CS341: Project in Mining Massive Datasets

Michele Catasta, Jure Leskovec, Jeffrey Ullman
Agenda

- Intro by Michele
- Logistics & Class Overview
- Intro to Google Cloud
Projects in Spring 2019

- Discovering Driver Signatures in Automotive Data (x 2)
- Subgraph Pattern Matching on Graphs with Deep Representations
- RecSys Challenge 2019
- Recommender System for Publisher of Technical News
- Diagnosing TMJ Arthritis
- Anomaly Detection of Computer Health
- Wildlife detection
- Longitudinal analysis of the Web Graph
Class Logistics

- Please register on Piazza if you haven’t: [https://piazza.com/stanford/spring2019/cs341](https://piazza.com/stanford/spring2019/cs341)

- Onboard: 4/3, we will meet every Wed on April, then on a per-need basis

- Checkpoint presentations: Checkpoint 1 on 4/24, Checkpoint 2 on 5/15

- Checkpoint reports: Checkpoint 1 on 4/28, Checkpoint 2 on 5/19
  
  - 1. What problem are you working on?
  - 2. What data are you using?
  - 3. What methods for solution have you tried?
  - 4. What are your results so far?
  - 5. What are your plans to complete the project?

- Final Presentation: 6/5 (Wed), more info to be given by then

- Final Report: 6/9
Expectations / Advice

● Self-motivation, how much you learn from the course totally depends on you

● Good to set up a regular meeting with mentors every week to keep track of progress

● Don’t wait for mentors to tell you what to do

● Please use Office Hours as much as possible! See scheduling information at http://cs341.stanford.edu/
  ○ Possible issues: build bugs, cloud setup, interpersonal issues, need ideas, etc.

● Use Piazza as a StackOverflow for TAs/mentors
Advice on conducting research

- Make sure you put in the time required (or more :-), work hard, consistently, independently, but also as a team player!
- Don’t be afraid to be innovative and creative in your thoughts
  - Don’t be afraid to modify/shift the project direction
Advice on conducting research

- Do supplemental reading
- Don’t be afraid to make a mistake or take a risk
  - Some of the best innovations occur from people taking risks, making errors, and learning from them
- Take your work seriously!
How to prepare for a meeting

How to prepare for a research meeting:

- **Update on your progress** (max 10 minutes)
  - Prepare a printout or slides with your past progress
    - Send these out before your meeting
  - Cover the essential results and findings. Be precise!
  - Results of failed experiments are especially useful
  - Don’t try to cover every little thing you did, just focus on important results
How to prepare for a meeting

How to prepare for a research meeting:

- Prepare questions/ideas for further directions
  - Bring a written list of questions or issues to each meeting
    - Mentors cannot fully answer questions that are not asked!
  - Think about what you plan to do next
- Take notes!
  - Keep precise research progress and meeting notes
Grading

The grade for the course is composed of the following parts

- Checkpoint 1 presentation: 10%
- Checkpoint 2 presentation: 20%
- Final project presentation: 20%
- Final project writeup: 50%
Google Cloud Platform

CS341
● Founded a company in 2014 (Denizen)
● Product Manager for a distributed systems company (Mesosphere)
● Research Fellow for Microsoft Research. Research topics: deep reinforcement Learning, curriculum learning, HCI
● Experienced with production deployment of distributed systems, e.g. Docker, Kubernetes, Mesos, Spark, Cassandra, Kafka, Akka etc.
● Come to me for help setting up data pipelines and infrastructure!

Abhay Agarwal (MS Design ‘19)
Agenda

- Account/Billing/Alerts
- Launching VMs
- Clusters
- Containers
- Tips
What is Google Cloud Platform?

