Data Migrations in the App Engine Datastore

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This Talk is in Python

Examples Use NDB

```
from google.appengine.ext import ndb
```

```
from google.appengine.ext import db
```

The Datastore

- Schemaless
- Entities of the same type can have different properties
- Most applications express an effective schema using application code
- All queries are served by pre-built indexes

Problem

- No general framework for making mass updates ("schema changes") to entities in the Datastore or helping the in-code model evolve

- Frameworks like Rails and Django (South) have tools to help manage this and are built on top of relational databases that allow SQL to be used to help migrate data

- We will look at techniques for doing this on the non-relational App Engine Datastore

Initial Data Model

```
from google.appengine.ext import ndb


class BlogPost(ndb.Model):
    title = ndb.StringProperty(required=True)
    blurb = ndb.StringProperty(required=True)
    content = ndb.StringProperty(required=True, indexed=False)
    published = ndb.DateTimeProperty(auto_now_add=True, required=True)


class Comment(ndb.Model):
    blog_post = ndb.KeyProperty(kind=BlogPost, required=True)
    content = ndb.StringProperty(required=True, indexed=False)
    timestamp = ndb.DateTimeProperty(required=True)
```

Add Likes

- Each comment has a count of “likes”
- Displayed with each comment
- No searching/sorting/etc
- Don’t care who liked what

Just Add Property with Default Value

```
class Comment(ndb.Model):
    blog_post = ndb.KeyProperty(kind=BlogPost, required=True)
    content = ndb.StringProperty(required=True, indexed=False)
    timestamp = ndb.DateTimeProperty(required=True)
    likes = ndb.IntegerProperty(default=0)
```

Adding a Post URL Slug

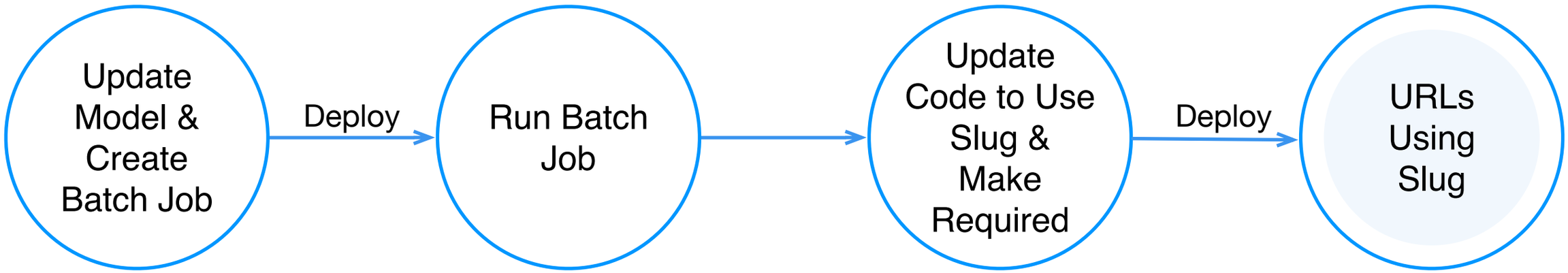
- Want to change URLs from
  `http://example.com/posts/1234`
  to
  `http://example.com/posts/this-is-my-post`

- Need to be able to query Datastore to locate the right post for a given slug

- All Posts need to have slugs populated before we start using them for URL lookups

- Slugs are determined by the title of the post

Steps


Update Model & Create Batch Job
Deploy
Run Batch Job
Update Code to Use Slug & Make Required
Deploy
URLs Using Slug

Add Slug to Model

```
class BlogPost(ndb.Model):
    title = ndb.StringProperty(required=True)
    blurb = ndb.StringProperty(required=True)
    content = ndb.StringProperty(required=True, indexed=False)
    published = ndb.DateTimeProperty(auto_now_add=True, required=True)
    slug = ndb.StringProperty()
```

Create Slugs for All Posts Deferred Tasks

```
BATCH_SIZE = 10

def add_slugs(cursor=None):
    posts, next_cursor, is_there_more \
         = BlogPost.query().fetch_page(BATCH_SIZE, start_cursor=cursor)

    for p in posts:
        p.slug = BlogPost.slug_from_title(p.title)

    if len(posts) > 0:
        ndb.put_multi(posts)

    if is_there_more:
        deferred.defer(add_slugs, cursor=next_cursor)
```

