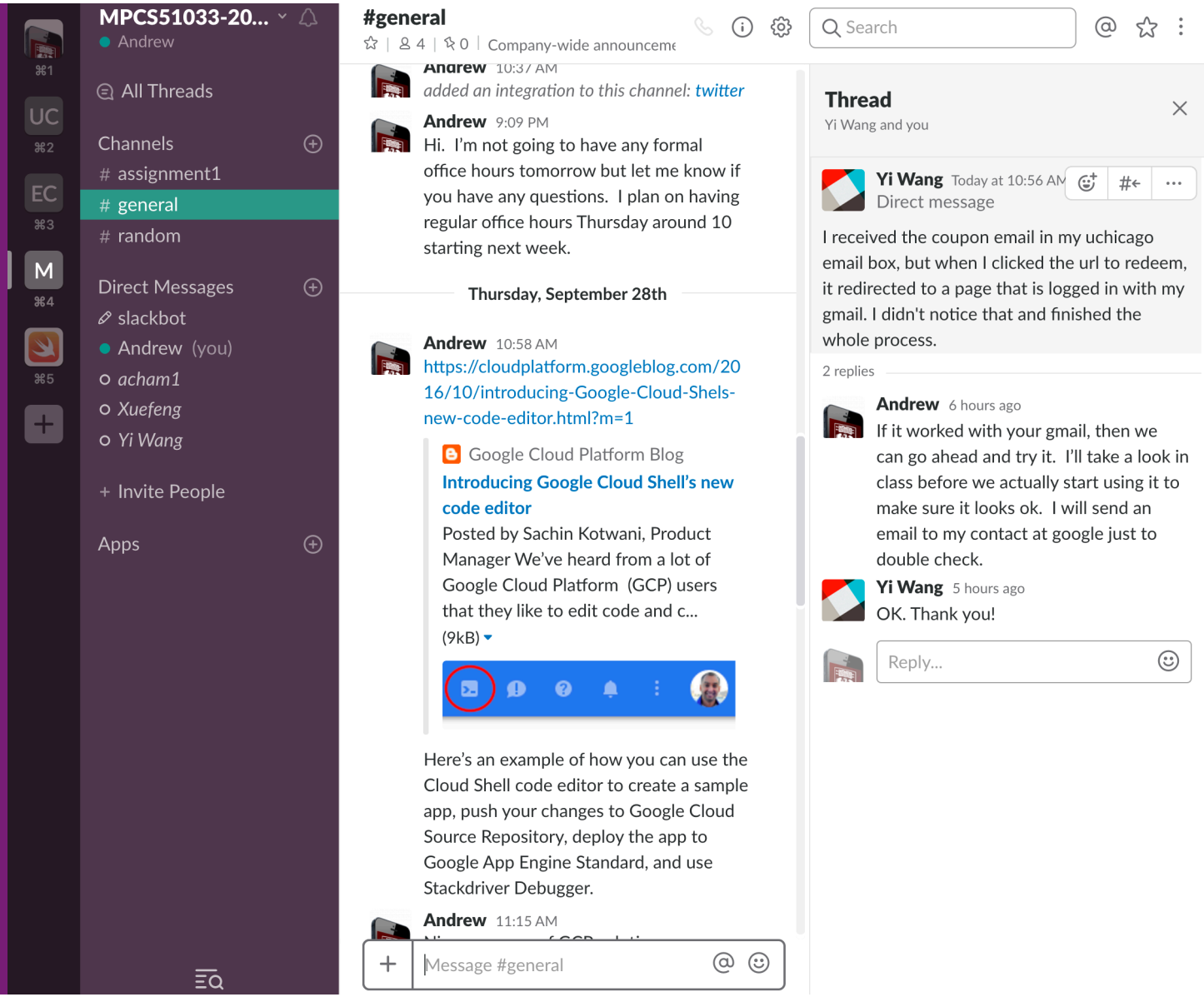
MPCS 51033 • AUTUMN 2017 • SESSION 2

BACKENDS FOR MOBILE APPLICATIONS

CLASS NEWS

CLASS NEWS

- Office hours Thursday 10AM in Young 308
- Threading in Slack



MOBILE APP BACKEND SERVICES WITH GCP

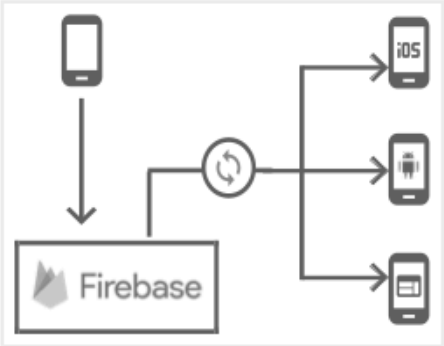
BACKEND SERVICES WITH GCP

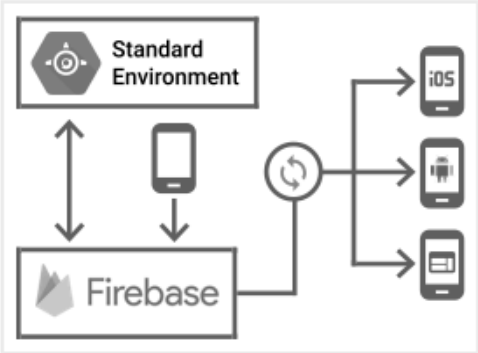
- Apple's trend is to do almost everything on device. Why do we need a backend?
- Most mobile apps and games need a backend service for things that can’t be done solely on-device
  - Sharing and processing data from multiple users
  - Storing large files
  - Group analytics statistics (leaderboard)

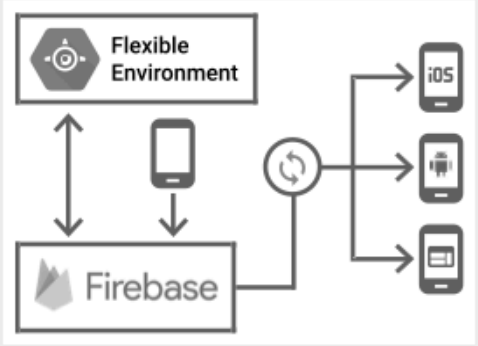
BACKEND SERVICES WITH GCP

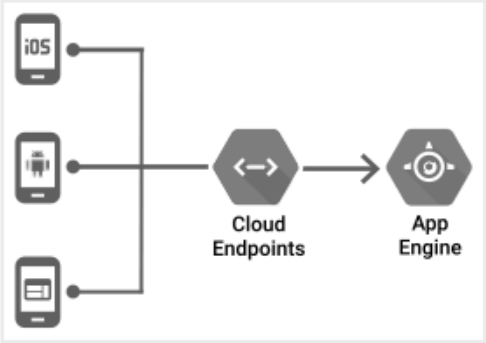
- Building a backend service for a mobile app is similar to building a web-based service, with some additional considerations
  - Limit on-device data storage
  - Synchronize data across multiple devices
  - Handle the online/offline transition gracefully
  - Send notifications and messages
  - Minimize battery drain (be a good citizen)

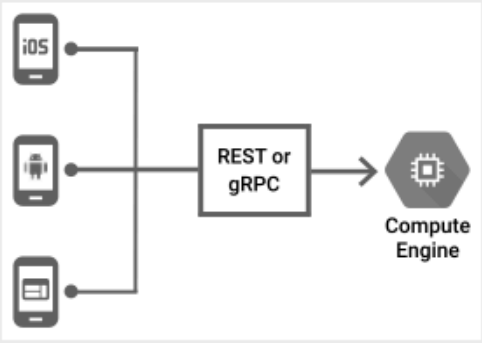
BACKEND SERVICES WITH GCP







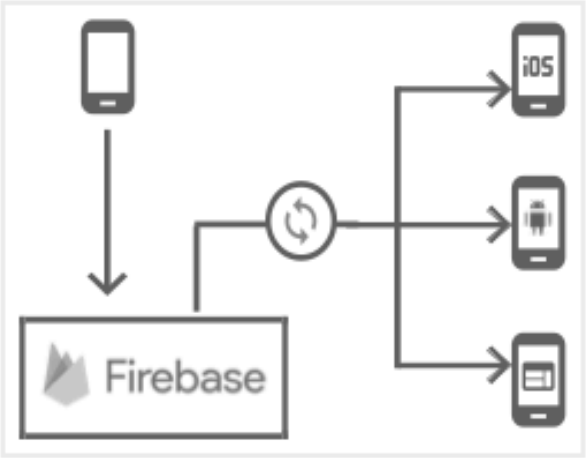


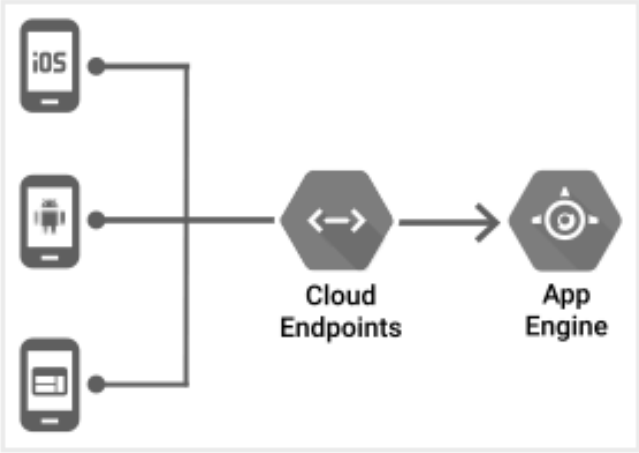


DESIGN PATTERNS USING GCP FOR BACKENDS SERVICES

BACKEND SERVICES WITH GCP

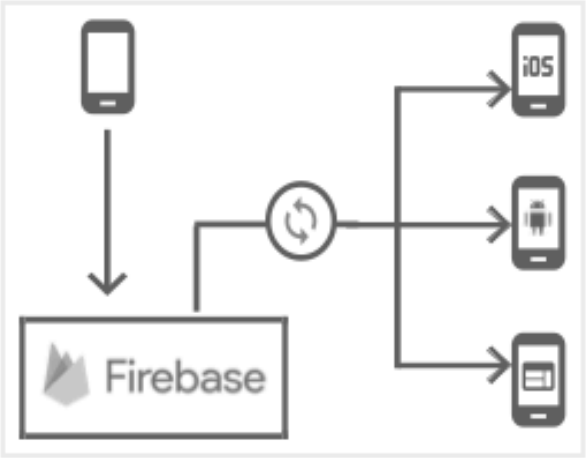
- Two-tier architecture with Firebase
  - Mobile app and Firebase manipulate data directly
  - Security and data validation handled in console

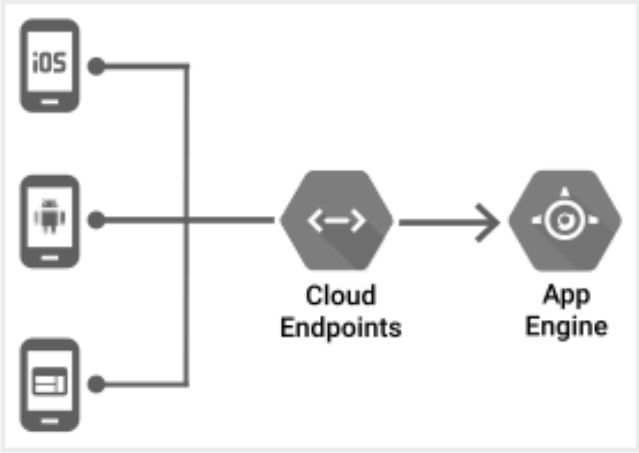




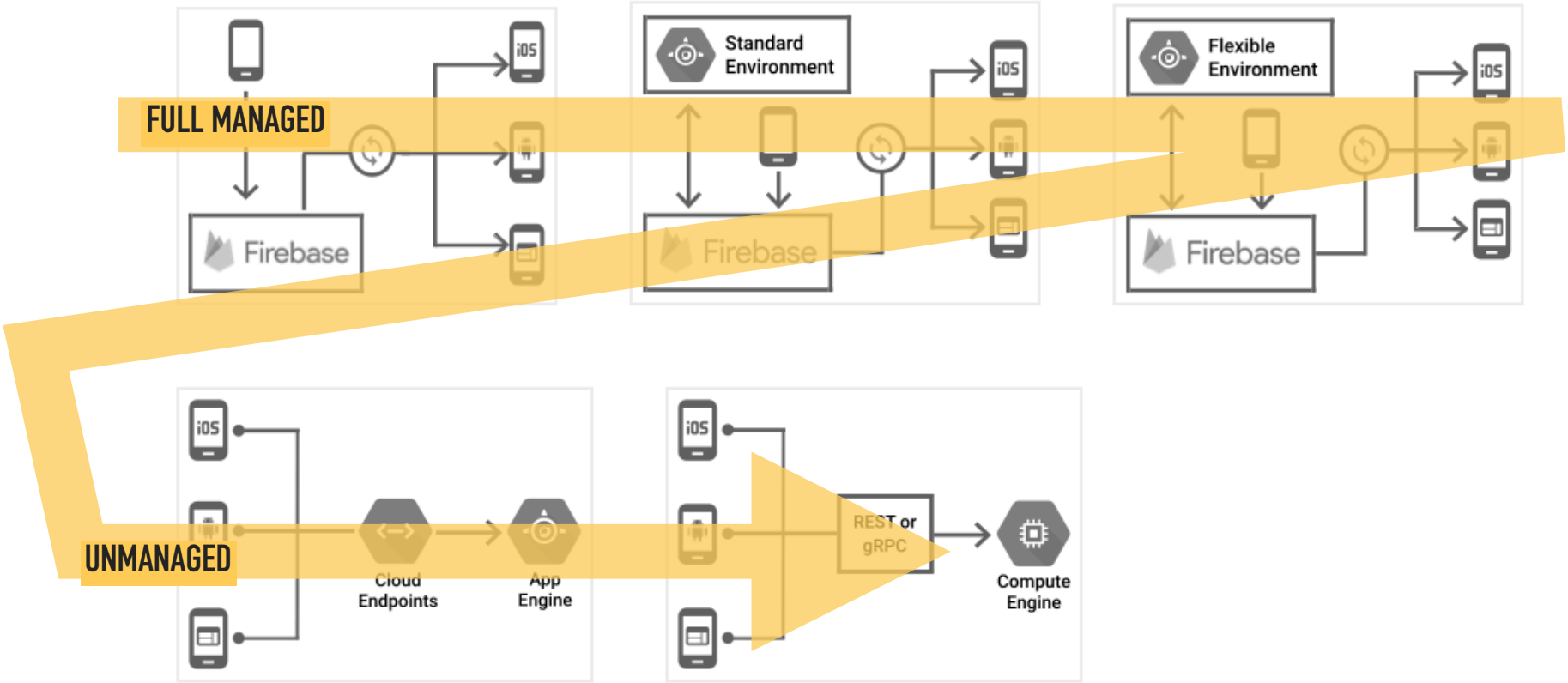
BACKEND SERVICES WITH GCP

- Three-tier architecture with App Engine
  - Communication layer between app and backend
  - Responsible for authentication and data-validation



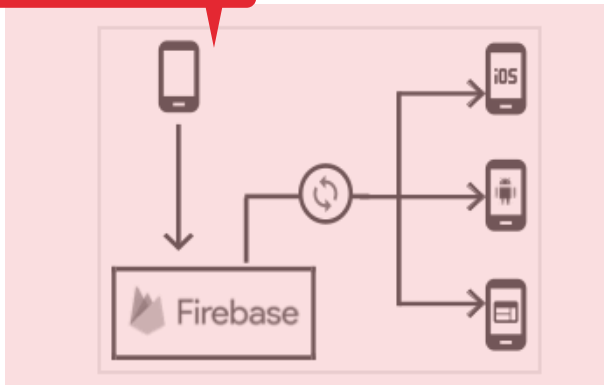


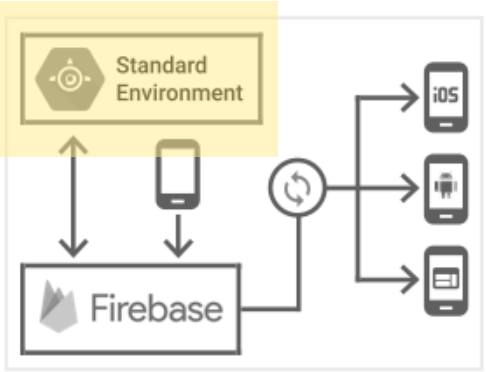
BACKEND SERVICES WITH GCP

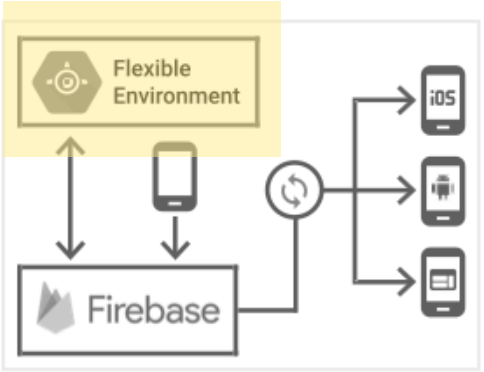


BACKEND SERVICES WITH GCP

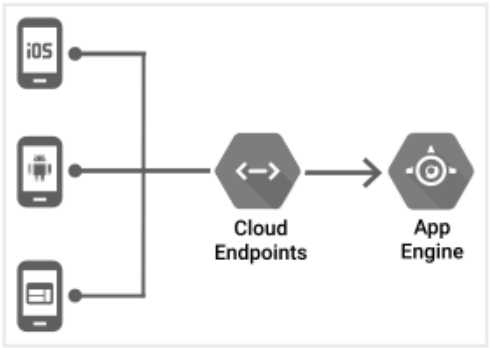
LATER IN THE COURSE

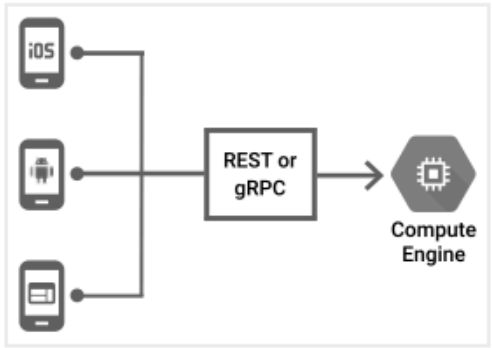






HYBRID PROVIDES MIX OF EASE OF USE AND FLEXIBILITY



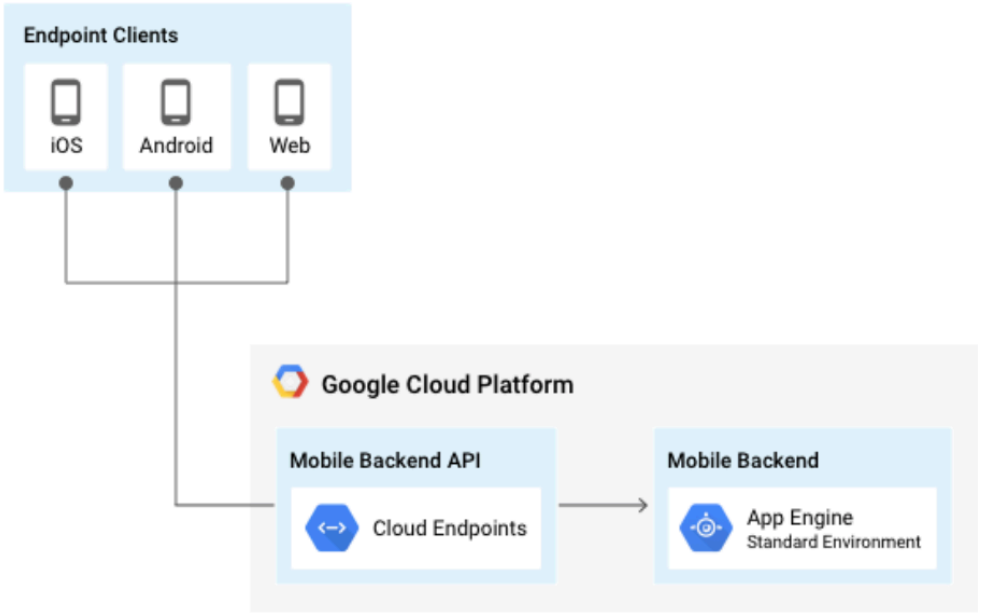


CLOUD ENDPOINTS

BACKEND SERVICES WITH GCP

CLOUD ENDPOINTS

- Google Cloud Endpoints generates APIs, client libraries, and discovery documentation for an App Engine application
- You don't write wrappers to handle communication with App Engine
- Cient libraries are generated by Cloud Endpoints to make direct API calls from your mobile app



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Cloud Endpoints

About Cloud Endpoints Frameworks

Contents

Google Cloud Endpoints Frameworks for App Engine consists of tools, libraries and capabilities that allow you to generate APIs and client libraries from an App Engine application. Referred to as an *API*, they simplify client access to data from other applications, such as web clients and Android mobile clients.

★ **Note:** Cloud Endpoints Frameworks supports only the App Engine standard environment; the App Engine flexible environment is not supported.