Google’s cloud computing service (using same infrastructure used by Google for products like search). Relevant for this class:

<table>
<thead>
<tr>
<th>Compute Engine</th>
<th>Virtual Machines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Services</td>
<td>Relational and NoSQL cloud storage</td>
</tr>
<tr>
<td>Data Services</td>
<td>Hadoop/Spark clusters, cloud ML service, APIs for natural language, vision, speech</td>
</tr>
</tbody>
</table>

Full list of products: [https://cloud.google.com/products/](https://cloud.google.com/products/)
Setup: Create a project

1. Visit https://console.cloud.google.com
2. Click on “Create a Project” and complete the flow. Billing should be set up automatically to use the EDU credits
3. Go to “IAM” from main menu, add rest of team members (using Google accounts, **NOT** stanford.edu account)
4. Go to Piazza for info about adding your Google Cloud credits (1 per team!)
Setup: Create Billing Alerts

1. **Very important!** You do not want to accidentally spend all of your money.
2. Go to Billing and select your project.
3. Set up many alerts based on monthly spend, percentage spend, etc.
Interacting with Google Cloud Platform

Broadly you can interact with GCP in three ways:

1. Graphical UI ([https://console.cloud.google.com/](https://console.cloud.google.com/)): Useful to create VMs, set up clusters, provision resources, manage teams etc

2. Command line (gcloud sdk tools): Useful for using the resources once provisioned. E.g. ssh into instances, submit jobs, copy files etc

3. Cloud Shell (recommended): Same as command line, but web-based and pre-installed with SDK and tools, and a persistent home directory (!). More info here: [https://cloud.google.com/shell/docs/quickstart](https://cloud.google.com/shell/docs/quickstart)
Setup: Command line tools

1. Make sure you have Python 2.7.9 or higher
2. Download SDK: https://cloud.google.com/sdk/docs/
3. Install: run ./install.sh and follow the installation steps
4. Authorize using your credentials: Run ./bin/gcloud init
5. Test: gcloud components list, gcloud auth list
Setup: Command line tools