Create Slugs for All Posts MapReduce

```
from mapreduce import base_handler, mapper_pipeline, operation

def create_slug_mapper(post):
    post.slug = BlogPost.slug_from_title(post.title)
    yield operation.db.Put(post)

class CreateSlugsPipeline(base_handler.PipelineBase):
    def run(self):
        yield mapper_pipeline.MapperPipeline(
            job_name="create slug",
            handler_spec="module.create_slug_mapper",
            input_reader_spec=\
                "mapreduce.input_readers.DatastoreInputReader",
            params={
                "entity_kind": "models.BlogPost"
            },
            shards=16)
```

Create Slugs for All Posts MapReduce

```
pipeline = module.CreateSlugsPipeline()
pipeline.start()
```

Add Number of Comments for Post

- When displaying the preview of a blog post, show the number of comments
- Cannot query for count for pages of multiple posts; too slow
- Need to de-normalize the data
- Need to go through and do computation for all existing posts

Add Comment Count to Model

```
class BlogPost(ndb.Model):
    title = ndb.StringProperty(required=True)
    blurb = ndb.StringProperty(required=True)
    content = ndb.StringProperty(required=True, indexed=False)
    published = ndb.DateTimeProperty(auto_now_add=True, required=True)
    slug = ndb.StringProperty(required=True)
    number_of_comments = ndb.IntegerProperty(default=0)
```

Count Comments for All Posts Deferred Tasks

```
BATCH_SIZE = 10

@ndb.toplevel
def count_comments(cursor=None):
    posts, next_cursor, is_there_more \
        = BlogPost.query().fetch_page(BATCH_SIZE, start_cursor=cursor)

    for p in posts:
        p.number_of_comments \
          = Comment.query(Comment.blog_post == p.key).count(limit=1000)
        p.put_async()

    if is_there_more:
        deferred.defer(count_comments, cursor=next_cursor)
```

Count Comments for All Posts MapReduce

```
from mapreduce import base_handler, operation, \
    mapreduce_pipeline

def count_comments_mapper(comment):
    yield (comment.blog_post.urlsafe(), "")


def count_comments_reducer(keystring, values):
    post = ndb.Key(urlsafe=keystring).get()
    post.number_of_comments = len(values)
    yield operation.db.Put(post)
```

Count Comments for All Posts MapReduce

```
class CountCommentsPipeline(base_handler.PipelineBase):
    def run(self):
        yield mapreduce_pipeline.MapreducePipeline(
            job_name="count comments",
            mapper_spec="module.count_comments_mapper",
            reducer_spec="module.count_comments_reducer",
            input_reader_spec=\
             "mapreduce.input_readers.DatastoreInputReader",
            mapper_params={
                "entity_kind": "models.Comment"
            },
            shards=16)
```

Deleting Properties from Models

- Removing a property from your model class doesn't change the data in the DataStore

- May want to delete data to reduce entity size, keep entities consistent, etc

```
class Cat(ndb.Model):
    tail = ndb.StringProperty()
    wiskers = ndb.StringProperty()
    skin = ndb.StringProperty()
```

Deleting a Property - NDB

```
c = Cat.get_by_id(1234)

if 'skin' in c._properties:
    del c._properties['skin']
    c.put()
```

- Delete the property from the _properties dictionary
- Note that `del cat.skin` would set the property to `None`

Deleting a Property - DB

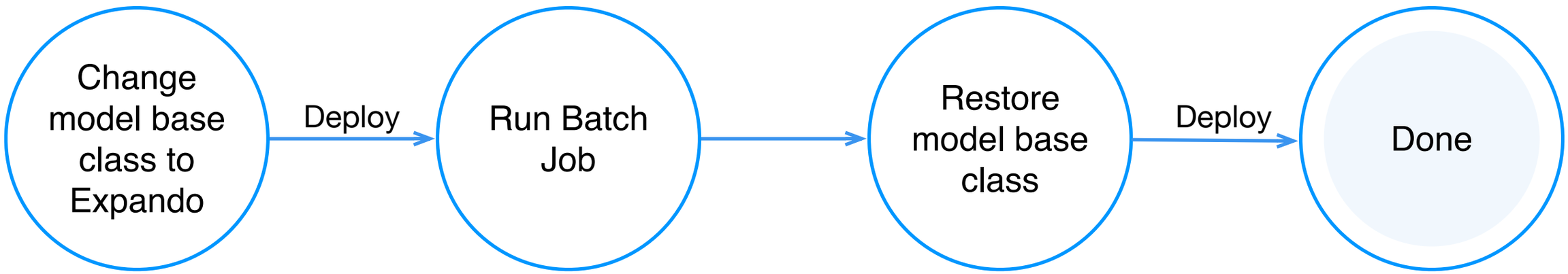
- Model objects have a _properties dictionary, but it cannot be used to delete a properties