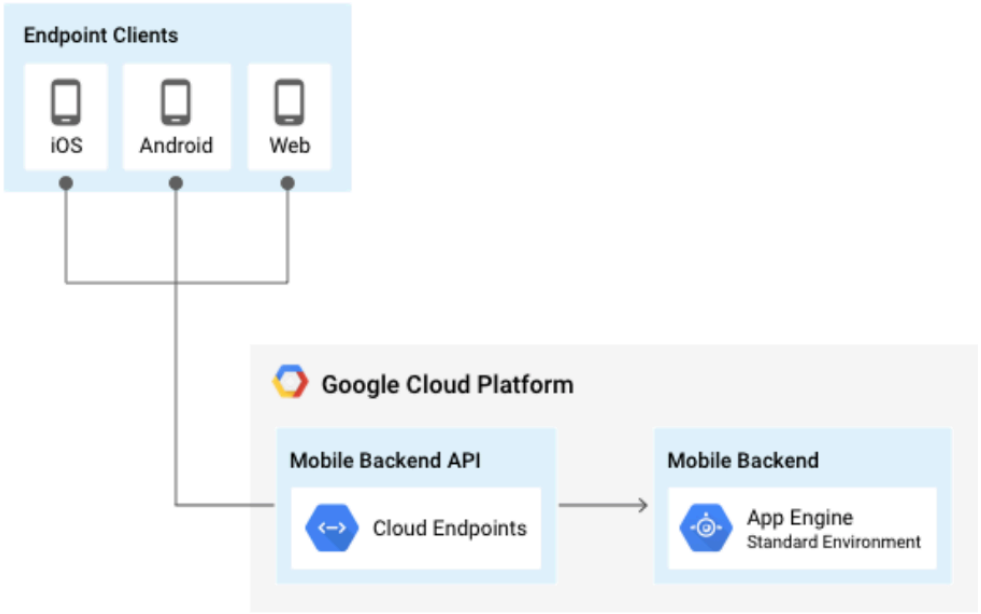
Cloud Endpoints Frameworks supports the following API management features provided by Cloud Endpoints:

- API key management
- API sharing
- user authentication
- View API metrics
- View API logs

BACKEND SERVICES WITH GCP

CLOUD ENDPOINTS

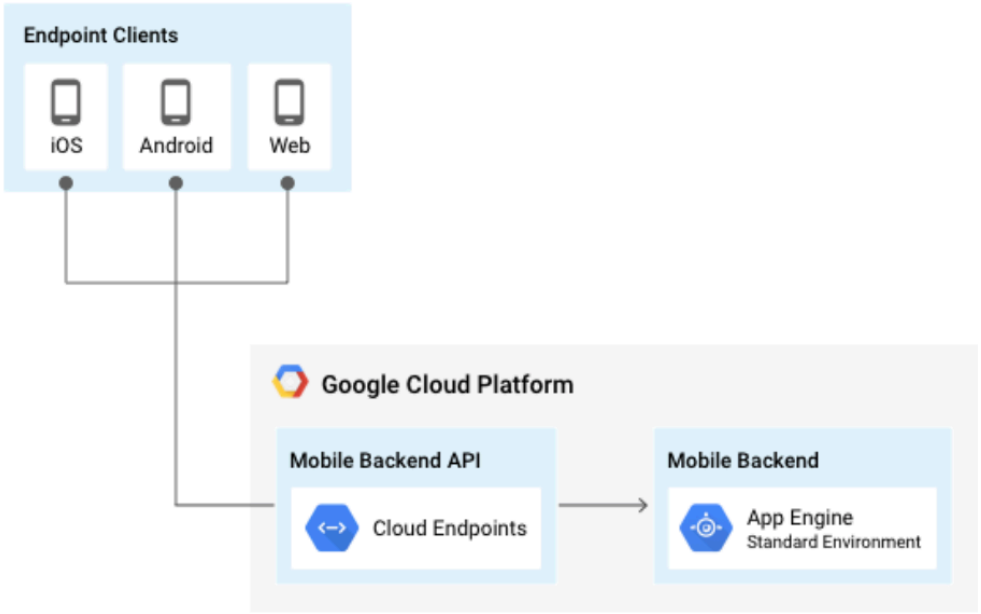
- Recommended use
  - Automated generation of client libraries that apps can use to call the backend service directly (ie ease of use)
  - Reducing on-device storage by moving files to Cloud Storage
  - Sending notifications by calling Cloud Messaging



BACKEND SERVICES WITH GCP

CLOUD ENDPOINTS

- Not recommended for
  - Apps that require automatic real-time data synchronization across devices
  - Backend services that require custom server or third party libraries.
  - Systems that do not support SSL; SSL is required by Cloud Endpoints.



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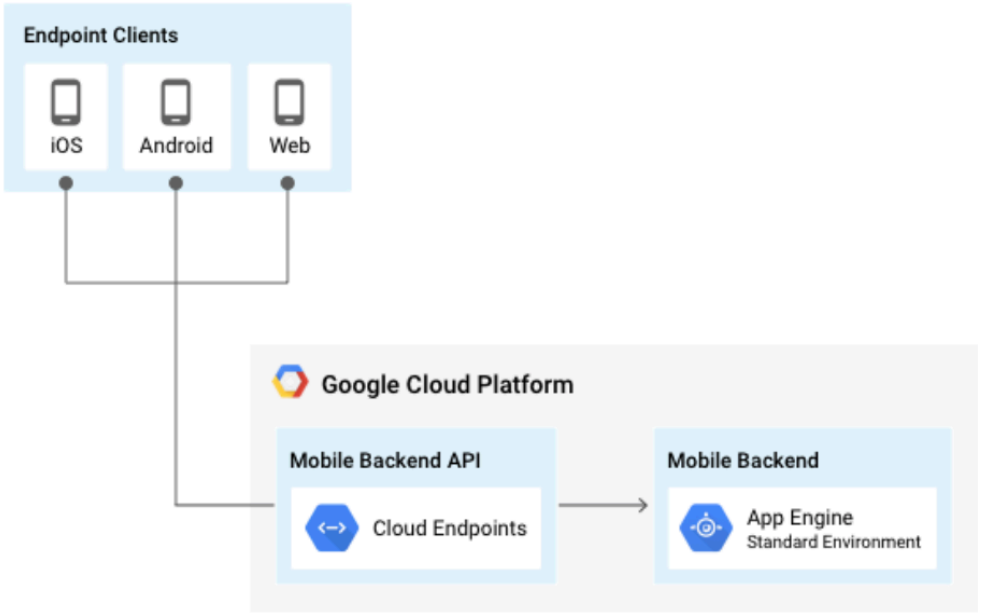
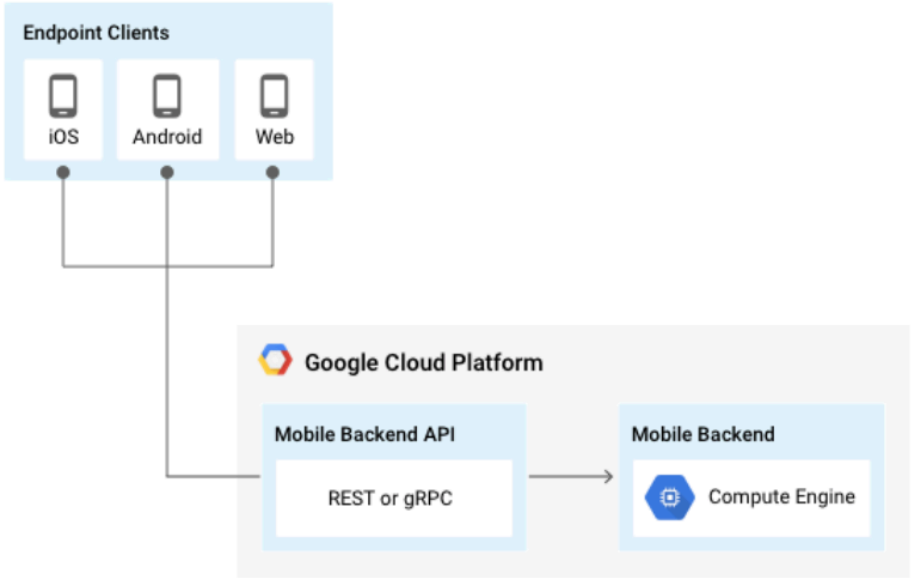


COMPUTE ENGINE

BACKEND SERVICES WITH GCP

COMPUTE ENGINE

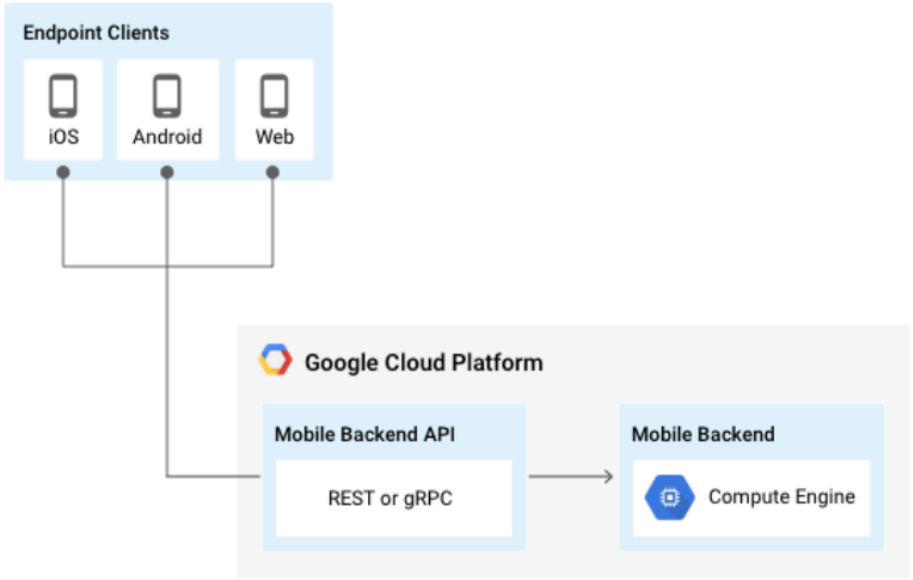
- Computer Engine lets you create and run virtual machines on Google infrastructure
- You have administrator rights to the server and full control over its configuration
    - You are responsible for updates and maintenance :(



BACKEND SERVICES WITH GCP

COMPUTE ENGINE

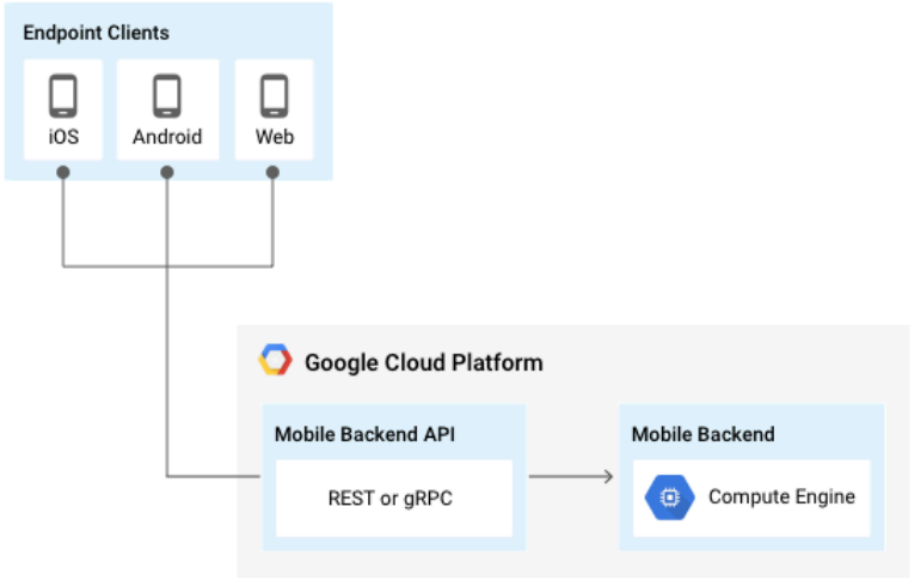
- Recommended for:
  - Porting an existing backend service running on an on-premise server or a virtual machine.
  - Backend services that require a custom server or third-party libraries.



BACKEND SERVICES WITH GCP

COMPUTE ENGINE

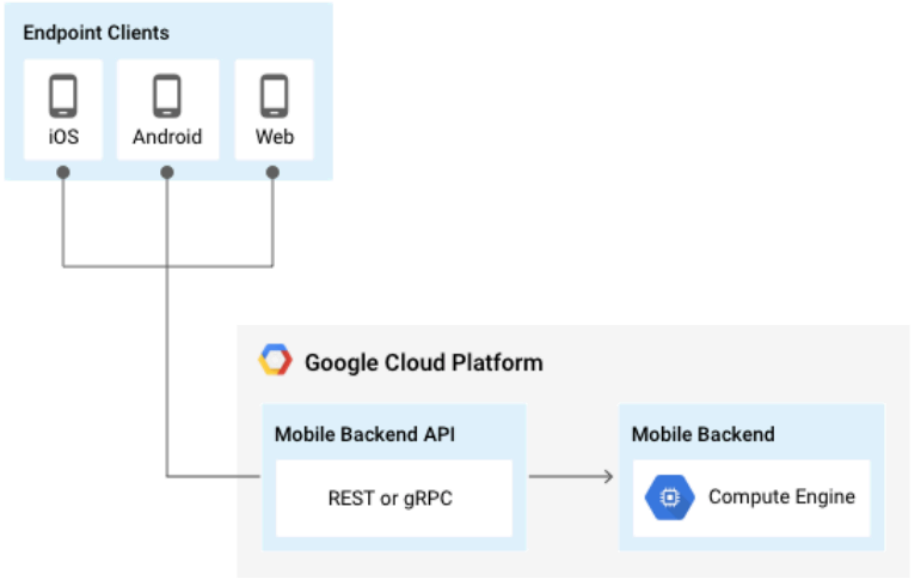
- Not recommended for:
  - Apps that require automatic real-time data synchronization across devices.
  - Automatic maintenance; you must maintain and upgrade the server yourself.
  - Automatic scaling; you must manually configure and manage an autoscaler.



BACKEND SERVICES WITH GCP

COMPUTE ENGINE

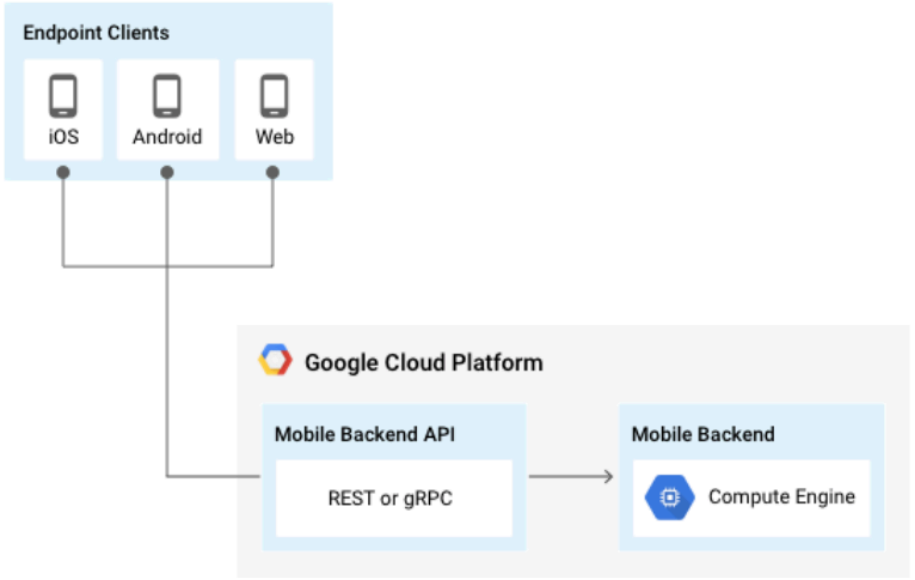
- Protocols used to connect to compute engine
  - REST - architecture based on HTTP
  - gRPC - framework using http/2



APP ENGINE

BACKEND SERVICES WITH GCP

- Everything that follows



APP WALK THROUGH: PHOTO TIMELINE

PHOTO TIMELINE

- Backend for a photo timeline application
- App behaviors
  - Users post pictures with a comment
  - Users retrieve pictures

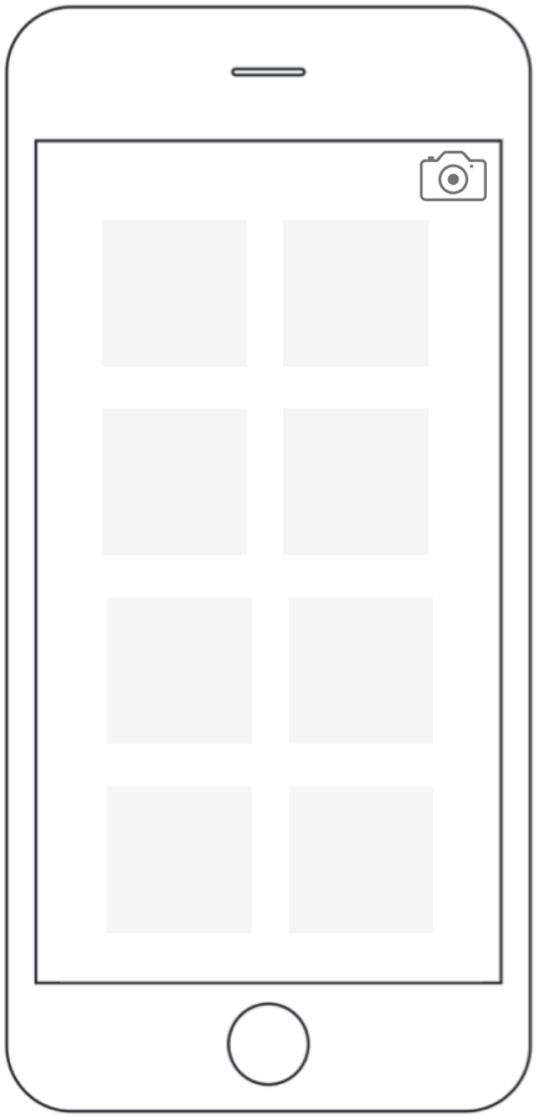
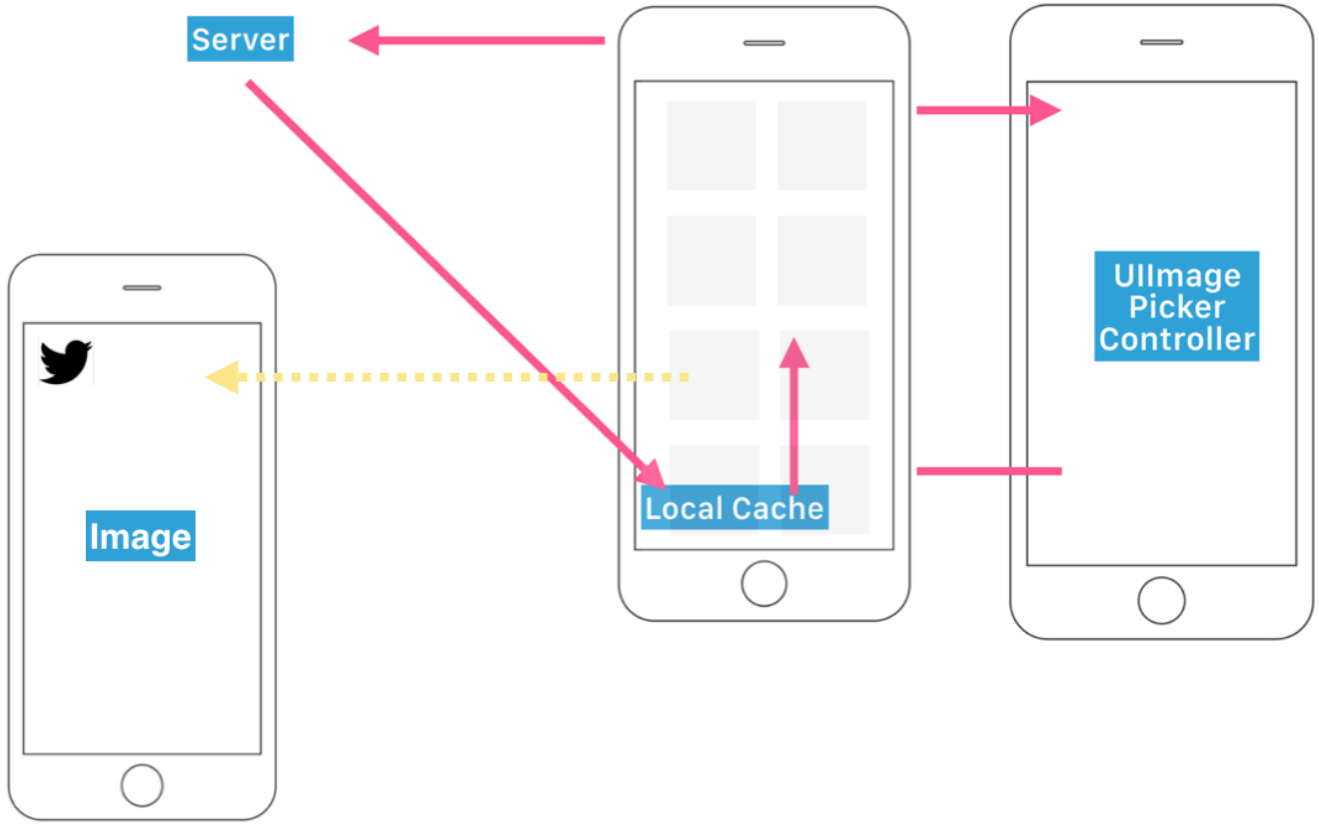


PHOTO TIMELINE



API

API

Get a json list of most recent submitted pictures

```
http://--.appspot.com/user/<USERNAME>/json/
```

See a list of the most recent on a web page (useful for debugging

```
http://--.appspot.com/user/<USERNAME>/web/
```

Endpoint for posting images to server. There is an optional "caption" parameter that you can use.

```
http://--.appspot.com/user/<USERNAME>/post/
```

PHOTO TIMELINE

API

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# Get a json list of most recent submitted pictures
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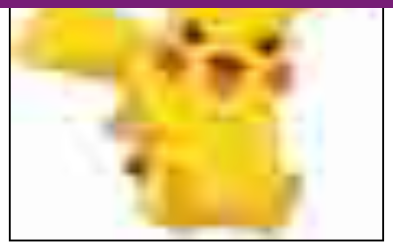
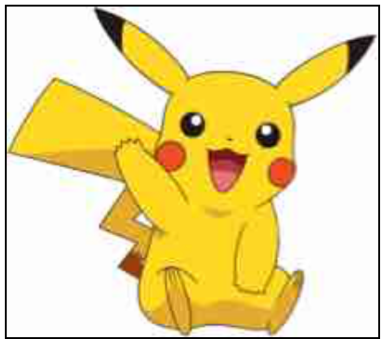