1. Make sure you have Python 2.7.9 or higher.
2. Download Sdk: `curl -o /usr/local/google-cloud-sdk/bin/google-cloud-sdk.sh https://storage.googleapis.com/cloud-sdk-linux/google-cloud-sdk.zip
   ./google-cloud-sdk.sh install
   . $HOME/google-cloud-sdk/bin/activate`
3. Install: run `gcloud components list`
4. Authorize user using `gcloud auth application-default login`
5. Test: gcloud components list, gcloud auth active

```
nhilt@nhilt-lp1:~/Documents$ gcloud components list
Your current Cloud SDK version is: 149.0.0
The latest available version is: 149.0.0
Components

<table>
<thead>
<tr>
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<th>Name</th>
<th>ID</th>
<th>Size</th>
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<td>47.7 MiB</td>
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<tr>
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<td>Cloud Datastore Emulator</td>
<td></td>
<td>15.4 MiB</td>
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<td>Cloud Datastore Emulator (Legacy)</td>
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<tr>
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<td>Default set of gcloud commands</td>
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<td>gcloud Alpha Commands</td>
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<td>gcloud Beta Commands</td>
<td></td>
<td>&lt; 1 MiB</td>
</tr>
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```
Configure and use a VM

2. Click on the “Create Instance” button.
3. Configure instance name, zone, machine type, network traffic, etc.
4. Congrats, your VM has been created! Use “View gcloud command” and copy the message in the pop-up dialog to your bash shell.
   (something like: gcloud compute --project "yourProjectID" ssh --zone "yourInstanceZone" "yourInstanceName")
Configure and use a VM (Cont’d)

5. Stop your machine when not in use to avoid unexpected charges.

6. For more details, see https://cloud.google.com/compute/docs/quickstart-linux.

FAQ: My bash shell is complaining gcloud command not found. :( Reload your bash_profile using the “source” command, OR simply restart your bash shell.
Attach a Disk to Your VM

1. **Create your blank disk.**
   (1) VM instances -> click on your instance -> “Edit” button at the top -> additional disks -> “Add item” button.
   (2) Select “Name” dropdown -> Create disk -> Source type: select “blank disk” -> configure whatever nickname and size to your disk.

2. **Format and mount your disk**

3. **Every time you reboot, you need to mount your disk again:**
   sudo mount -o discard,defaults /dev/[DEVICE_ID] /mnt/disks/[MNT_DIR]

4. For more details, see
   [https://cloud.google.com/compute/docs/disks/add-persistent-disk](https://cloud.google.com/compute/docs/disks/add-persistent-disk)
Create a Cluster

1. **Two ways to create a cluster:**
   - Use command line (easier): `gcloud dataproc clusters create <cluster-name>`
   - **OR** Use GUI: visit [https://console.cloud.google.com/dataproc/clusters](https://console.cloud.google.com/dataproc/clusters).

2. **View your clusters:** [https://console.cloud.google.com/dataproc/clusters](https://console.cloud.google.com/dataproc/clusters).

**Clusters:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Zone</th>
<th>Total worker nodes</th>
<th>Cloud Storage staging bucket</th>
<th>Created</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>cluster-1</td>
<td>us-central1-a</td>
<td>2</td>
<td>dataproc-a60e0265-f815-44e1-83e2-8b7284431f9e-us</td>
<td>Apr 4, 2017, 11:34:03 PM</td>
<td>Running</td>
</tr>
</tbody>
</table>

**Instances:** 1 master node and 2 worker nodes have been created
Submit a Job

1. **Create your job.**
   
   *Simple example: add one to every element in an array.*

   ```python
   import pyspark
   sc = pyspark.SparkContext()
   original_array_rdd = sc.parallelize([3,2,5,1,4])
   new_array_rdd = original_array_rdd.map(lambda x: x+1)
   new_array = sorted(new_array_rdd.collect())
   print(new_array)
   ```

2. **Submit your job:**
   
   ```bash
   gcloud dataproc jobs submit pyspark --cluster <my-dataproc-cluster> my-first-job.py
   ```

3. **View your jobs:** [https://console.cloud.google.com/dataproc/jobs](https://console.cloud.google.com/dataproc/jobs)
Storage Solutions for Clusters

1. You can choose to use
   (1) cloud storage
   (2) share a persistent disk among your cluster
   (3) Other solutions depending on your needs

   This page offers detailed explanation

2. To set up **cloud storage**, see tutorial on

3. To **share a persistent disk** among all machines in your cluster, see tutorial on
Google Kubernetes Engine (GKE)

1. Containers are lightweight, isolated VM-like objects for running code in a consistent, repeatable environment (e.g. packaging your code with needed libraries)
2. Visit https://cloud.google.com/kubernetes-engine/
3. Create a cluster
4. Launch a distributed application
5. Congrats, you are running a distributed system with isolation, scalability, repeatability.
Create a Cluster & Deploy your app

1. Use command line: `gcloud container clusters create [CLUSTER_NAME]`
2. Deploy an application: `kubectl run hello-server --image [my-app]`
3. Your application can run code, expose a web UI, scrape from the web, add data to a table, etc. If your process dies, it is restarted automatically.
4. Find more info in the quickstart guide: [https://cloud.google.com/kubernetes-engine/docs/quickstart](https://cloud.google.com/kubernetes-engine/docs/quickstart)
Other services that might be useful

- Natural Language: [https://cloud.google.com/natural-language/](https://cloud.google.com/natural-language/)
- BigQuery: [https://cloud.google.com/bigquery](https://cloud.google.com/bigquery)
- DataPrep: [https://cloud.google.com/dataprep/](https://cloud.google.com/dataprep/)
- DataProc: [https://cloud.google.com/dataproc/](https://cloud.google.com/dataproc/)
- Cloud ML Engine: [https://cloud.google.com/ml-engine/](https://cloud.google.com/ml-engine/)
Suggested Developer Patterns

- Create a Continuous Integration Pipeline: create a git repo with your code, add a build manifest that compiles/packages/tests your code, add a dockerfile that runs the build tool, and create a build trigger to auto-build a container for every code push. [https://docs.docker.com/docker-hub/builds/](https://docs.docker.com/docker-hub/builds/)
- Delete your dataproc clusters automatically after your jobs complete! Saves tons of money. Create a bash script for your job: [https://cloud.google.com/dataproc/docs/guides/manage-cluster#delete_a_cluster](https://cloud.google.com/dataproc/docs/guides/manage-cluster#delete_a_cluster)
- Create versioned models and host them in your data store!