- Two approaches: switch model to Expando or direct Datastore access

Deleting a Property - DB Expando

```
class Cat(db.Expando):
    pass

c = Cat.get_by_id(12345)

del c.skin
c.put()
```

Deleting a Property - DB Expando



Downsides:

- Must change base class; problematic if using custom base class with logic
- Requires two deploys

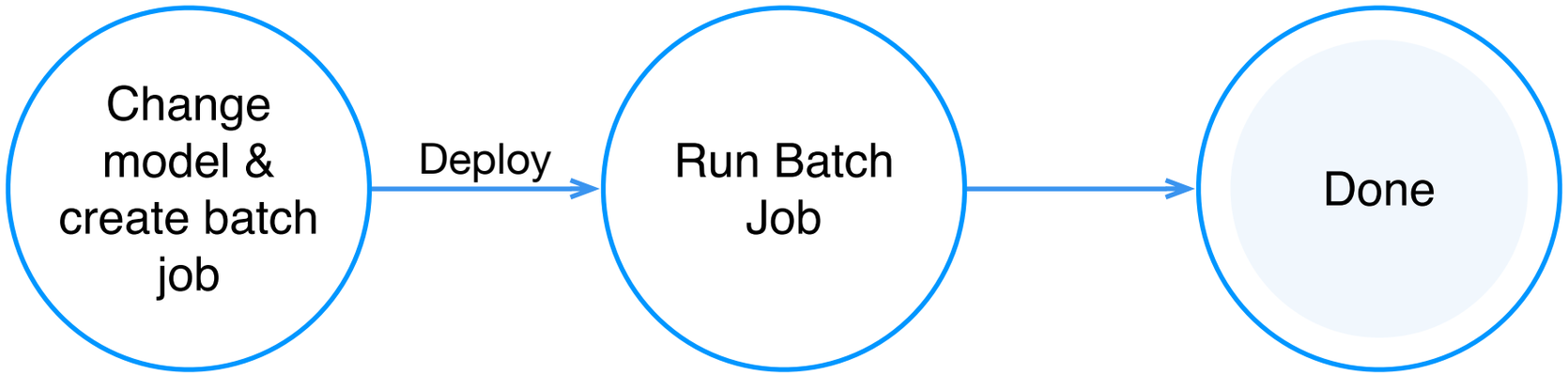
Deleting a Property - DB Direct Datastore Access

```
from google.appengine.api import datastore
from google.appengine.api import datastore_errors

def get_entities(keys):
    rpc = datastore.GetRpcFromKwargs({})
    keys, multiple = datastore.NormalizeAndTypeCheckKeys(keys)
    entities = None
    try:
        entities = datastore.Get(keys, rpc=rpc)
    except datastore_errors.EntityNotFoundError:
        assert not multiple

    return entities

def put_entities(entities):
    rpc = datastore.GetRpcFromKwargs({})
    keys = datastore.Put(entities, rpc=rpc)
    return keys
```

Deleting a Property - DB Direct Datastore Access

```
key = db.Key.from_path('Cat', 12345)
c = get_entities([key])[0]

if 'skin' in c:
    del c['skin']
    put_entities([c])
```

Deleting a Property - DB Direct Datastore Access



Advantages:

- Does not require multiple deploys which can be hard to automate across multiple environments & developers
- Does not interfere with the base class of the model

Renaming Models

- Approach depends on your need
- If you just want to keep the code clean, alias the model in code
    - Be cautious: GQL and other textual references to the model for queries will need to use name in Datastore
- If you want the underlying entities renamed, need to create new entities
    - Problematic if there are keys to the entity or child entities

Rename Blog Post to Article NDB

```
class Article(ndb.Model):

    @classmethod
    def _get_kind(cls):
      return 'BlogPost'

    title = ndb.StringProperty()
    blurb = ndb.StringProperty()
    content = ndb.StringProperty()
    published = ndb.DateTimeProperty()
    slug = ndb.StringProperty()
    number_of_comments = ndb.IntegerProperty()
```