Caption: bye
User: tabinks
Date:2016-08-01 14:13:30.511470

http://stachesandglasses.appspot.com/user/tabinks/web/



Caption: bye
User: tabinks
Date:2016-08-01 14:06:58.791530

API

"user": "default"}, {"date": "2015-04-15 08:55:14.177850", "caption": "Test2", "image_url":
"image/ahNzfnN0YWNoZXNhbmRnbGFzc2Vzch4LEgRVc2VyIgdkZWZhdWx0DAsSBVBob3RvGIm
"user": "default"}, {"date": "2014-04-29 17:20:39.047800", "caption": "", "image_url":
"image/ahNzfnN0YWNoZXNhbmRnbGFzc2Vzch0LEgRVc2VyIgdkZWZhdWx0DAsSBVBob3RvGPl
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"image/ahNzfnN0YWNoZXNhbmRnbGFzc2Vzch0LEgRVc2VyIgdkZWZhdWx0DAsSBVBob3RvGOk
"user": "default"}, {"date": "2013-05-08 18:11:30.375380", "caption": "test", "image_url":
"image/ahNzfnN0YWNoZXNhbmRnbGFzc2VzchwLEgRVc2VyIgdkZWZhdWx0DAsSBVBob3RvGA
"user": "default"}]}

http://stachesandglasses.appspot.com/user/tabinks/json/

API

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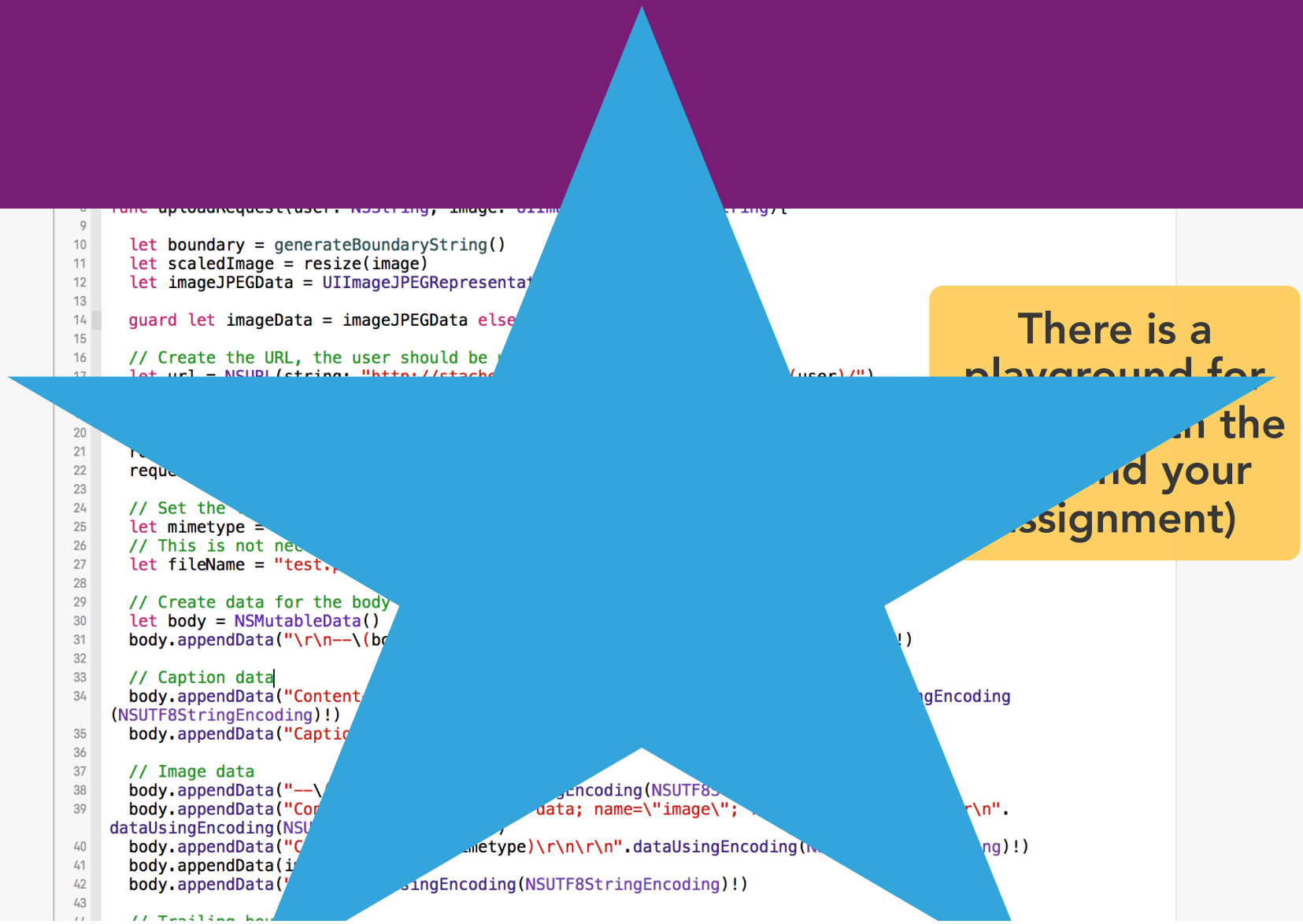
API



FILE STRUCTURE

PHOTO TIMELINE

- Application files
  - app.yaml - App Engine application settings
  - main.py - Main application
  - models.py - Datastore models
  - index.yaml - Generated files for indexing

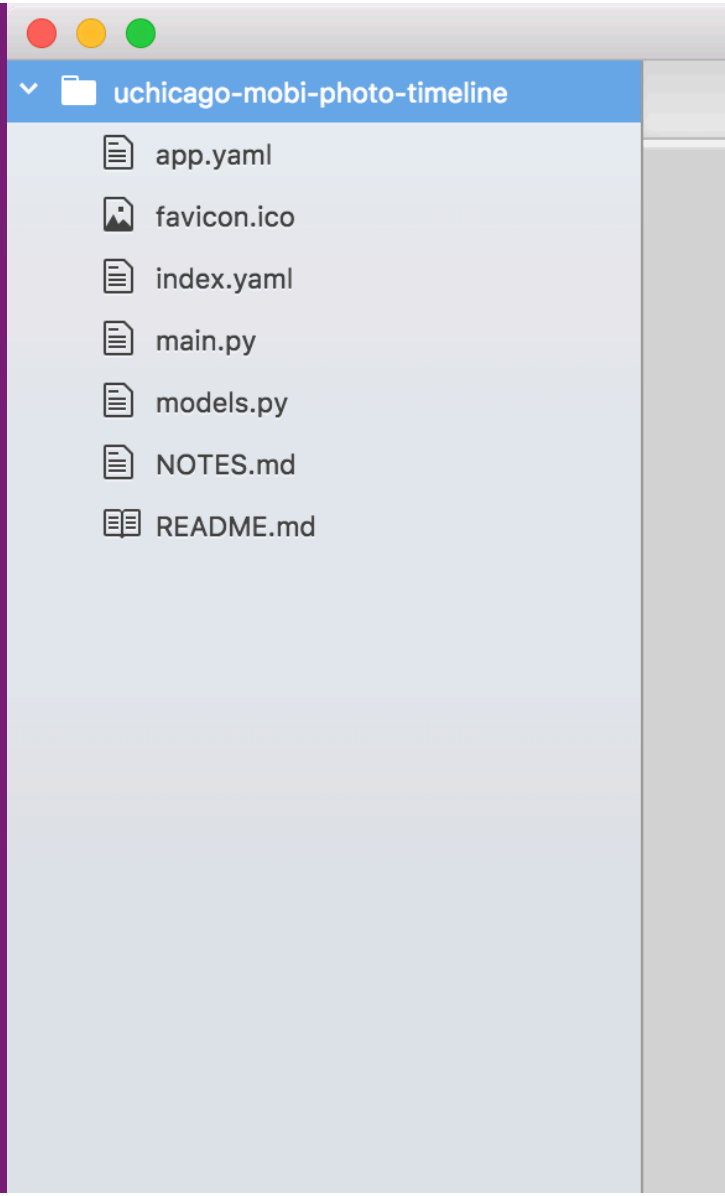


PHOTO TIMELINE

- app.yml file
- More options
  - Specify machines
  - Global variables
  - ...

How should the application route requests

libraries to import

```
application: uchicago-mobi-photo-timeline
runtime: python27
api_version: 1
threadsafe: true

# [START handlers]
handlers:
- url: /favicon\.ico
  static_files: favicon.ico
  upload: favicon\.ico

- url: /.*
  script: main.app
# [END handlers]

# [START libraries]
libraries:
- name: webapp2
  version: latest
- name: jinja2
  version: latest
# [END libraries]

skip_files:
- ^(.*/)?#.*#$
- ^(.*/)?.*~$
- ^(.*/)?.*\.py[co]$
- ^(.*/)?\..*$
- ^(.*/)?\.txt$
```

Environment

Files to skip when uploading

PHOTO TIMELINE

- models.py
  - Datastore classes
  - Common organization

Model class entities

class methods to query entities

```
from google.appengine.ext import ndb

class Photo(ndb.Model):
    """Models a user uploaded photo entry"""

    user = ndb.StringProperty()
    image = ndb.BlobProperty()
    caption = ndb.StringProperty()
    date = ndb.DateTimeProperty(auto_now_add=True)

    @classmethod
    def query_user(cls, ancestor_key):
        """Return all photos for a given user"""
        return cls.query(ancestor=ancestor_key).order(-cls.date)

    @classmethod
    def query_user_alternate(cls, ancestor_key):
        """Return all photos for a given user using the gql syntax.
        It returns the same as the above method.
        """
        return ndb.gql('SELECT * '
                       'FROM Photo '
                       'WHERE ANCESTOR IS :1 '
                       'ORDER BY date DESC LIMIT 10',
                       ancestor_key)
```

PHOTO TIMELINE

MODELS.PY

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@classmethod
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    """Return all photos for a given user"""
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                   ancestor_key)
```

same thing different way

PHOTO TIMELINE

MAIN.PY

URL Routing

```
app = webapp2.WSGIApplication([
    ('/', HomeHandler),
    webapp2.Route('/logging/', handler=LoggingHandler),
    webapp2.Route('/image/<key>/', handler=ImageHandler),
    webapp2.Route('/post/<user>/', handler=PostHandler),
    webapp2.Route('/user/<user>/<type>/',handler=UserHandler)
    ],
    debug=True)
```

PHOTO TIMELINE

MAIN.PY

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```

http://localhost:8080/

PHOTO TIMELINE

MAIN.PY

http://localhost:8080/logging/

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http://localhost:8080/post/<user>/

PHOTO TIMELINE

MAIN.PY

http://localhost:8080/image/<abcdefg12345>/

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    webapp2.Route('/logging/', handler=LoggingHandler),
    webapp2.Route('/image/<key>/', handler=ImageHandler),
    webapp2.Route('/post/<user>/', handler=PostHandler),
    webapp2.Route('/user/<user>/<type>/',handler=UserHandler)
    ],
    debug=True)
```

http://localhost:8080/user/<user>/json/

PHOTO TIMELINE

MAIN.PY

```
app = webapp2.WSGIApplication([
    ('/', HomeHandler),
    webapp2.Route('/logging/', handler=LoggingHandler),
    webapp2.Route('/image/<key>/', handler=ImageHandler),
    webapp2.Route('/post/<user>/', handler=PostHandler),
```

```
"""The home page of the app"""
class HomeHandler(webapp2.RequestHandler):

    """Show the webform when the user is on the home page"""
    def get(self):
```

PHOTO TIMELINE

```
    webapp2.Route('/image/<key>/', handler=ImageHandler),
    webapp2.Route('/post/<user>/', handler=PostHandler),
    webapp2.Route('/user/<user>/<type>/',handler=UserHandler)
    ],
    debug=True)

"""Handle requests for an image ebased on its key"""
class ImageHandler(webapp2.RequestHandler):

    def get(self,key):
        """Write a response of an image (or 'no image') based on a ke
        photo = ndb.Key(urlsafe=key).get()
        if photo.image:
```

PHOTO TIMELINE

```
    webapp2.Route('/post/<user>/', handler=PostHandler),
    webapp2.Route('/user/<user>/<type>/',handler=UserHandler)
    ],
    debug=True)
```

```
"""Handle activities associated with a given user"""
class UserHandler(webapp2.RequestHandler):

    """Print json or html version of the users photos"""
    def get(self,user,type):
        ancestor_key = ndb.Key("User", user)
```

PHOTO TIMELINE

- The URI (uniform resource identifiers) is a matter of style

```
app = webapp2.WSGIApplication([
    ('/', HomeHandler),
    webapp2.Route('/logging/', handler=LoggingHandler),
    webapp2.Route('/image/<key>/', handler=ImageHandler),
    webapp2.Route('/post/<user>/', handler=PostHandler),
    webapp2.Route('/user/<user>/<type>/',handler=UserHandler)
    ],
    debug=True)
```

/users/<user>/json

/?user=<user>&style=json

Same data is passed

PHOTO TIMELINE

```
# Test you application from the command line using `curl`


curl -X GET http://localhost:8080/

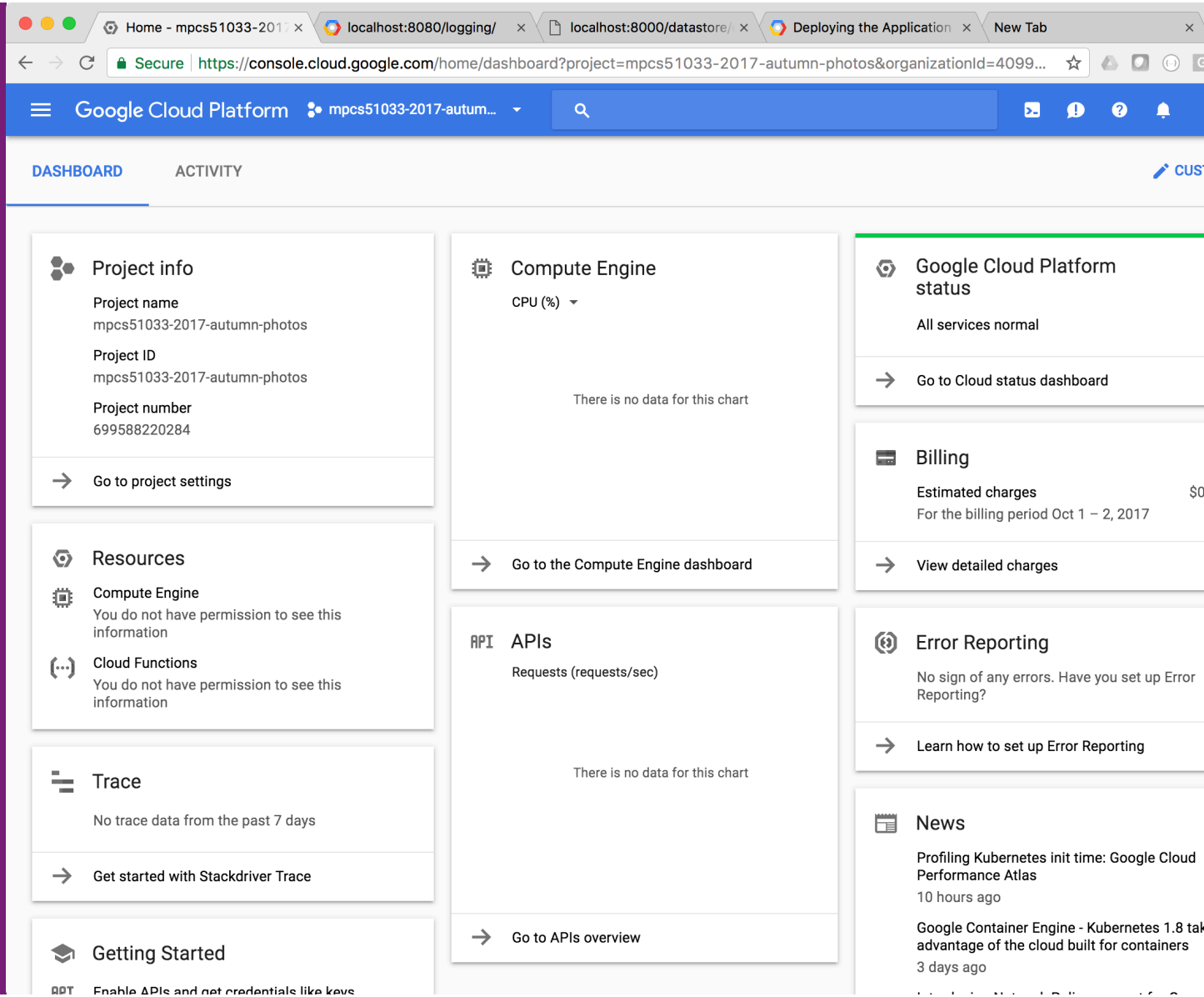

curl -X GET http://localhost:8080/user/default/json/


curl -X POST -H "Content-Type: multipart/form-data" -F
caption='curl' -F "image=@kitten.jpg"  http://localhost:
8080/post/lolakitty/
```

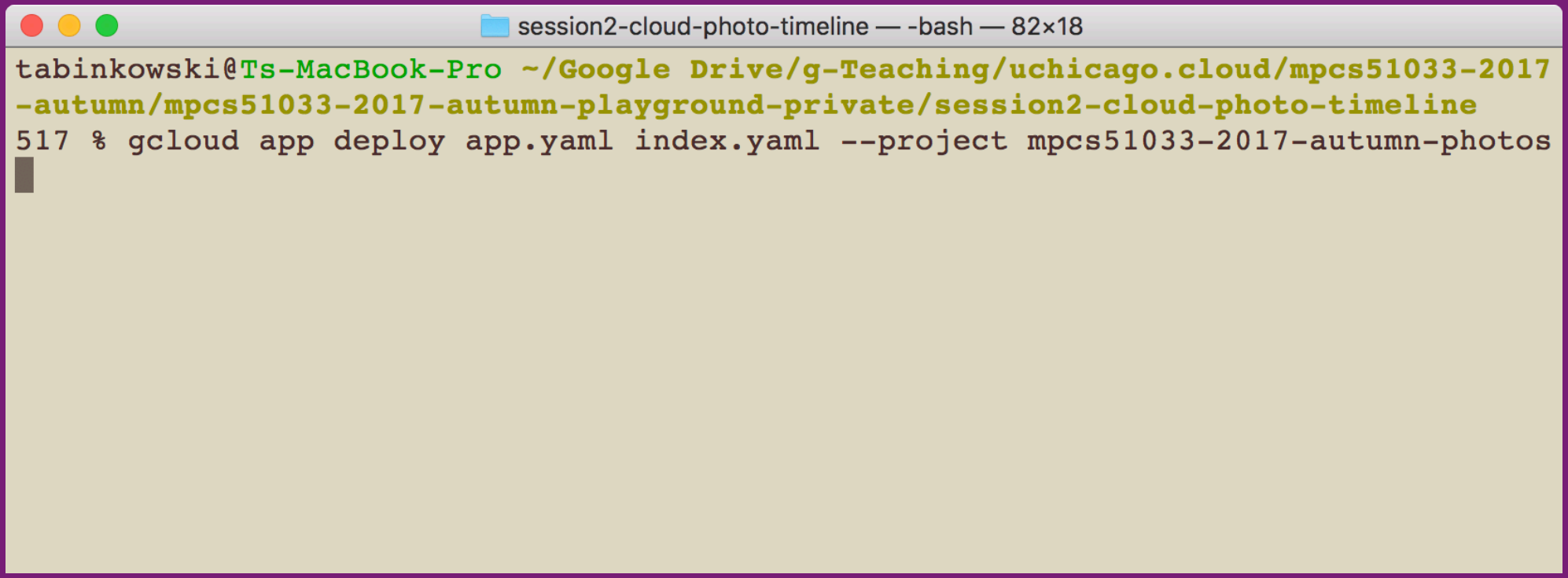
DEPLOY TO APP ENGINE

DEPLOY TO APP ENGINE

- Create a new project



DEPLOY TO APP ENGINE



- Deploy using gcloud

DEPLOY TO APP ENGINE

```
517 % gcloud app deploy app.yaml index.yaml --project mpcs51033-2017-autumn-photos
You are creating an app for project [mpcs51033-2017-autumn-photos].
WARNING: Creating an App Engine application for a project is irreversible and the region
cannot be changed. More information about regions is at
<https://cloud.google.com/appengine/docs/locations>.

Please choose the region where you want your App Engine application
located:

 [1] us-central    (supports standard and flexible)
 [2] europe-west   (supports standard and flexible)
 [3] europe-west3  (supports standard and flexible)
 [4] europe-west2  (supports standard and flexible)
 [5] us-east1      (supports standard and flexible)
 [6] us-east4      (supports standard and flexible)
 [7] asia-northeast1 (supports standard and flexible)
 [8] australia-southeast1 (supports standard and flexible)
 [9] southamerica-east1 (supports standard and flexible)
 [10] cancel
Please enter your numeric choice:
```

DEPLOY TO APP ENGINE

```
Services to deploy:

descriptor:      [/Users/tabinkowski/Google Drive/g-Teaching/uchicago.cloud/mpcs51033-2017-au
tumn/mpcs51033-2017-autumn-playground-private/session2-cloud-photo-timeline/app.yaml]
source:          [/Users/tabinkowski/Google Drive/g-Teaching/uchicago.cloud/mpcs51033-2017-au
tumn/mpcs51033-2017-autumn-playground-private/session2-cloud-photo-timeline]
target project:  [mpcs51033-2017-autumn-photos]
target service:  [default]
target version:  [20171002t194803]
target url:      [https://mpcs51033-2017-autumn-photos.appspot.com]


Configurations to update:

descriptor:      [/Users/tabinkowski/Google Drive/g-Teaching/uchicago.cloud/mpcs51033-2017-au
tumn/mpcs51033-2017-autumn-playground-private/session2-cloud-photo-timeline/index.yaml]
type:            [datastore indexes]
target project:  [mpcs51033-2017-autumn-photos]


Do you want to continue (Y/n)?
```

