Web of Science in Cloud Kotta

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Motivation

- Data driven research is ubiquitous. Data is fast becoming the defining assets for researchers, particularly those in the computational social sciences and humanities.

- Data is increasingly large; it is also valuable, proprietary, and sensitive.

- Social scientists (and other researchers) lack the technical and financial resources to securely and scalably manage large amounts of data while also supporting flexible and large-scale analytics.

- Cloud computing provides “infinite” storage and compute resources, however it requires technical expertise to deploy, configure, manage, and use.

- Cloud Kotta is a cloud-hosted environment that supports the secure management and analysis of large scientific datasets.
With private data-sets comes great responsibility

A significant fraction of the 10TB we manage is sensitive/proprietary data

Web of Science - from Thomson Reuters (1TB)
UChicago AURA grants DB - under NDA (~200GB)
IEEE full texts - under license (5.5TB)

We want to make this data accessible to our colleagues and collaborators, but secured within our infrastructure.
With massive data comes massive COST

We hold a tad over 10TB of research data.

10TB on EBS (SSD) = $1000 / mo
10TB on S3 (std) = $300 / mo
10TB on S3 (IA) = $125 / mo
10TB on Glacier = $70 / mo

Each comes with its own tradeoffs.
Large-scale data analytics

- Analyses are user driven and often interactive
- Development is often iterative
- Analyses are often compute intensive or memory intensive
- Complex analyses can be broken down to a many-task model (SPMD) and computed in parallel
- Scientific workloads are inherently sporadic and bursty (tracking submission deadlines)
- Variable lengths of time (minutes to weeks)
- Analyses are written in many languages (e.g., Python, Julia, BaSH, C++)
With massive compute comes massive COST

We’ve run over 75K* compute hours in 6 months

- On-demand = $15984.37
- Spot-market (variable) = ~$4795.31
- 1 Reserved instance for 6mo = $17677.44

With i2.8xlarge, you can burn a 10K AWS credit in just 2 months.

We want to optimize for both cost and time-to-solution.

* Core hours
Solution
Cloud Kotta

- Cloud Kotta is a cloud-based platform that enables secure and cost-effective management and analysis of large, potentially sensitive data.
- The platform automatically provisions cloud infrastructure to host user submitted jobs.
- Data is migrated between storage tiers depending on access patterns and pre-defined policies.
- Role based access model for security.

* Pictured: Mehrangarh Fort at Jodhpur, Rajasthan
User Workflow
User Interfaces

Web Interface

REST API

```
curl -i -H "Accept: application/json" http://52.2.217.165:8888/rest/v1/status
HTTP/1.1 200 OK
Content-Length: 3982
Content-Type: application/json
Date: Tue, 25 Oct 2016 05:43:38 GMT
Server: ip-10-0-0-93

{"status": "completed",
"items":
["0": {
"username": "Yadu Nand B"},
"1": {
"z_stagoin_dur": 0.018196286121775175809,
"executable": "/bin/bash myscript.sh"},
"3": {
"job_id": "d76d2d8d-4467-44df-8a0c-3e29e8427f9"},
"4": {
"complete_time": "2016-10-20 18:29:97"},
"5": {
"submit_stamp": "2016-10-20 18:32:56"},
"6": {
"z_processing_dur": -0.996824026107788859375},
"7": {
"status": "completed"},
"8": {
"outputs": "<a href="https://lab-j..."}
```

Command Line Interface
Data Interface

- **Upload Data**

- **Browse Data**

![Data Interface Diagram]

- **Upload Data**
  - Open File
  - Places:
    - Search
    - Recently Used
    - yadu
    - Desktop
    - File System
    - 16 GB Volume
    - Windows
    - galactica

- **Browse Data**
  - Directory Structure:
    - Parent
    - abstracts_by_publication: Directory
    - medline_etump: Directory
      - Last Modified: 2016-10-10T18:57:09.000Z
    - scopus.uchicago.affiliated.data: Directory
    - summaries: Directory
      - Last Modified: 2016-08-21T00:25:23.000Z
    - 1982.doc_jobs.txt: 93.81 KB
    - APSfigureCount.py: 1.84 KB
    - APSword2vecFULLTEXT.py: 3.28 KB
    - Equation_Count.py: 2.07 KB
    - LDRO_installer.sh: 1.39 KB
    - LDRO_virtua1env.tar.gz: 3.09 MB
    - MCR_F2012a_gmx64_installer.zip: 332.25 MB

![File System Structure]

**URL**

- File Name: AEKWXVYINCBNNY5MRM0YND6CWWA
- Parent Directory: /klab-jobs/uploads/amzn1.account
- Last Modified: 09/10/2016
Job Submission
Job management

status: completed

L_published: 1
z_stagen_dur: 329.211119174975275390625
execuable: /bin/bash myscript.sh
job_id: 087209h1-3bcb-413c-a5d3-8a9e9a2d8818
complete_time: 2016-07-11 22:26:44
publishdate: 2016-07-13 16:19:22
submit_timestamp: 2016-07-11 19:54:00
z_processing_dur: 1295.08447903561357421875
username: Wanj Zhu

Inputs: article_influence.py

description: Job Behavior: Computes the Article Influence of journals based on eigenfactor and article counts for # of papers published. Data obtained from web of science. Done in parallel insantly fast, but it's not necessary as it's not computationally intensive. Inputs: journal_counts_1995.csv ~ journal_counts_2015.csv, one per year, in tab-separated values of (including headers for the first row) JOURNAL COUNT eigenfactors_1995.csv ~ eigenfactors_2015.csv, one per year, in tab-separated values of (no headers) JOURNAL EIGENFACTOR Outputs: Calculate the Article Influence for each of the years and output to article_influence.csv. Also outputs intermediate values for debugging, but they are not useful.

Outputs: myscript.sh
Outputs: article_influence.csv
Outputs: t_counts.csv
Outputs: j_counts.csv
Outputs: j_ef.csv
Outputs: STDEFR.txt
Outputs: STDOUT.txt
Start time: 2016-07-11 19:54:00
Usage
Early science on Cloud Kotta

- Text Analytics
- Matrix Factorization
- Optical Character Recognition (tesseract)
- Network Analysis
- Author-Topic models
Thanks

- Github repo: https://github.com/yadudoc/cloud_kotta
- Documentation: http://docs.cloudkotta.org/
- Support: yadunand@uchicago.edu
Automated storage management

- Worker (EC2)
- EBS: $100/TB/mo
- S3 Standard Bucket: $30/TB/mo
- S3 Infrequent Access Bucket: $12.5/TB/mo
- Glacier: $7/TB/mo
Elastic Provisioning
Security model

- Principle of least privilege throughout
- “Log in with Amazon”
- Users are assigned roles
- Policies permit access to resources for individual roles
- Instances are granted a trusted role that allows them to switch to a user role temporarily in order to inherit user permissions (e.g., access secure data)
- Compute layer is hosted within a private subnet enclosed within a VPC
Cloud Formation

Security

Auto Scaling

Data Caching
Elastic scaling experiment

- To demonstrate the automatic scaling behavior we used a test-workload derived from historical production usage.
- 40 jobs of 1, 3, or 4 hour durations with inter-arrival time from poisson-distribution ($\lambda = 0.1667$).
- Jobs simply call `sleep()`.
- Each job uses a randomly selected data input of size {1, 3, 5, 7, 9}GB.
- The scaling limit was set to a maximum of 40 nodes.
- We plot the total nodes active and idle, as well as the state of each of the 40 jobs. X axis is time.
Acknowledgements