Rename Blog Post to Article DB

```
class Article(db.Model):

    @classmethod
    def kind(cls):
      return 'BlogPost'

    title = db.StringProperty()
    blurb = db.StringProperty()
    content = db.StringProperty()
    published = db.DateTimeProperty()
    slug = db.StringProperty()
    number_of_comments = db.IntegerProperty()
```

Renaming Fields

- Approach depends on your need
- If you just want to keep the code clean, alias the model in code
    - Be cautious: GQL and other textual references to the field for queries will need to use name in Datastore
- If you want the underlying fields on the entities renamed, need multi-step migration

Alias url_slug to slug

NDB

```
url_slug = ndb.StringProperty(name='slug')
```

DB

```
url_slug = db.StringProperty(name='slug')
```

Truly Rename Property

1. Create new model property

2. Create new @property on the Class that sets the value to both the new and the old property, but gets from the old property

3. Update all get/sets to use the @property. Queries still use the old property

4. Create Batch migration to copy values from old to new property

Truly Rename Property (2)

5. Deploy the code & run the migration

6. Update code, remove @property and old model property, everything uses new property, including queries

7. Deploy

8. (optional) Create batch job to delete old property

On-the-Fly Migrations

- Create your own base model class that derives from ndb.Model or db.Model

- Have a class-level property that defines the current version of that model

- Store the schema version for each specific entity

- When an entity loads, compare its schema version to the latest schema version. Run migrations as needed

On-the-Fly Migrations

Advantages:

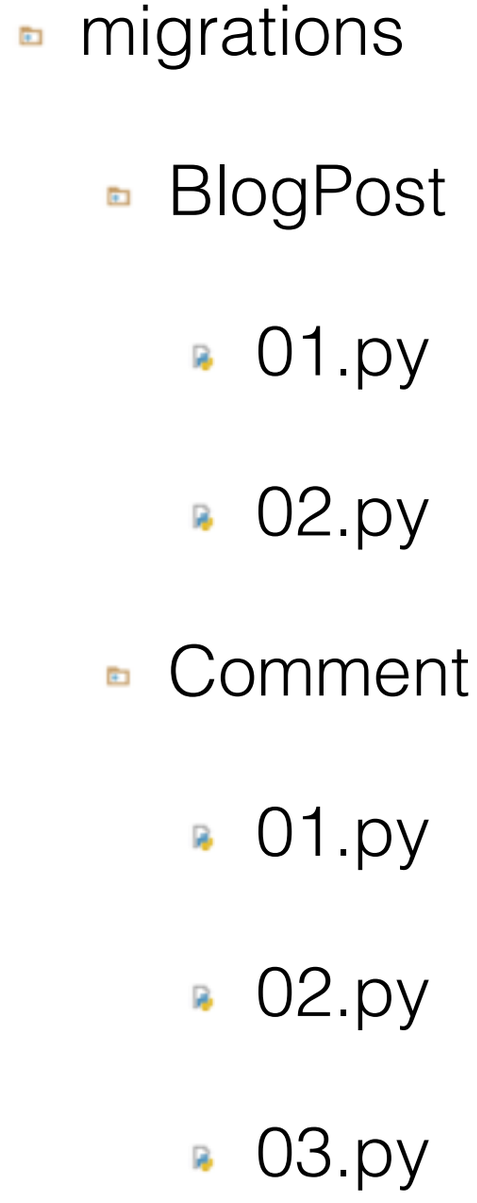
- Allows for more aggressive code roll out
- Let's you be running a batch migration in the background while live code expects the migrated schema
- Only migrate entities that get used; don't need to mess with historical data

Disadvantages:

- Cannot use it for migrations that will need to support queries
- Not all entities in same schema version unless combined with batch job
- Potential for performance issues

Code Structure

- Docalytics has a specific format for how we lay out migration logic
- Module for each entity, with each migration in its own module
- Well-known names for migration functions that are called from the on-the-fly and batch logic
- Allows us to write the batch logic once rather than specific to the migration



Final Thoughts

- Pay attention to indexes
    - Make sure added/renamed fields are added index.yaml
        - Delete old Indexes that aren’t needed
- Watch out for caching as you migrate data
- Think about the processes for how you manage migrations both as code rolls to deployed environments and to other developer workstations

Questions?

https://github.com/Docalytics/app-engine-datastore-migrations