DEPLOY TO APP ENGINE

session2-cloud-photo-timeline — -bash — 93×21

```
╠═ Uploading 8 files to Google Cloud Storage                                  ═╣
╚═══════════════════════════════════════════════════════════════════════════════╝

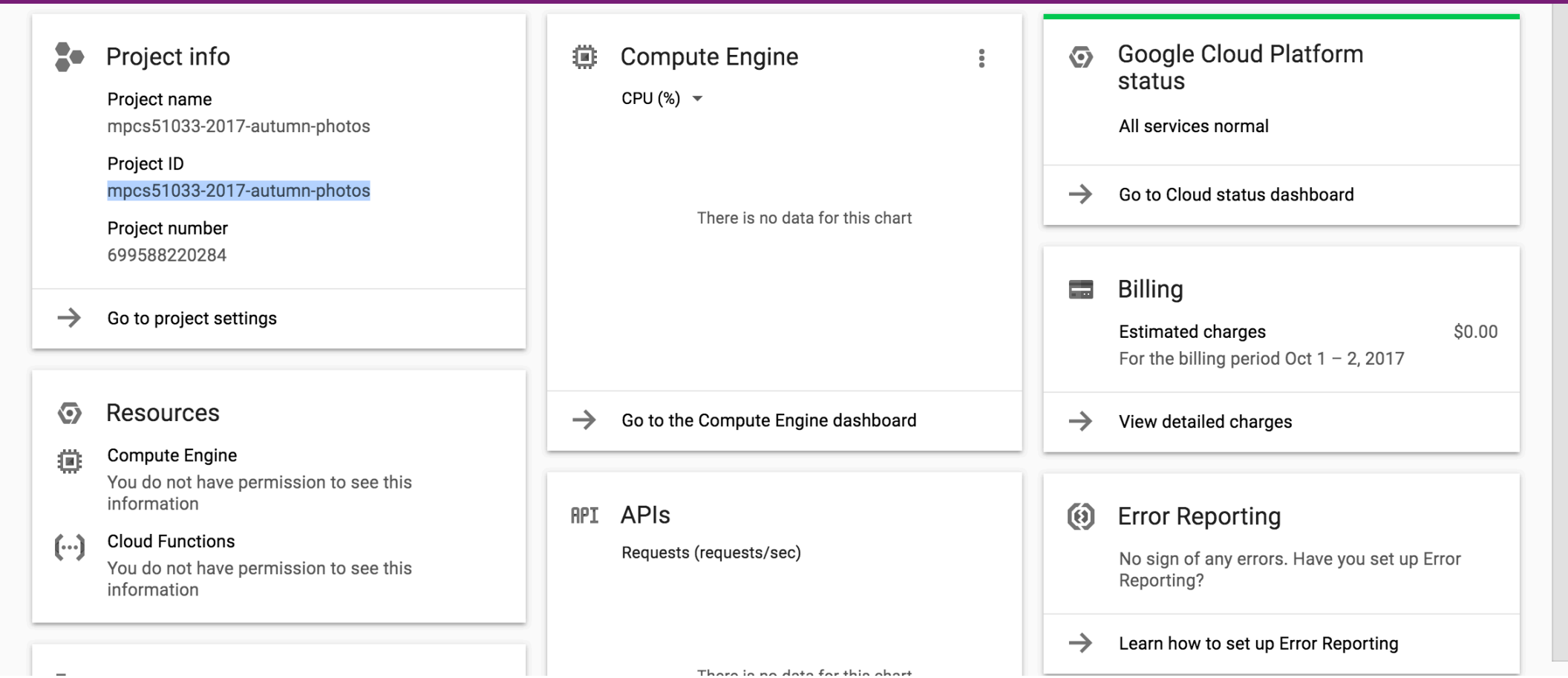
File upload done.
Updating service [default]...done.
Updating service [default]...Waiting for operation [apps/mpcs51033-2017-autumn-photos/operati
ons/3504ca7a-1189-4de0-aca1-
f24639618faf] to complete...done.
Updating service [default]...done.
Deployed service [default] to [https://mpcs51033-2017-autumn-photos.appspot.com]
Updating config [index]...done.

Indexes are being rebuilt. This may take a moment.

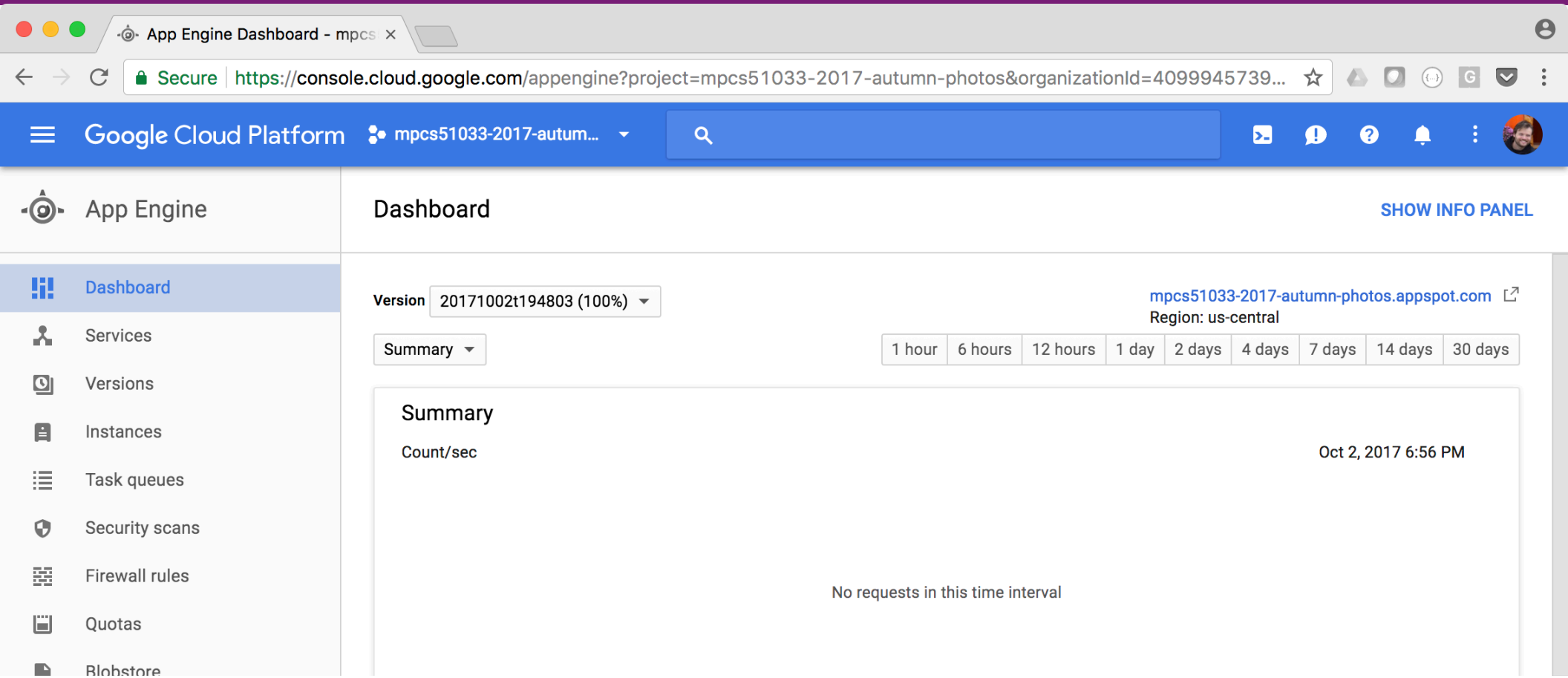
You can stream logs from the command line by running:
  $ gcloud app logs tail -s default

To view your application in the web browser run:
  $ gcloud app browse
tabinkowski@Ts-MacBook-Pro ~/Google Drive/g-Teaching/uchicago.cloud/mpcs51033-2017-autumn/mpc
s51033-2017-autumn-playground-private/session2-cloud-photo-timeline
```

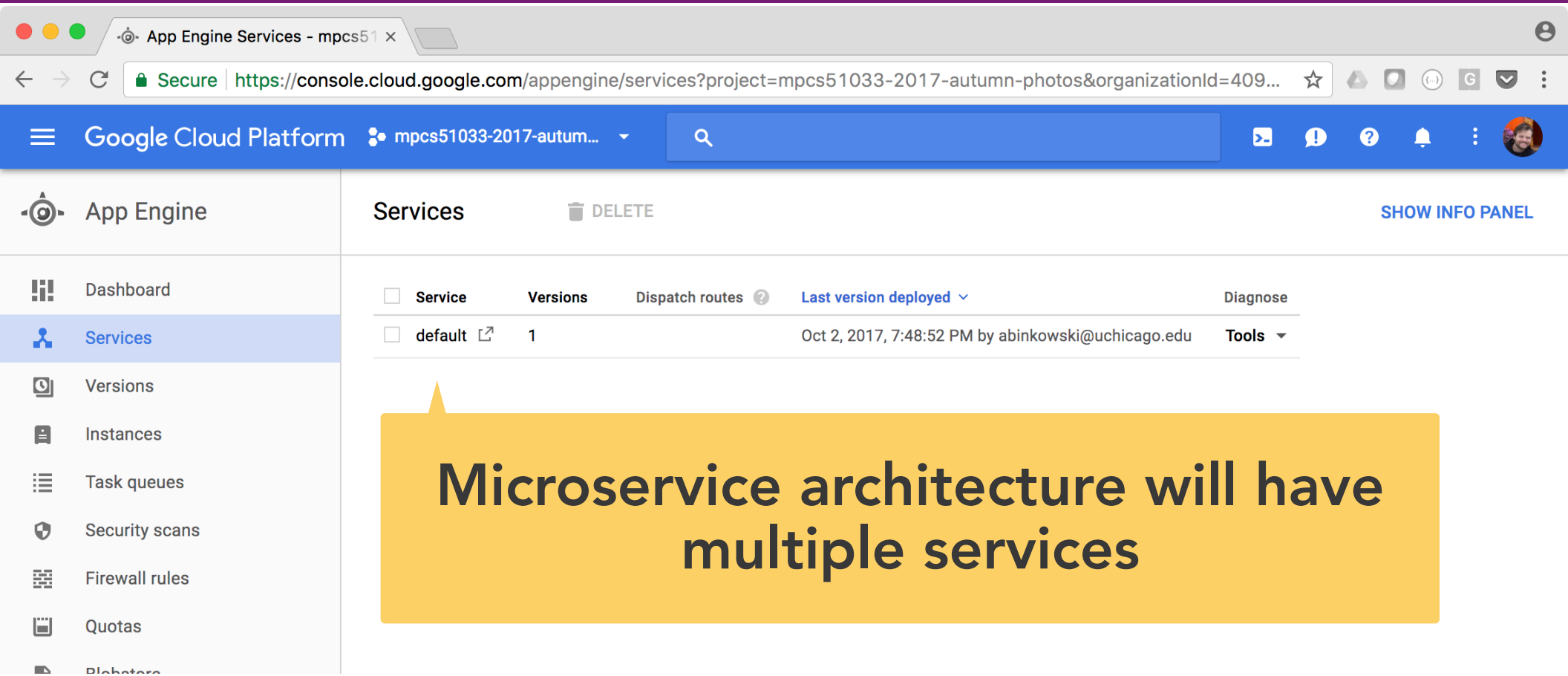
DEPLOY TO APP ENGINE



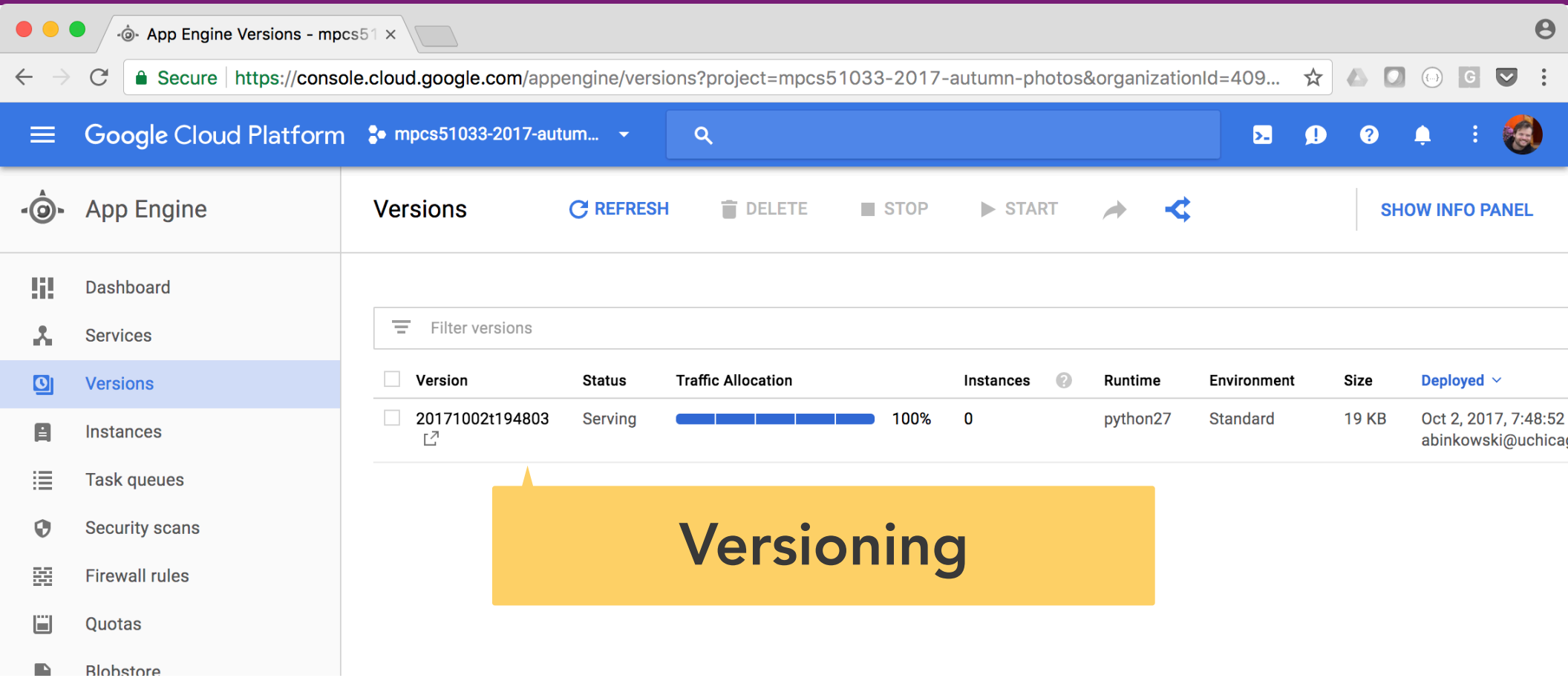
DEPLOY TO APP ENGINE



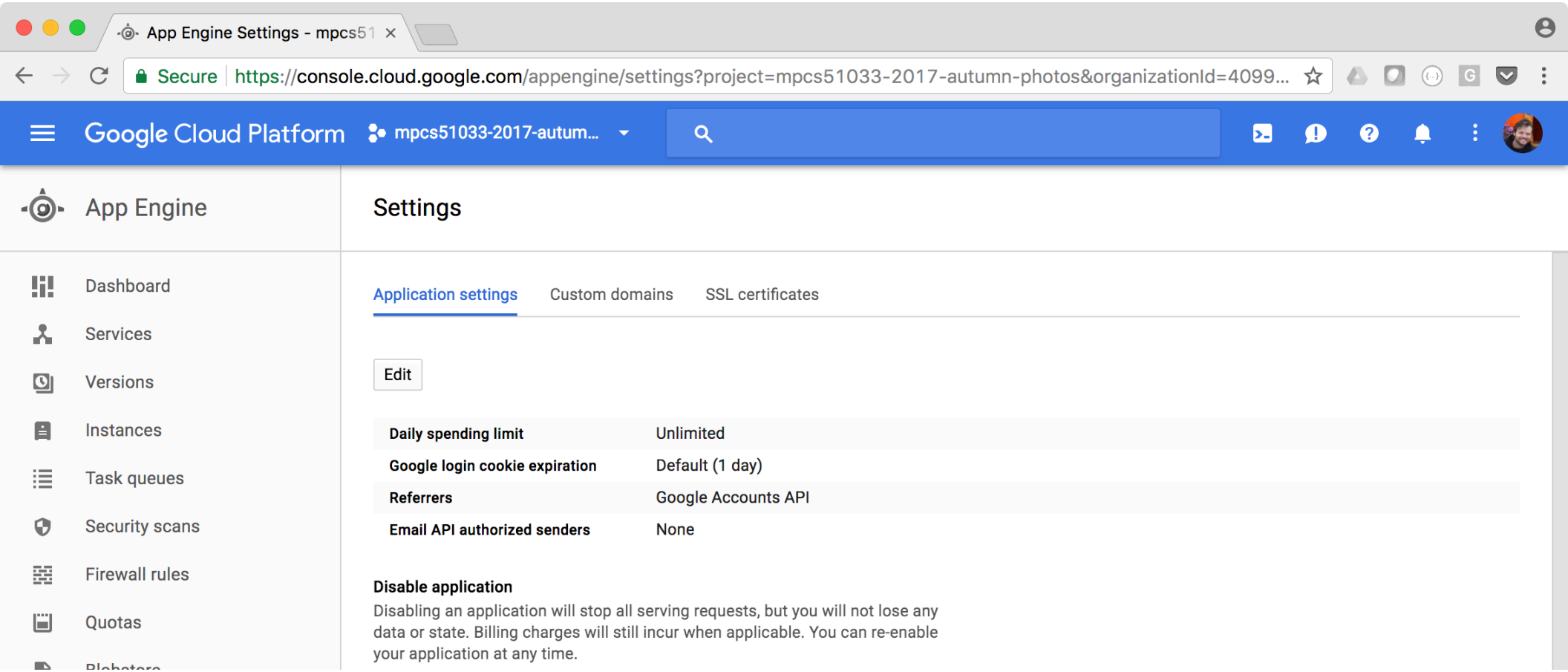
DEPLOY TO APP ENGINE



DEPLOY TO APP ENGINE



DEPLOY TO APP ENGINE



DEPLOY TO APP ENGINE

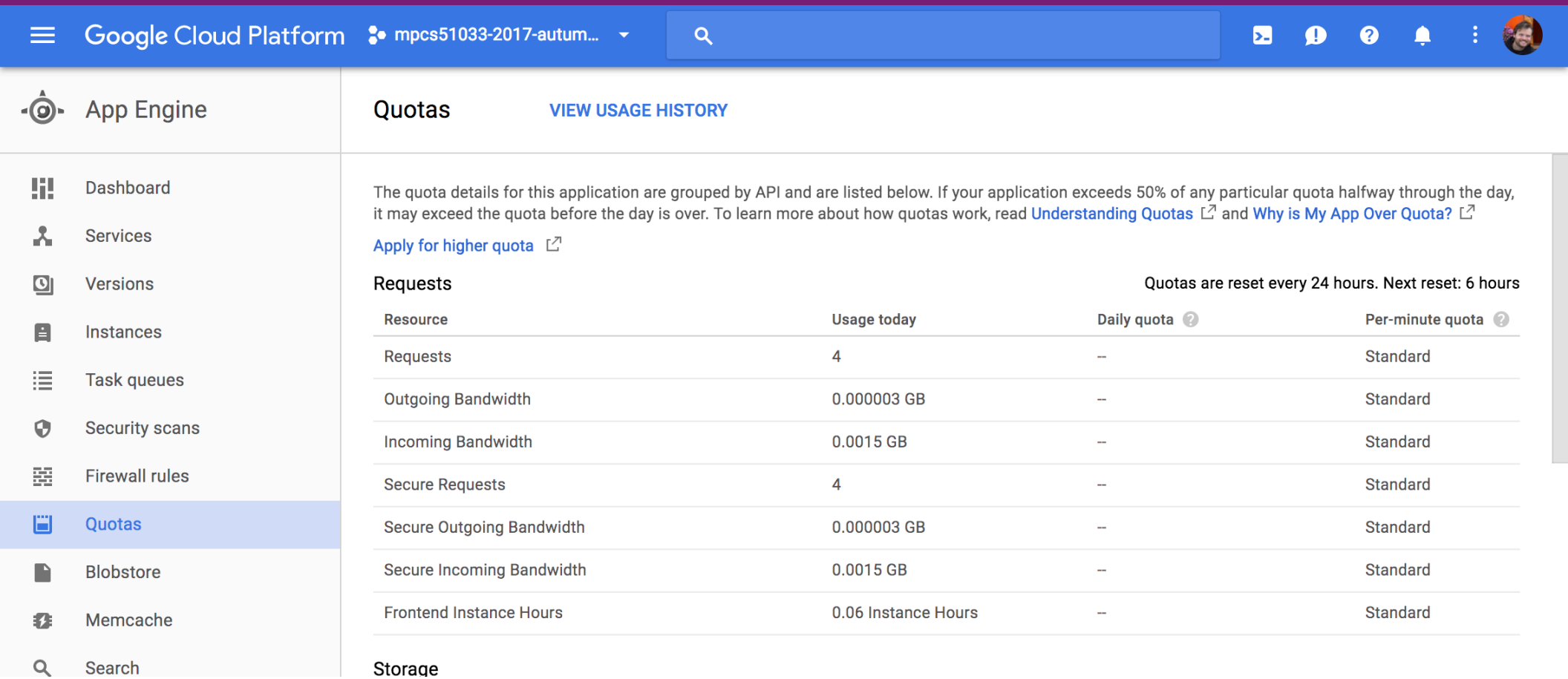


PHOTO TIMELINE

```
# Test you application from the command line using `curl`

curl -X GET https://mpcs51033-2017-autumn-photos.appspot.com

curl -X GET https://mpcs51033-2017-autumn-photos.appspot.com/user/default/json/

curl -X POST -H "Content-Type: multipart/form-data" -F caption='curl' -F
"image=@kitten.jpg"  https://mpcs51033-2017-autumn-photos.appspot.com/post/
lolakitty/
```

DEPLOY TO APP ENGINE

- JSON for our mobile app

Developer Discover Design Develop Distribute Support

Documentation › Foundation › Archives and Seriali... › Using JSON with Cu... Language: Swift

Sample Code

Using JSON with Custom Types

Demonstrates approaches for encoding and decoding different kinds of JSON in Swift.

Download

Overview

JSON data you send or receive from other apps, services, and files can come in many different shapes and structures. Use the techniques described in this sample to handle the differences between external JSON data and your app's model types.

DEVELOPMENT AND LOGGING

DEVELOPMENT AND LOGGING

- Different levels of logging
- Appear different in the console
- Used to filter logs

```
import logging

class LoggingHandler(webapp2.RequestHandler):
    """Demonstrate the different levels of logging"""

    def get(self):
        logging.debug('This is a debug message')
        logging.info('This is an info message')
        logging.warning('This is a warning message')
        logging.error('This is an error message')
        logging.critical('This is a critical message')

        try:
            raise ValueError('This is a sample value error.')
        except ValueError:
            logging.exception('A example exception log.')

        self.response.out.write('Logging example.')
```

DEVELOPMENT AND LOGGING

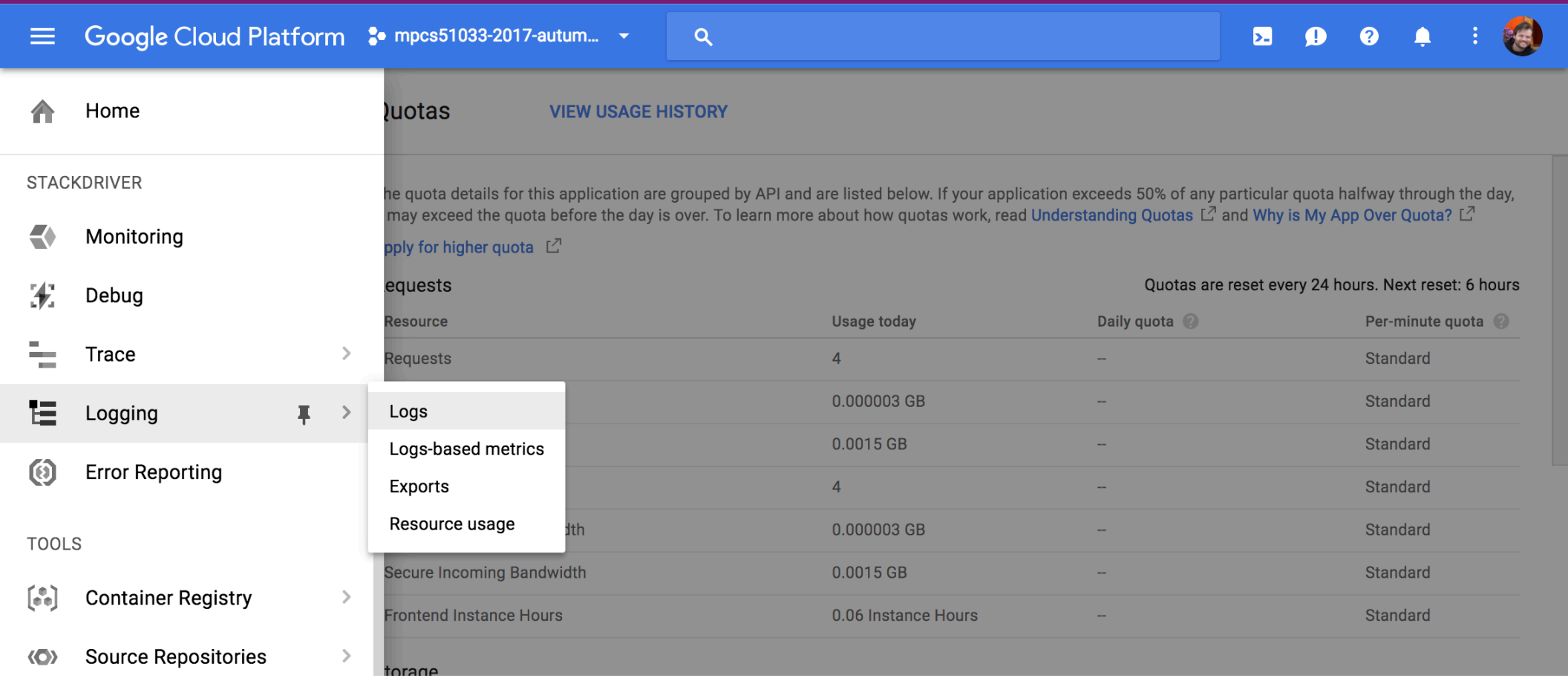
```
def get(self):
    logging.debug('This is a debug message')
    logging.info('This is an info message')
    logging.warning('This is a warning message')
    logging.error('This is an error message')
    logging.critical('This is a critical message')

    try:
        raise ValueError('This is a sample value error.')
    except ValueError:
        logging.exception('A example exception log.')
```

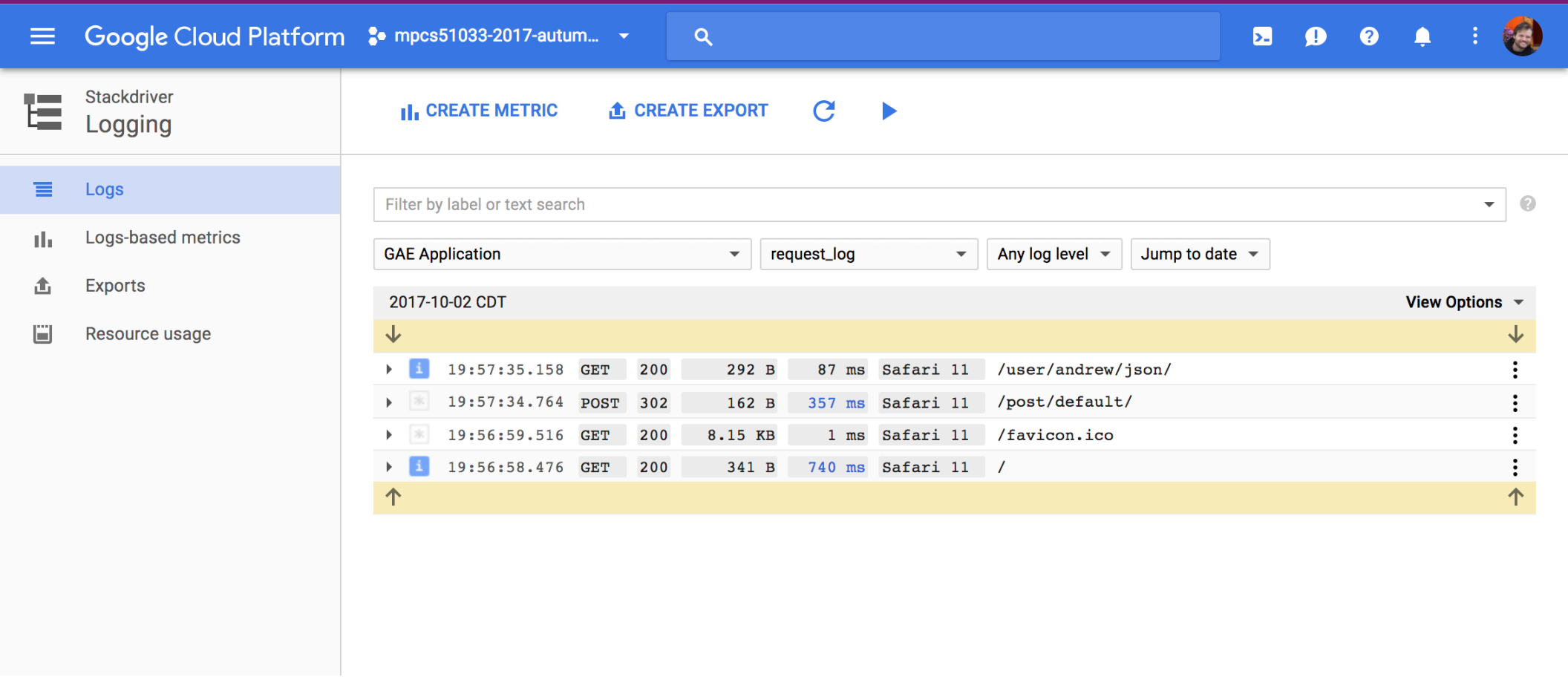
session2-cloud-photo-timeline — python

```
TTP/1.1" 200 188
INFO     2017-10-03 00:20:33,178 module.py
  /Users/tabinkowski/Google Drive/g-Teachi
mpcs51033-2017-autumn-playground-private/session2-cloud-photo-timeline/README.md
INFO     2017-10-03 00:39:24,441 main.py:153] This is an info message
WARNING  2017-10-03 00:39:24,442 main.py:154] This is a warning message
ERROR    2017-10-03 00:39:24,442 main.py:155] This is an error message
CRITICAL 2017-10-03 00:39:24,442 main.py:156] This is a critical message
ERROR    2017-10-03 00:39:24,442 main.py:161] A example exception log.
Traceback (most recent call last):
  File "/Users/tabinkowski/Google Drive/g-Teaching/uchicago.cloud/mpcs51033-2017-a
utumn/mpcs51033-2017-autumn-playground-private/session2-cloud-photo-timeline/main.
py", line 159, in get
    raise ValueError('This is a sample value error.')
ValueError: This is a sample value error.
INFO     2017-10-03 00:39:24,474 module.py:821] default: "GET /logging/ HTTP/1.1"
200 16
```

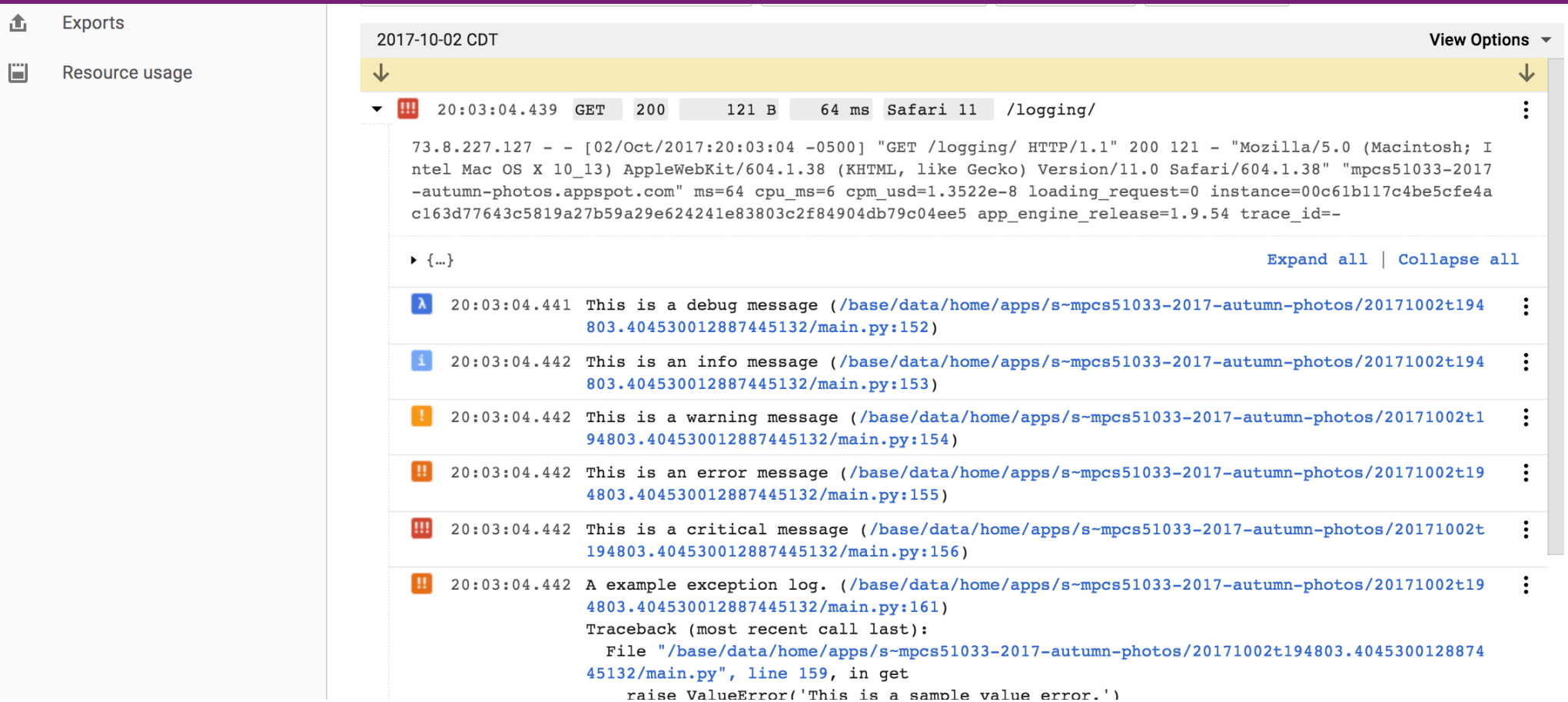
DEVELOPMENT AND LOGGING



DEVELOPMENT AND LOGGING



DEVELOPMENT AND LOGGING



DEVELOPMENT AND LOGGING

```
# Download the logs from a running application

% gcloud app logs read -s default
```

DATASTORE

DATASTORE

- NoSQL document database
- Highly structured mutable data
- Designed and implemented for scaling

Cloud Datastore Overview

SEND FEEDBACK

Python | Java | PHP | Go

Google Cloud Datastore is a NoSQL document database built for automatic scaling, high performance, and ease of application development. Cloud Datastore features include:

- **Atomic transactions**. Cloud Datastore can execute a set of operations where either all succeed, or none occur.
- **High availability of reads and writes**. Cloud Datastore runs in Google data centers, which use redundancy to minimize impact from points of failure.
- **Massive scalability with high performance**. Cloud Datastore uses a distributed architecture to automatically manage scaling. Cloud Datastore uses a mix of indexes and query constraints so your queries scale with the size of your result set, not the size of your data set.
- **Flexible storage and querying of data**. Cloud Datastore maps naturally to object-oriented and scripting languages, and is exposed to applications through multiple clients. It also provides a SQL-like query language.
- **Balance of strong and eventual consistency**. Cloud Datastore ensures that entity lookups by key and ancestor queries always receive strongly consistent data. All other queries are eventually consistent. The consistency models allow your application to deliver a great user experience while handling large amounts of data and users.
- **Encryption at rest**. Cloud Datastore automatically encrypts all data before it is written to disk and automatically decrypts the data when read by an authorized user. For more information, see Server-Side Encryption.
- **Fully managed with no planned downtime**. Google handles the administration of the Cloud Datastore service so you can focus on your application. Your application can still use Cloud Datastore when the service receives a planned upgrade.

Comparison with traditional databases

While the Cloud Datastore interface has many of the same features as traditional databases, as a NoSQL database it differs from them in the way it describes relationships between data objects. Here's a high-level comparison of Cloud Datastore and relational database concepts:

Concept	Cloud Datastore	Relational database
Category of object	Kind	Table
One object	Entity	Row
Individual data for an object	Property	Field
Unique ID for an object	Key	Primary key

DATASTORE

- Remember just one of many options for store data
- Available via API through all GPC services

Cloud Datastore is ideal for applications that rely on highly available structured data at scale. You can use Cloud Datastore to store and query all of the following types of data:

- Product catalogs that provide real-time inventory and product details for a retailer.
- User profiles that deliver a customized experience based on the user's past activities and preferences.
- Transactions based on ACID properties, for example, transferring funds from one bank account to another.

Other storage options

Cloud Datastore is not ideal for every use case. For example, Cloud Datastore is not a relational database, and it is not an effective storage solution for analytic data.

Here are some common scenarios where you should probably consider an alternative to Cloud Datastore:

- If you need a relational database with full SQL support for an online transaction processing (OLTP) system, consider Google Cloud SQL.
- If you don't require support for ACID transactions or if your data is not highly structured, consider Cloud Bigtable.
- If you need interactive querying in an online analytical processing (OLAP) system, consider Google BigQuery.
- If you need to store large immutable blobs, such as large images or movies, consider Google Cloud Storage.

For more information about other storage options, see the Choosing a Storage Option guide.

Connecting to Cloud Datastore with App Engine

App Engine's Python standard runtime connects to Cloud Datastore using the NDB Client Library. The NDB Client Library provides persistent storage in a schemaless object datastore. It supports automatic caching, sophisticated queries, and atomic transactions.

DATASTORE

- Data types available
- Some very specialized for applications

Property class	Value type	Sort order
`IntegerProperty`	`int` `long` (64 bits)	Numeric
`FloatProperty`	`float`	Numeric
`BooleanProperty`	`bool`	**`False`** < **`True`**
`StringProperty`	`str` `unicode`	Unicode (**`str`** is treated as ASCII)
`TextProperty`	`db.Text`	None
`ByteStringProperty`	`ByteString`	Byte order
`BlobProperty`	`db.Blob`	None

`DateProperty`
`TimeProperty`
`DateTimeProperty`
	`datetime.date`
	`datetime.time`
	`datetime.`
	`datetime`
		Chronological

`GeoPtProperty`	`db.GeoPt`	By latitude, then longitude
`PostalAddressProperty`	`db.` `PostalAddress`	Unicode
`PhoneNumberProperty`	`db.` `PhoneNumber`	Unicode
`EmailProperty`	`db.Email`	Unicode
`UserProperty`	`users.User`	Email address in Unicode order. Note that you should avoid using **`UserProperty`**, per the note under UserProperty class description.
`IMProperty`	`db.IM`	Unicode
`LinkProperty`	`db.Link`	Unicode
`CategoryProperty`	`db.Category`	Unicode
`RatingProperty`	`db.Rating`	Numeric
`ReferenceProperty` `SelfReferenceProperty`	`db.Key`	By path elements (kind, identifier, kind, identifier...)
`blobstore.` `BlobReferenceProperty`	`blobstore.` `BlobInfo`	Byte order
`ListProperty` `StringListProperty`	`list` of a supported type	If ascending, by least element; if descending, by greatest element

DATASTORE

- Photo model in our photo timeline app
- Objects with same ancestor have different behaviors

```
class Photo(ndb.Model):
    """Models a user uploaded photo entry"""

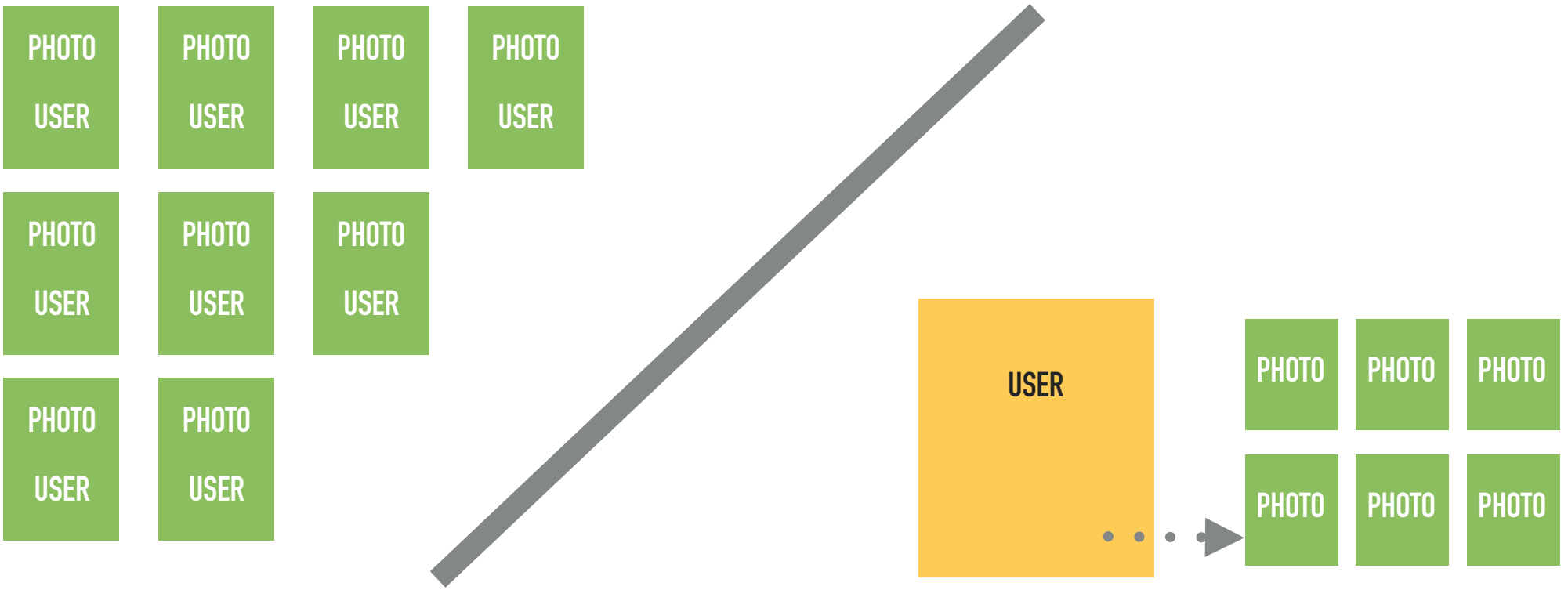
    user = ndb.StringProperty()
    image = ndb.BlobProperty()
    caption = ndb.StringProperty()
    date = ndb.DateTimeProperty(auto_now_add=True)

    @classmethod
    def query_user(cls, ancestor_key):
        """Return all photos for a given user"""
        return cls.query(ancestor=ancestor_key).order(-cls.date)

    @classmethod
    def query_user_alternate(cls, ancestor_key):
        """Return all photos for a given user using the gql syntax.
        It returns the same as the above method.
        """
        return ndb.gql('SELECT * '
                       'FROM Photo '
                       'WHERE ANCESTOR IS :1 '
                       'ORDER BY date DESC LIMIT 10',
                       ancestor_key)
```

DATASTORE

PHOTO TIMELINE DATA MODEL



DATASTORE

PHOTO TIMELINE DATA MODEL

```
# 1 to many relationships is Datastore?

class Photo(ndb.Model):
 image = ndb.BlobProperty()


class User(ndb.Model):
 name = ndb.StringProperty()

 photos = ndb.KeyProperty(kind='Photo', repeated=True)
 # You could use Key or Structured property
 photos = nab.StructuredProperty(kind='Photo',
                                 repeated=True)
```

repeated means list of type

DATASTORE

PHOTO TIMELINE DATA MODEL

- Structured Property
  - Although the Photo instances are defined using the same syntax as for model classes they are not full-fledged entities
  - Don't have their own keys
  - Cannot be retrieved independently of the User entity to which they belong
  - Can't have "top rated"

```
# 1 to many relationships is

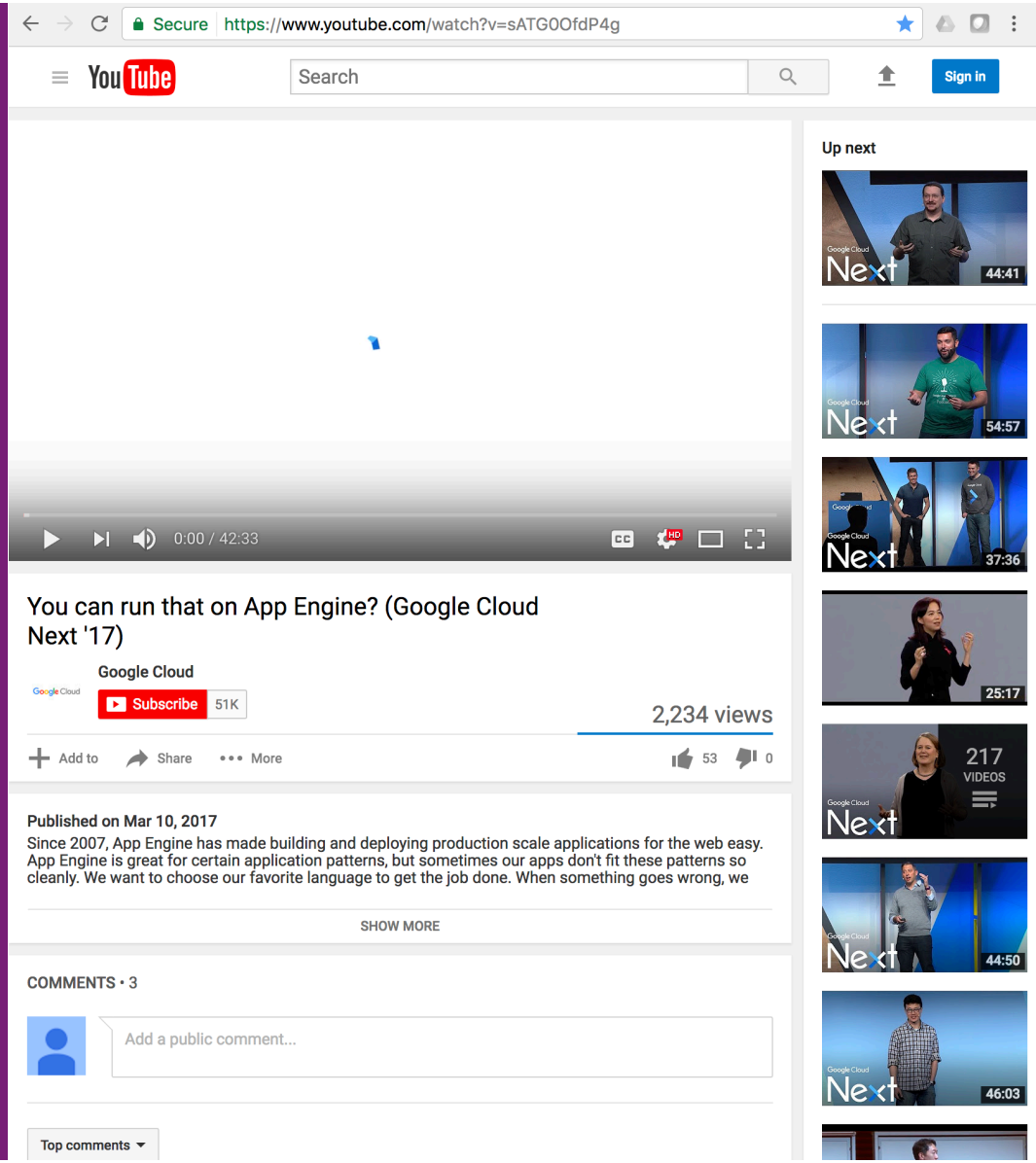
class Photo(ndb.Model):
 image = nab.BlobProperty()

class User(ndb.Model):
 name = ndb.StringProperty()

 photos = ndb.KeyProperty(ki
 # or #
 photos = nab.StructuredProp
```

DATASTORE

- Cloud Datastore 101: Overview of Google's scalable NoSQL document database (Google Cloud Next '17a)
  - https://www.youtube.com/watch?v=uZDk0NZGqHs
- Building scalable apps with Cloud Datastore (Google Cloud Next '17) - YouTube
  - https://www.youtube.com/watch?v=0EIqacNVuAo&t=11s



MEMCACHE

MEMCACHE

- App Engine memcache service provides a fast in-memory cache of data
  - Speed up common datastore queries (for repeated queries)
  - Store temporary values

Memcache Overview

Contents

Python | Java | PHP | Go

This page provides an overview of the App Engine memcache service. High performance scalable web applications often use a distributed in-memory data cache in front of or in place of robust persistent storage for some tasks. App Engine includes a memory cache service for this purpose. To learn how to configure, monitor, and use the memcache service, read Using Memcache.

Note: The cache is global and is shared across the application's frontend, backend, and all of its services and versions.

When to use a memory cache

MEMCACHE

- Memcache is key/value pairs
  - In memory at any time
  - Change as items are written and retrieved from the cache
  - Value evicted when memory runs low
  - Expire policy

Memcache Overview

Contents

Python | Java | PHP | Go

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When to use a memory cache

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Memcache Overview

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Note: The cache is global and is shared across the application's frontend, backend, and all of its services and versions.

When to use a memory cache

MEMCACHE

- Memcache pattern is similar to other cache patterns
- Fallback to generating the data

```
def get_data():
    data = memcache.get('key')
    if data is not None:
        return data
    else:
        data = query_for_data()
        memcache.add('key', data, 60)
    return data
```

MEMCACHE

```
# Add a value if it doesn't exist in the cache
# with a cache expiration of 1 hour.
memcache.add(key="weather_USA_98105", value="raining", time=3600)

# Set several values, overwriting any existing values for these keys.
memcache.set_multi(
    {"USA_98115": "cloudy", "USA_94105": "foggy", "USA_94043": "sunny"},
    key_prefix="weather_",
    time=3600
)

# Atomically increment an integer value.
memcache.set(key="counter", value=0)
memcache.incr("counter")
memcache.incr("counter")
memcache.incr("counter")
```

MEMCACHE

- Best practices
  - Handle memcache API failures gracefully
  - Use the batching capability of the API
  - Distribute load across your memcache keyspace
    - Having a single or small set of memcache items represent a disproportionate amount of traffic will hinder your app from scaling

MEMCACHE

```
def get_data(user):
    """Get data from the datastore only if we don't have it cached"""
    key = user + "_photos"
    data = memcache.get(key)
    if data is not None:
        logging.info("Found in cache")
        return data
    else:
        logging.info("Cache miss")
        ancestor_key = ndb.Key("User", user)
        data = Photo.query_user(ancestor_key).fetch(100)
        if not memcache.add(key, data, 3600):
            logging.info("Memcache failed")
    return data
```

```
# Clear the cache (the cached version is going to be outdated)
key = user + "_photos"
memcache.delete(key)
```

MEMCACHE

```
def get_data(user):
    """Get data from the datastore only if we don't have it cached"""
    key = user + "_photos"
    data = memcache.get(key)
    if data is not None:
        logging.info("Found in cache")
        return data
    else:
        logging.info("Cache miss")
        ancestor_key = ndb.Key("User", user)
        data = Photo.query_user(ancestor_key).fetch(100)
        if not memcache.add(key, data, 3600):
            logging.info("Memcache failed")
    return data
```

NDB uses memcache internally but it is not transparent

POTENTIAL PROBLEMS WITH THE CURRENT ARCHITECTURE

PHOTO TIMELINE

FORESEEABLE PROBLEMS

- This solution will not scale very well once we have more users
- All the data is in a single entity, Photos, has to be searched to retrieve the photos for a given user name
  - This could be very costly

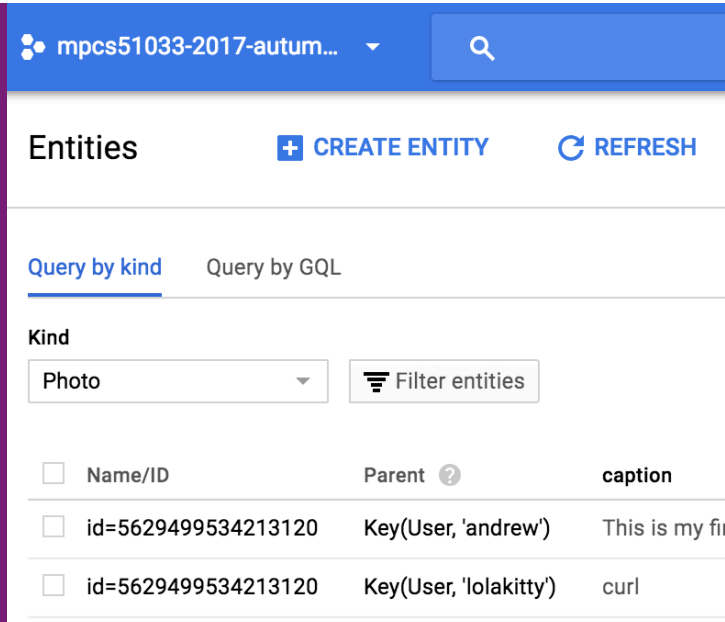


PHOTO TIMELINE

FORESEEABLE PROBLEMS

- No security
  - Anyone can post or retrieve with just a username
  - No way to uniquely identify a user

PHOTO TIMELINE

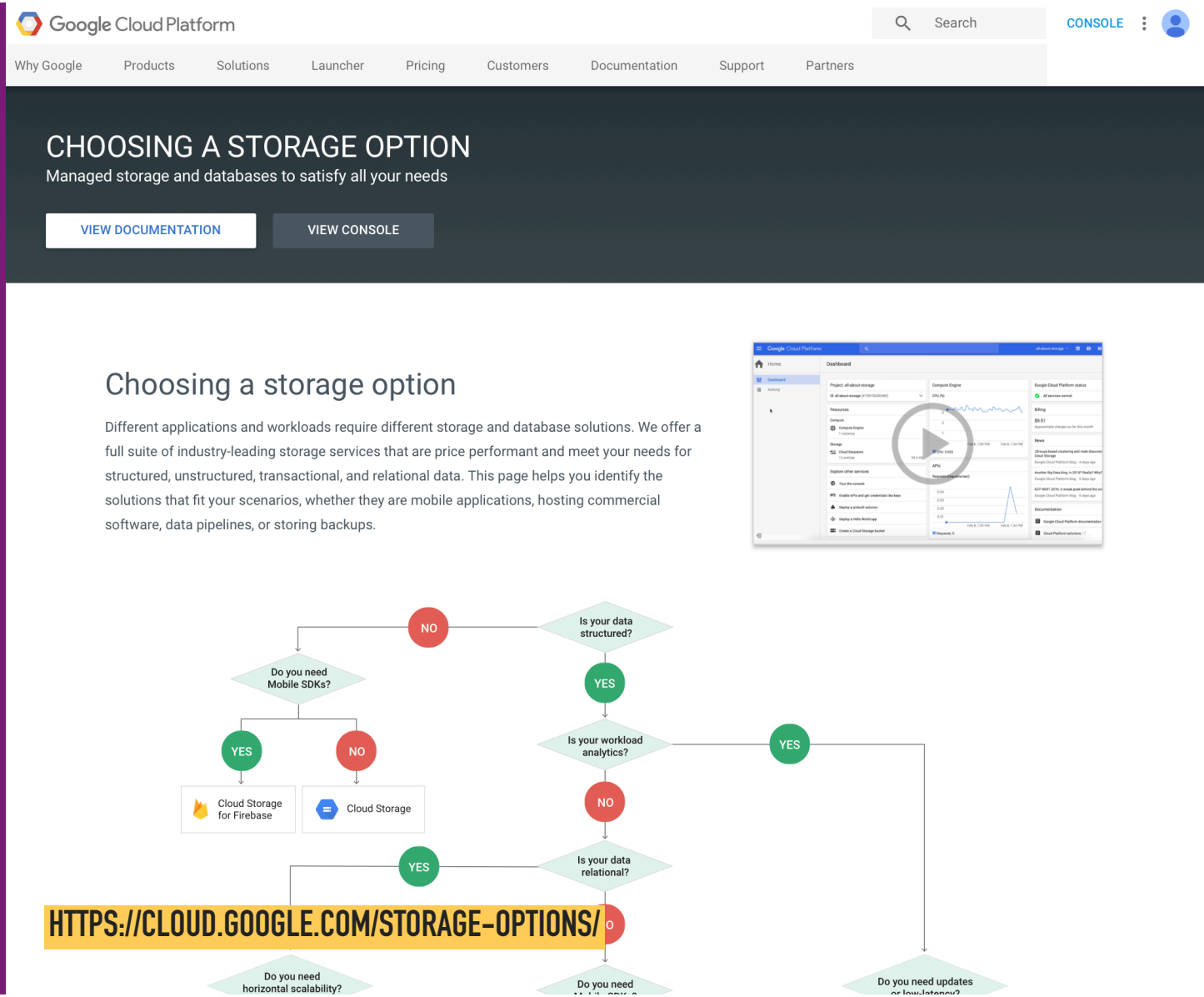
FORESEEABLE PROBLEMS

- No API to delete embarrassing photos

PHOTO TIMELINE

FORESEEABLE PROBLEMS

- No API to delete embarrassing photos
- Storing images in Datastore

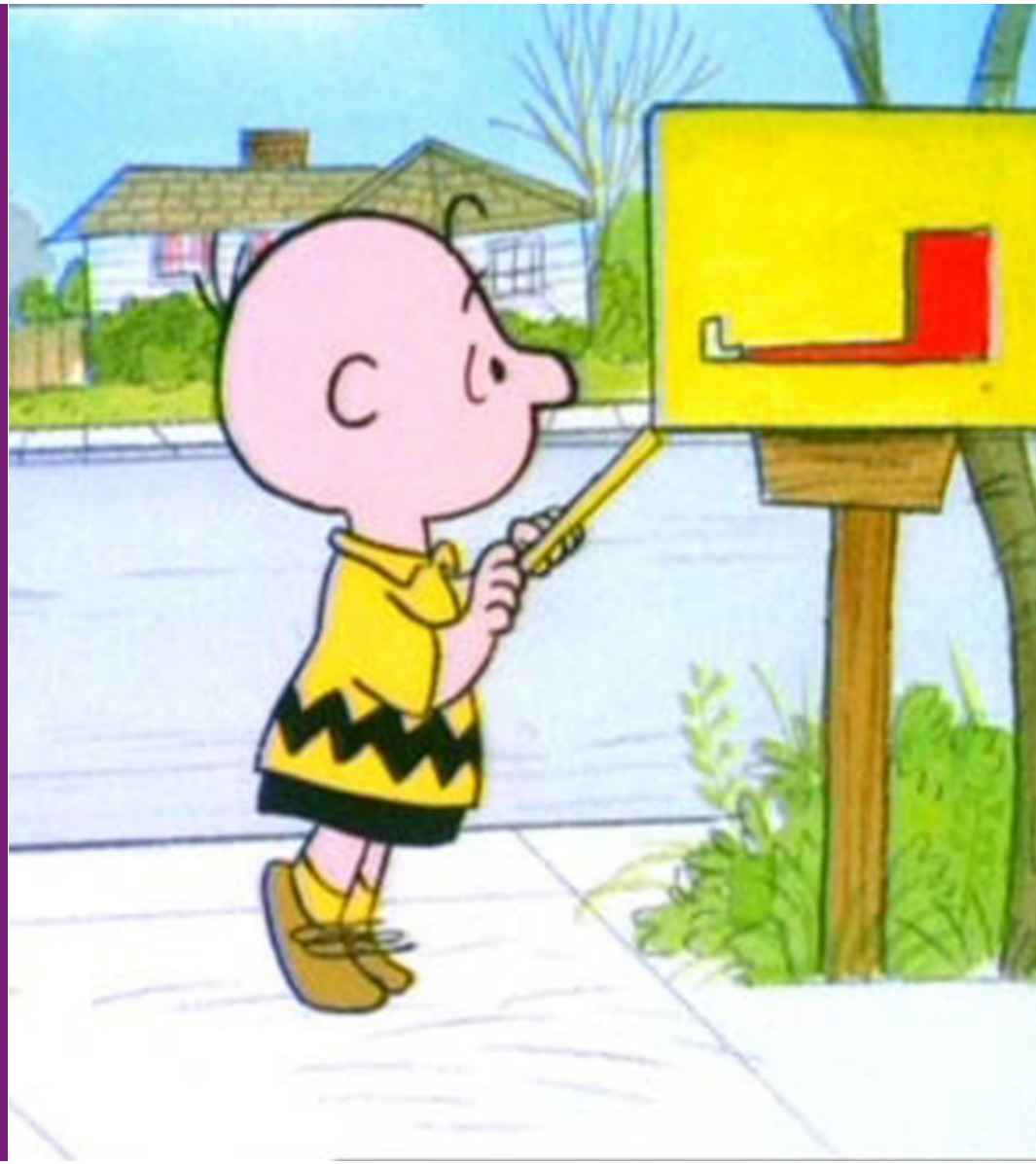


BREAK TIME 

SENDING EMAIL WITH APP ENGINE

SENDING EMAIL

- Two APIs for sending an email message in App Engine environment
  - mail.send_mail()
  - EmailMessage class



SENDING EMAIL

- Who can send email?
  - The Gmail or Google Apps Account of the user who is currently signed in
  - Any email address of the form anything@[APP_NAME].appspotmail.com or anything@[APP_ALIAS].appspotmail.com
  - Any email address listed in the Cloud Platform Console under Email API Authorized Senders

SENDING EMAIL

- Mail will bounce back to the senders email
  - App Engine doesn't know
- There are special rules if you are sending out bulk emails

SENDING EMAIL

```
from google.appengine.api import mail


mail.send_mail(sender="me@uchicago-mobi-photo-
                       timeline.appspotmail.com",
                    to="abinkowski@uchicago.edu",
                    subject="New Photo!",
                    body="Hi!")
```

SENDING EMAIL

```
mail.send_mail(sender=sender_address,
                    to="Albert Johnson
<Albert.Johnson@example.com>",
                    subject="Your account has been approved",
                    body="""Dear Albert:

Your example.com account has been approved.  You can now visit
http://www.example.com/ and sign in using your Google Account to
access new features.

Please let us know if you have any questions.

The example.com Team
""")
```

SENDING EMAIL

```
message = mail.EmailMessage(
        sender=sender_address,
        subject="Your account has been approved")
message.to = "Albert Johnson <Albert.Johnson@example.com>"
message.body = "Hi"
message.send()
```

SENDING EMAIL

Limit	Amount
Maximum size of outgoing mail messages, including attachments	31.5 MB
Maximum size of incoming mail messages, including attachments	31.5 MB
Maximum size of message when an administrator is a recipient	16 KB
Maximum number of authorized senders	50

SENDING EMAIL

```
try:
  mail.SendMessage(to='test@example.com',
                   from='admin@example.com',
                   subject='Test Email',
                   body='Testing')
except apiproxy_errors.OverQuotaError, message:
  # Log the error.
  logging.error(message)
  # Display an informative message to the user.
  self.response.out.write('The email could not be sent. '
                          'Please try again later.')
```

SENDING EMAIL

```
try:
  mail.SendMessage(to='test@example.com',
                   from='admin@example.com',
                   subject='Test Email',
                   body='Testing')
except apiproxy_errors.OverQuotaError, message:
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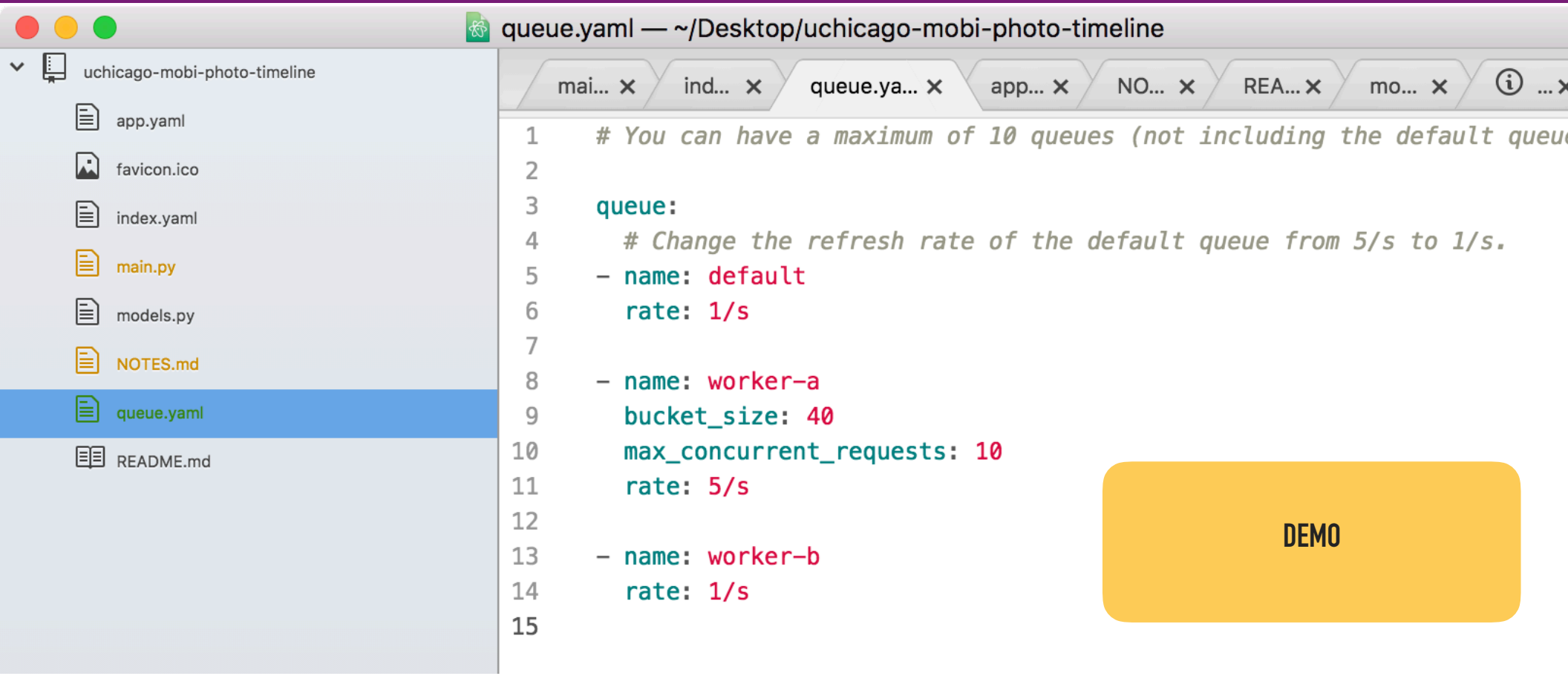
SENDING EMAIL



TASK QUEUE

TASK QUEUE

- Task Queue API lets applications perform work, called tasks, asynchronously outside of a user request
- If an app needs to execute work in the background, it adds tasks to task queues
- The tasks are executed later, by scalable App Engine worker services in your application

Task Queue Overview

Contents

Python | Java | PH

This page describes what task queues are, and when and how to use them. The Task API lets applications perform work, called *tasks*, asynchronously outside of a user re an app needs to execute work in the background, it adds tasks to *task queues*. The ta executed later, by scalable App Engine worker services in your application.

Push queues and pull queues

Task queues come in two flavors, *push* and *pull*. The manner in which the Task Queue service dispatches task requests to worker services is different for the different queu

Push queues dispatch requests at a reliable, steady rate. They guarantee reliable task execution. Because you can control the rate at which tasks are sent from the queue, y control the workers' scaling behavior and hence your costs.

Because tasks are executed as App Engine requests targeted at services, they are su stringent deadlines. Tasks handled by automatic scaling services must finish in ten m Tasks handled by basic and manual scaling services can run for up to 24 hours.

TASK QUEUE

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- The manner in which the Task Queue service dispatches task requests to worker services is different for the different queues

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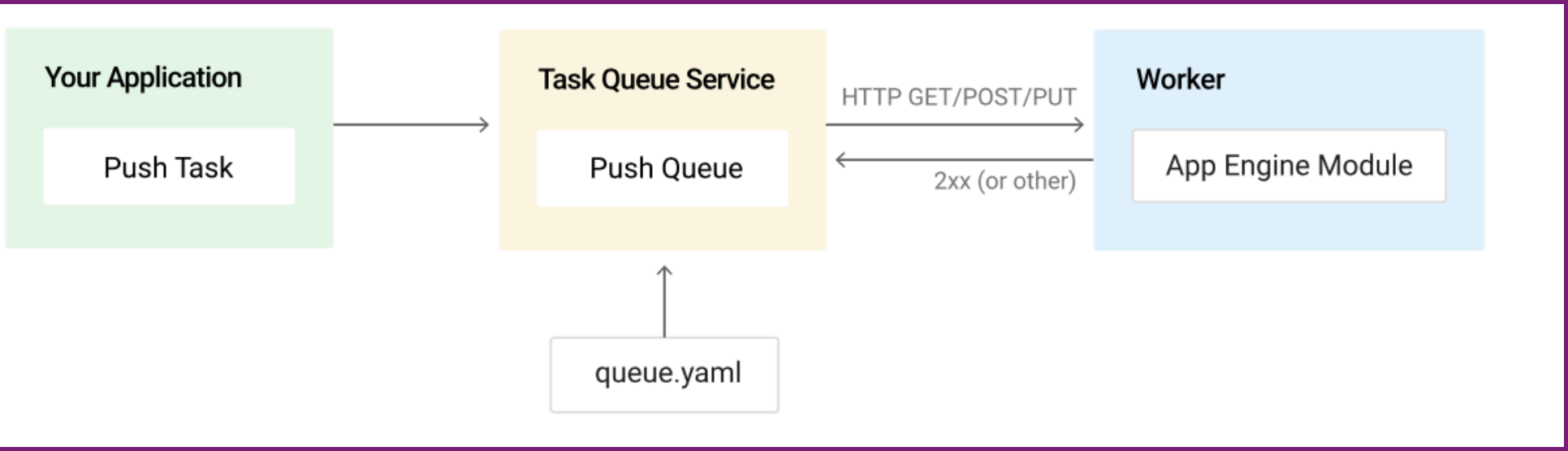
TASK QUEUE

USE CASES

- Push queue
  - Long running operations
  - Scheduled tasks
- Pull queue
  - Tasks that are interdependent
  - Related tasks that can be batched for efficiency

PUSH QUEUE

PUSH QUEUES



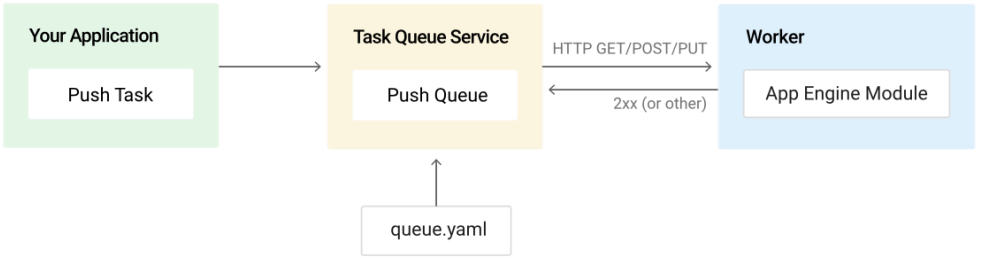
- Push queues run tasks by delivering HTTP requests to App Engine worker services

TASK QUEUE

- Push queue
  - Dispatch requests at a reliable, steady rate
  - They guarantee reliable task execution
  - You can control the workers' scaling behavior (and hence your costs)
  - Tasks handled by automatic scaling services must finish in ten minutes
  - Tasks handled by basic and manual scaling services can run for up to 24 hours

PUSH QUEUES

- Requests are delivered at a constant rate
- If a task fails, the service will retry the task, sending another request
- An HTTP response code between 200–299 indicates success
  - All other values indicate the task failed



PUSH QUEUES

- You must write a handler for every kind of task you use
- A single service can have multiple handlers for different kinds of tasks,
  - You you can use different services for different task types

PUSH QUEUES

- Requirements
  - Define a queue (or be content with default)
  - Write a handler to process a task request
  - Create tasks and add them to the queue

PUSH QUEUES

CREATE A QUEUE

- You can have a maximum of 10 queues (not including the default queue
- Optional parameters help to control quotas

```
queue:
  # Change the refresh rate of the default queue from 5/s to 1/s.
- name: default
  rate: 1/s

- name: worker-a
  bucket_size: 40
  max_concurrent_requests: 10
  rate: 5/s

- name: worker-b
  rate: 1/s
```

PUSH QUEUES

CREATE A TASK

- Create and add a task to the "worker" queue

```
task = taskqueue.add(
    url='/count_pictures',
    target='worker',
    params={'amount': amount})
```

PUSH QUEUES

CREATE A TASK

```
taskqueue.add(method=GET, url='/update-counter?key=blue', target='worker')
taskqueue.add(url='/update-counter', params={'key': 'blue'}, target='worker')
taskqueue.add(url='/update-counter', payload="{'key': 'blue'}", target='worker')
```

- Different ways of passing parameters to the task
- No difference in behavior

PUSH QUEUES

CREATE A TASK HANDLER

- Create a class to handle the task and a handler to route it

```
class EmailTaskHandler(webapp2.RequestHandler):
    """Handler for task queue emails"""

    def post(self):
        message = self.request.get('message', default_value='default')
        logging.info('This is an info message')
        mail.send_mail(sender="me@uchicago-mobi-photo-timeline.appspotmail.com",
        to="abinkowski@uchicago.edu",
        subject="New Photo!",
        body="A new photo has been uploaded to your account.")


##################################################################################
#
##################################################################################
app = webapp2.WSGIApplication([
    ('/', HomeHandler),
    ('/email_task/', EmailTaskHandler),
    webapp2.Route('/logging/', handler=LoggingHandler),
    webapp2.Route('/image/<key>/', handler=ImageHandler),
    webapp2.Route('/post/<user>/', handler=PostHandler),
    webapp2.Route('/user/<user>/<type>/',handler=UserHandler)
    ],
    debug=True)
```

PUSH QUEUES

CREATE A TASK HANDLER

- Putting it all together
- You can test by directly accessing the URL

```
        task = taskqueue.add(
            url='/email_task/',
            params={'message': 'hi'}
        )
        logging.debug('Task {} enqueued, ETA {}.'.format(task.name, task.eta))

        # Redirect to print out JSON
        self.redirect('/user/%s/json/' % user)


class LoggingHandler(webapp2.RequestHandler):


class EmailTaskHandler(webapp2.RequestHandler):
    """Handler for task queue emails"""

    def post(self):
        message = self.request.get('message', default_value='default')
        logging.info('This is an info message')
        mail.send_mail(sender="me@uchicago-mobi-photo-timeline.appspotmail.com",
        to="abinkowski@uchicago.edu",
        subject="New Photo!",
        body="A new photo has been uploaded to your account.")


##################################################################################
#
##################################################################################
app = webapp2.WSGIApplication([
    ('/', HomeHandler),
    ('/email_task/', EmailTaskHandler),
    webapp2.Route('/logging/', handler=LoggingHandler),
    webapp2.Route('/image/<key>/', handler=ImageHandler),
    webapp2.Route('/post/<user>/', handler=PostHandler),
    webapp2.Route('/user/<user>/<type>/',handler=UserHandler)
    ],
    debug=True)
```

PUSH QUEUES

CREATE A TASK HANDLER

```
        task = taskqueue.add(
            url='/email_task/',
            params={'message': 'hi'}
        )
        logging.debug('Task {} enqueued, ETA {}.'.format(task.name, task.eta))

        # Redirect to print out JSON
        self.redirect('/user/%s/json/' % user)
```

```
class LoggingHandler(webapp2.RequestHandler):…


class EmailTaskHandler(webapp2.RequestHandler):
    """Handler for task queue emails"""

    def post(self):
        message = self.request.get('message', default_value='default')
```

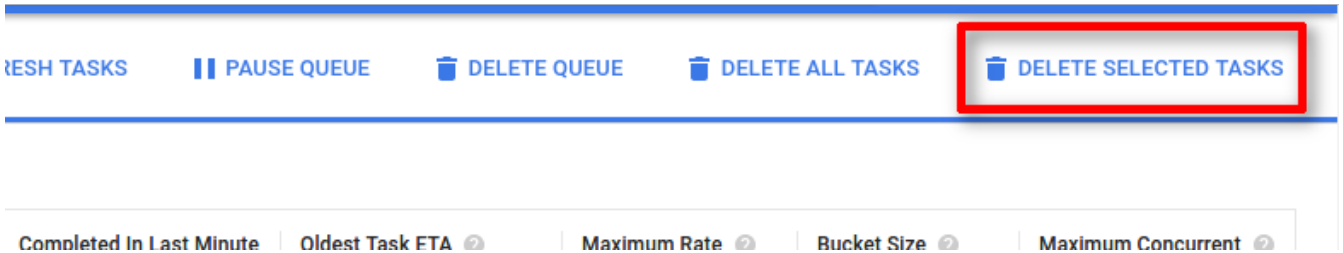
DEMO

PUSH QUEUES

DELETE TASK

```
from google.appengine.api import taskqueue

# Delete an individual task...
q = taskqueue.Queue('queue1')
q.delete_tasks(taskqueue.Task(name='foo'))
```

- Delete a task from a queue

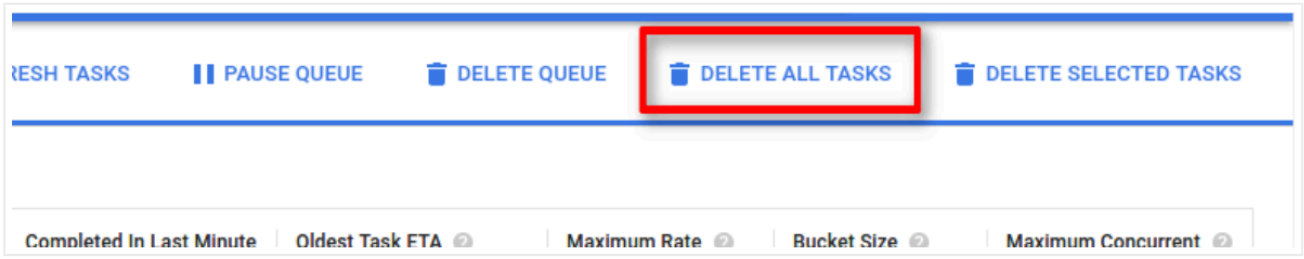


PUSH QUEUES

DELETE TASK

```
from google.appengine.api import taskqueue

# Purge entire queue...
q = taskqueue.Queue('queue1')
q.purge()
```

- Delete all tasks from a queue



PUSH QUEUES

DEFFERRED TASK

- Submit ad-hoc tasks with deffered
- No difference in how its run compared to push queue

Background work with the deferred library

Contents

Nick Johnson
October 15, 2009

Introduction

Thanks to the Task Queue API released in SDK 1.2.3, it's easier than ever to do work 'offline', separate from user serving requests. In some cases, however, setting up a handler for each distinct task you want to run can be cumbersome, as can serializing and deserializing complex arguments for the task - particularly if you have many diverse but small tasks that you want to run on the queue.

Fortunately, a new library in release 1.2.5 of the SDK makes these ad-hoc tasks much easier

PUSH QUEUES

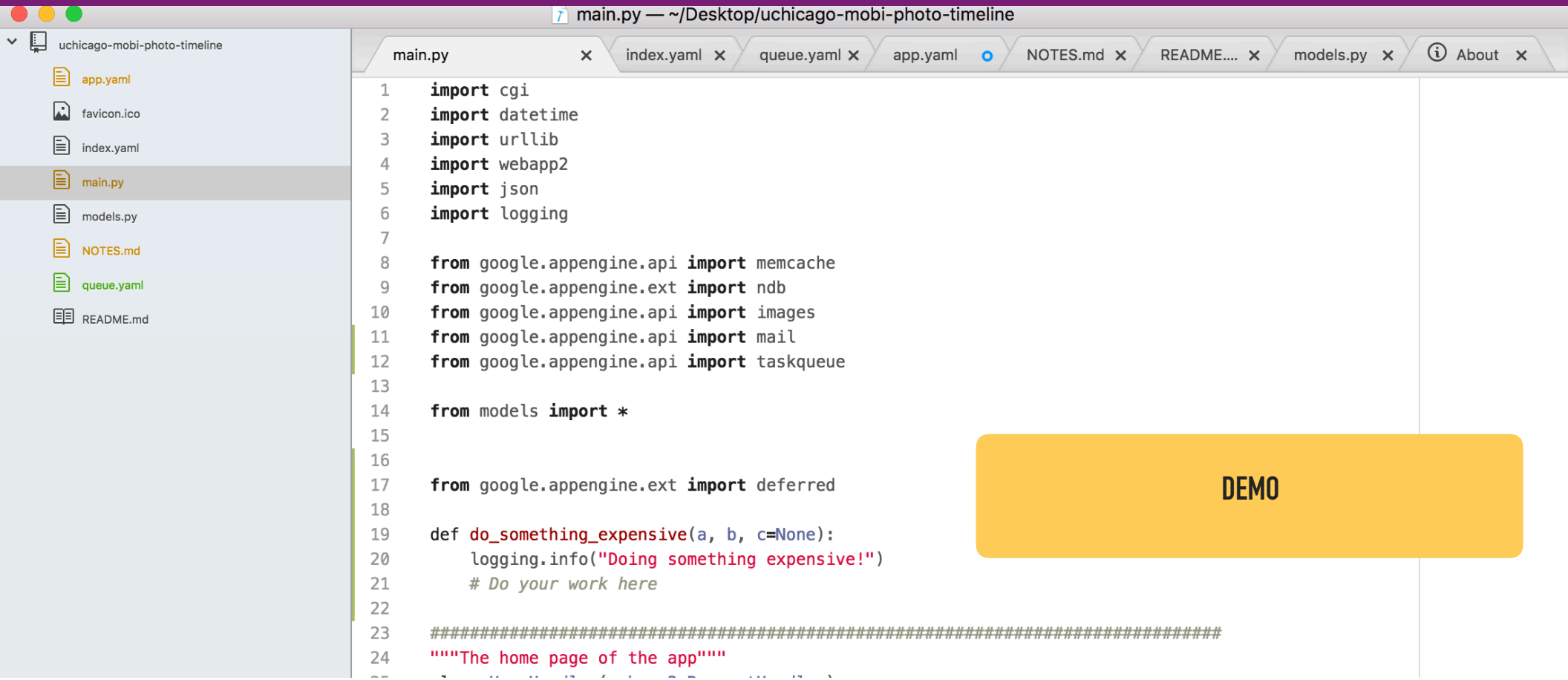
DEFERRED TASKS

```
from google.appengine.ext import deferred

def do_something_expensive(a, b, c=None):
    logging.info("Doing something expensive!")
    # Do your work here

# Somewhere else
deferred.defer(do_something_expensive, "Hello, world!", 42, c=True)
```

- Run in the default queue

PUSH QUEUES

DEFERRED TASK



PULL QUEUE

PULL QUEUE

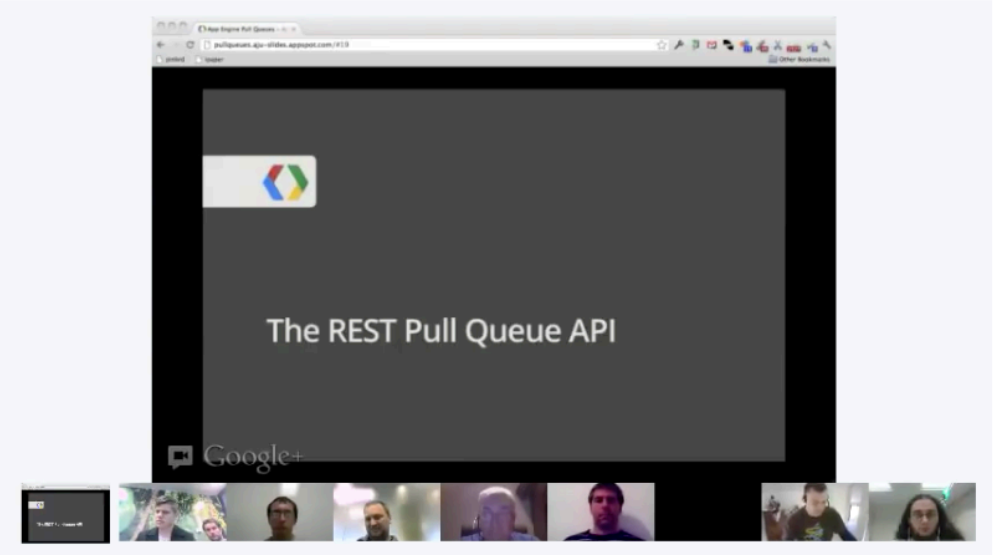
- Pull queues allow a task consumer to process tasks outside of App Engine's default task processing system
  - More cutstomizeable
- If the task consumer is a part of your App Engine app, you can manipulate tasks using simple API calls from the google.appengine.api.taskqueue module
- Task consumers outside of App Engine can pull tasks using the Task Queue REST API
  - More interoperability with outside services

PULL QUEUE

- Pull queue
  - Do not dispatch tasks at all
  - They depend on other worker services to "lease" tasks from the queue on their own initiative
  - Pull queues give you more power and flexibility over when and where tasks are processed, but they also require you to to do more queue management
  - Tasks must complete in the specified deadline or it will be expire

TASK QUEUE

- Google Hangout video with developer relations
  - https://cloud.google.com/appengine/docs/standard/python/taskqueue/overview-pull#



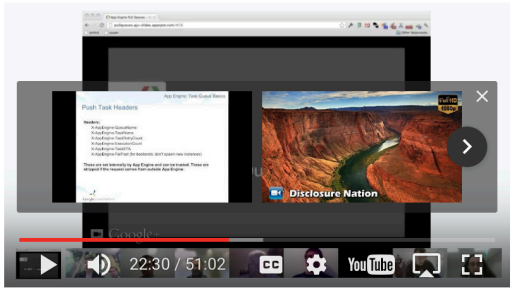
TASK QUEUE

- In practice, start with push queues and consider pull queues when you need more control

Using Pull Queues in Python

SEND FEEDBACK

Contents



Pull queues allow you to design your own system to consume App Engine tasks. The task consumer can be part of your App Engine app, such as a service, or a system outside of App Engine by using the Task Queue REST API. The task consumer leases a specific number of tasks for a specific duration, then processes and deletes them before the lease ends.

Using pull queues requires your application to handle some functions that are automated in push queues:

- Your application needs to scale the number of workers based on processing volume. If your application does not handle scaling, you risk wasting computing resources if there are no tasks to process; you also risk latency if you have too many tasks to process.
- Your application also needs to explicitly delete tasks after processing. In push queues, App Engine deletes the tasks for you. If your application does not delete pull queue tasks after processing, another worker might re-process the task. This wastes computing resources and risks errors if tasks are not idempotent.

Pull queues require a specific configuration in `queue.yaml`. For more information, see Defining Pull Queues.

DEPLOY QUEUES

DEPLOY TASK QUEUES

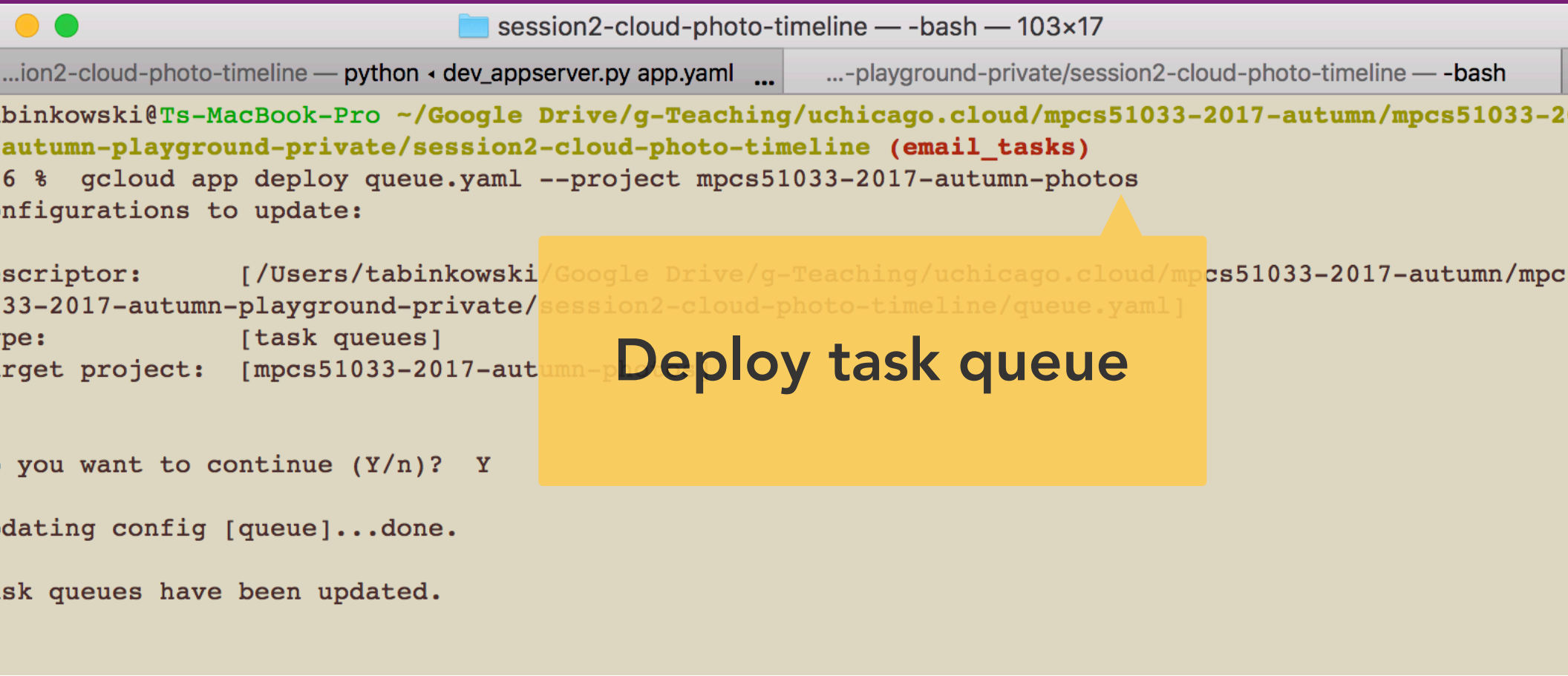
- Cron.yaml file

```yaml
# cron.yaml

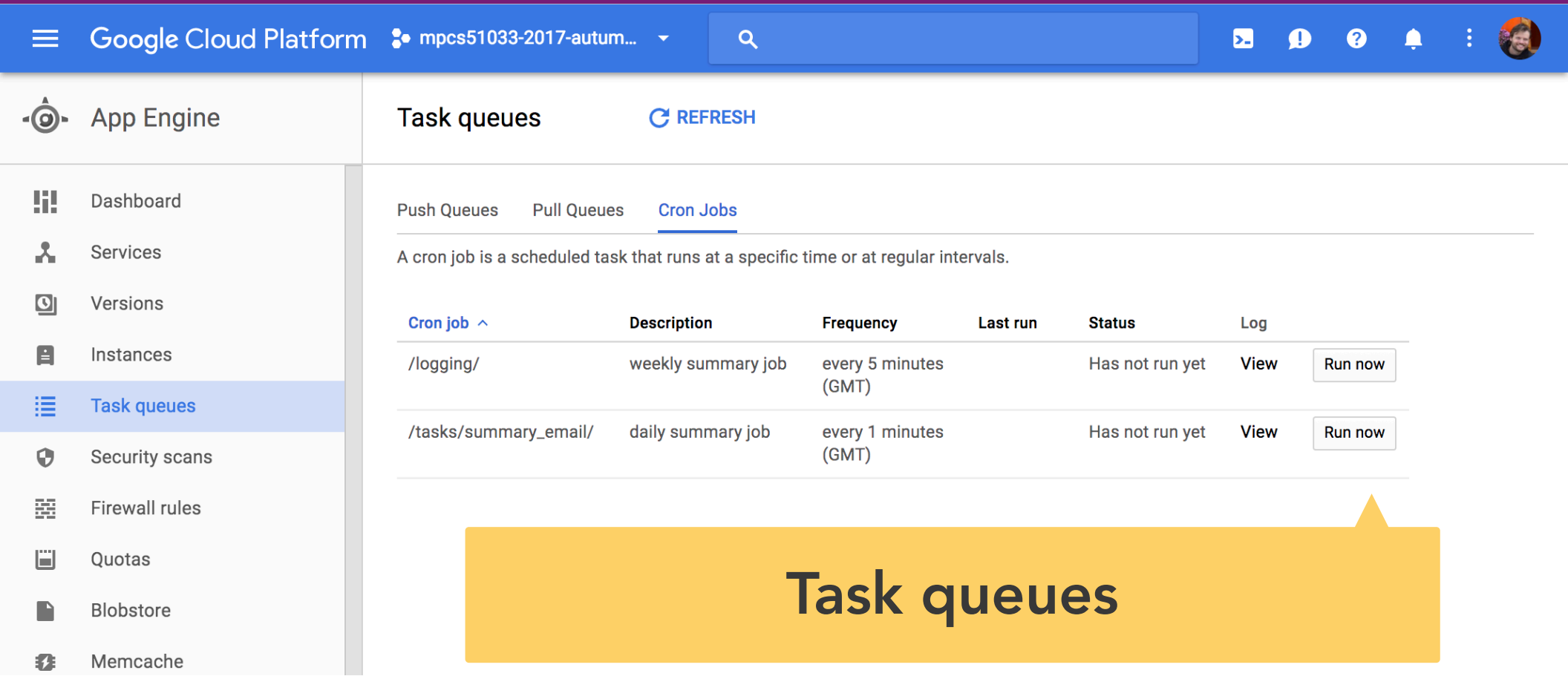
cron:
- description: daily summary job
  url: /tasks/summary_email/
  schedule: every 1 minutes

- description: weekly summary job
  url: /logging/
  schedule: every 5 minutes
```

DEPLOY TASK QUEUES



DEPLOY TASK QUEUES



SCHEDULING TASKS WITH CRON

SCHEDULING TASKS WITH CRON

- Cron Service allows you to configure regularly scheduled tasks that operate at defined times or regular intervals
  - "cron" jobs in unix
- Jobs are automatically triggered by the App Engine Cron Service

Scheduling Tasks With Cron for Python

Contents

...

Pyth

The App Engine Cron Service allows you to configure regularly scheduled tasks that opera
regular intervals. These tasks are commonly known as *cron jobs*. These cron jobs are aut
the App Engine Cron Service. For instance, you might use a cron job to send out an email
or to update some cached data every 10 minutes, or refresh summary information once a

A cron job invokes a URL, using an HTTP `GET` request, at a given time of day. A cron job r
same limits as those for push task queues.

Creating a cron job

1. Create the `cron.yaml` file in the root directory of your application (alongside `app.y`
2. Add one or more `<cron>` entries to your file and define the necessary elements for
   required `<url>` and `<schedule>` elements.

   The following example creates a basic cron job that runs daily:

```
cron:
- description: daily summary job
```

SCHEDULING TASKS WITH CRON

- Use cases
  - Send out an email report on a daily basis
  - Update cached data every 10 minutes
  - Refresh summary information once an hour

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SCHEDULING TASKS WITH CRON

- A cron job invokes a URL, using an HTTP GET request, at a given time of day
- Job request is subject to the same limits as those for push task queues

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   The following example creates a basic cron job that runs daily:

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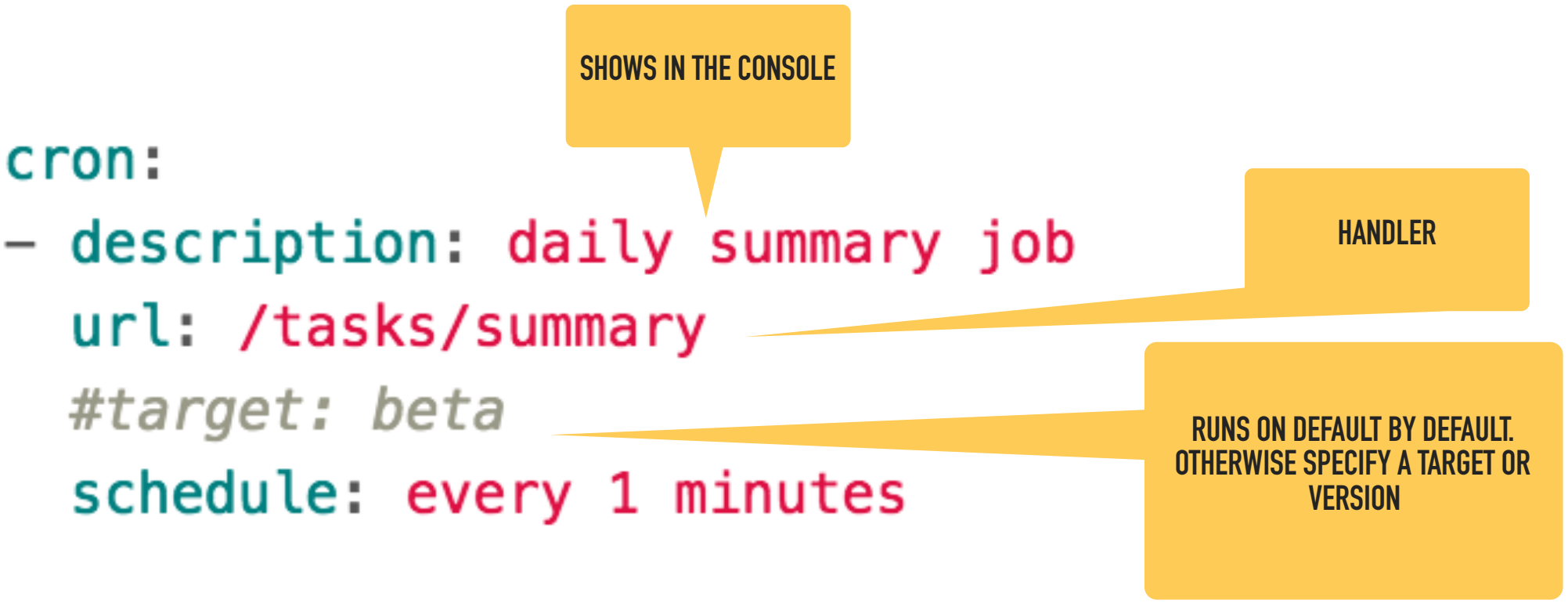
```

SCHEDULING TASKS WITH CRON

- Create a cron job
  - Add a cron.yaml file
  - Add entries
  - Create a handler for cron jobs URL

```
cron:
- description: daily summary job
  url: /tasks/summary
  target: beta
  schedule: every 24 hours
```

SCHEDULING TASKS WITH CRON



SCHEDULING TASKS WITH CRON

```
every 12 hours
every 5 minutes from 10:00 to 14:00
every day 00:00
every monday 09:00
2nd,third mon,wed,thu of march 17:00
1st monday of sep,oct,nov 17:00
1 of jan,april,july,oct 00:00
```

- Schedule format

SCHEDULING TASKS WITH CRON

```
cron:
- description: "daily summary job"
  url: /tasks/summary
  schedule: every 24 hours
- description: "monday morning mailout"
  url: /mail/weekly
  schedule: every monday 09:00
  timezone: Australia/NSW
- description: "new daily summary job"
  url: /tasks/summary
  schedule: every 24 hours
  target: beta
```

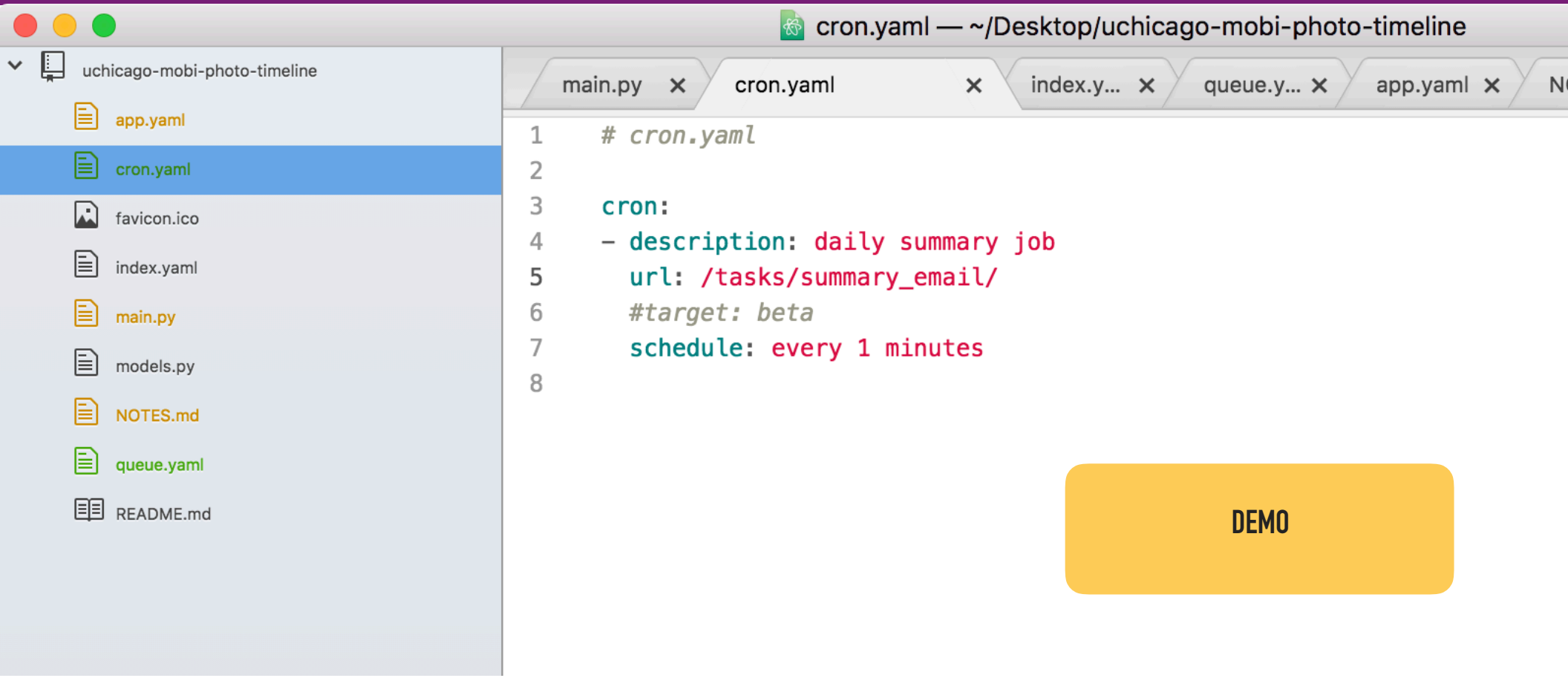
RUNS ON DEFAULT BY DEFAULT. OTHERWISE SPECIFY A TARGET OR VERSION

SCHEDULING TASKS WITH CRON

- The handler should execute any tasks that you want scheduled
- The handler should respond with an HTTP status code between 200 and 299 (inclusive) to indicate success
  - Other status codes can be returned and can be used to trigger retrying the job

```
cron:
- description: daily summary job
  url: /tasks/summary
  target: beta
  schedule: every 24 hours
```

SCHEDULING TASKS WITH CRON



DEPLOY

PUSH QUEUES

- Cron.yaml file

```yaml
# cron.yaml

cron:
- description: daily summary job
  url: /tasks/summary_email/
  schedule: every 1 minutes

- description: weekly summary job
  url: /logging/
  schedule: every 5 minutes
```

PUSH QUEUES

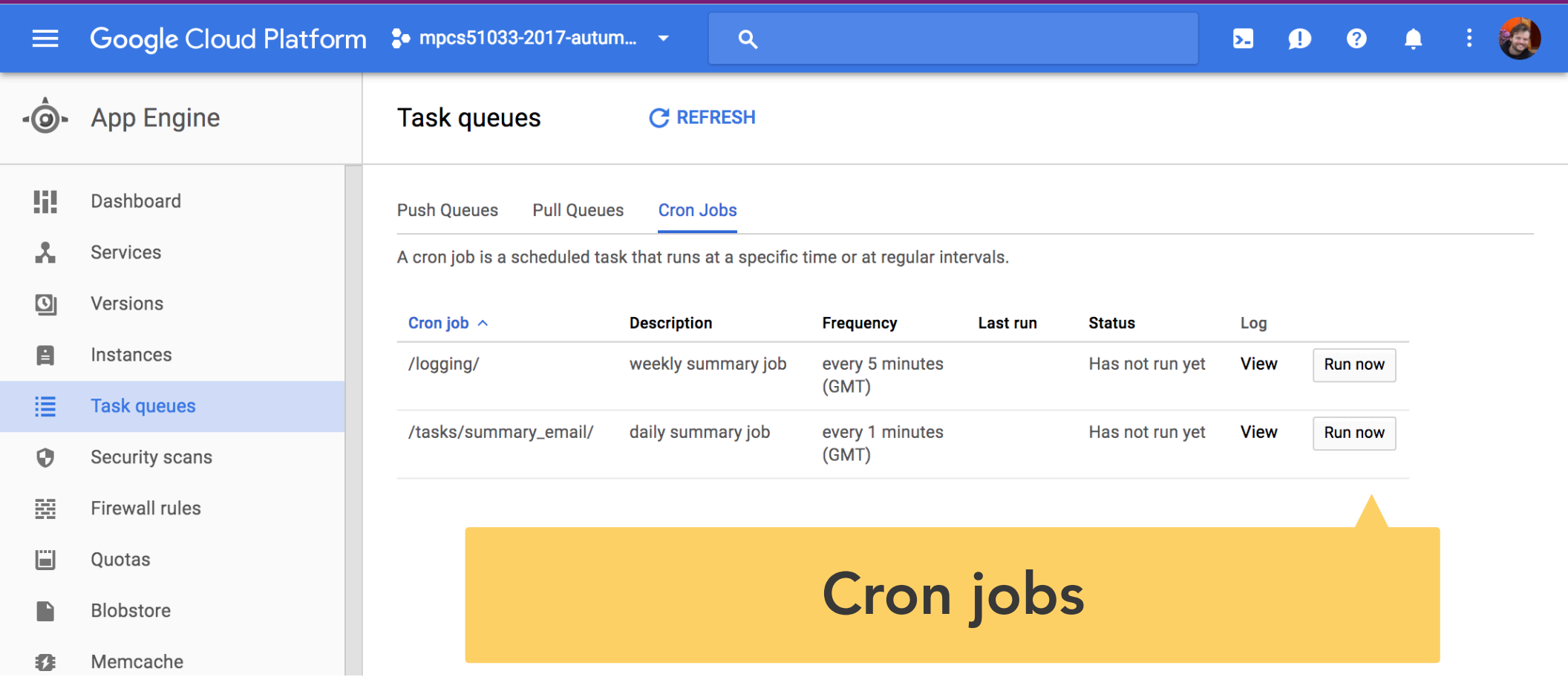
```
tabinkowski@Ts-MacBook-Pro ~/Google Drive/g-Teaching/uchicago.cloud/mpcs51033-201
7-autumn-playground-private/session2-cloud-photo-timeline (email_tasks)
[513 %  gcloud app deploy cron.yaml --project mpcs51033-2017-autumn-photos
Configurations to update:

descriptor:      [/Users/tabinkowski/Google Drive/g-Teaching/uchicago.cloud/mpcs5
1033-2017-autumn-playground-private/session2-cloud-photo-timeline/cron.yaml]
type:            [cron jobs]
target project:  [mpcs51033-2017-autumn-photos]


Do you want to continue (Y/n)?
```

Deploy cron jobs for project

PUSH QUEUES


Google Cloud Platform
mpcs51033-2017-autum...
App Engine
Dashboard
Services
Versions
Instances
Task queues
Security scans
Firewall rules
Quotas
Blobstore
Memcache
Task queues
REFRESH
Push Queues
Pull Queues
Cron Jobs
A cron job is a scheduled task that runs at a specific time or at regular intervals.
Cron job
Description
Frequency
Last run
Status
Log
/logging/
weekly summary job
every 5 minutes (GMT)
Has not run yet
View
Run now
/tasks/summary_email/
daily summary job
every 1 minutes (GMT)
Has not run yet
View
Run now
Cron jobs

ASSIGNMENT 2

ASSIGNMENT 2

HTTP://UCHICAGO.CLOUD/SESSIONS/SESSION2/

Assignment 2

As discussed in class, there are some potential issues with our photo timeline backend. In the fist part of the assignment you will update our existing code base (available here on Github) with the following changes.

Update the Data Model

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BACKENDS FOR MOBILE APPLICATIONS