Why Hadoop?

Jason Poovey
Branch Head of HPC and Data Analytics
Georgia Tech + OHDSI

• Work with our partners data to
  - Merge together data from many sources: structured, unstructured, omics, sensor/IoT
  - Harmonize and Standardize across health domains and sources
  - Build computable and shareable phenotypes that describe cohorts uniformly across multi-modal data
  - Build statistical models for: precision medicine, care recommendation, clinical decision support
  - Provide interoperable reports and dashboards

• OHDSI provides the common model for the predictive pipelines
Using Hadoop in GT

- Machine Learning Pipelines

  Spaceship Predictive Modeling Pipeline
  - Feature construction
  - Feature Selection
  - Cohort Construction
  - Model Training
  - Evaluation
  - Web Application for Result Visualization

- Storing Sensor Data (H5 files + HIVE)

- NLP / Clinical Notes

256GB memory
64 processing units
Infrastructure Needs

• **Data Storage and Access**
  - GT has invested in a secure, PHI environment to hold several large datasets
  - Current capacity
    • 96TB for *PHI data*
    • 256TB for *Hadoop*
    • 20TB for *Solr Cluster*
  - Expect need for an environment that holds a mixture of PHI and non-PHI
    • **Clinical Data** – Standardized Data Format
    • **Sensor Data** – Patient Generated Data, IoT/SmartCities Data
    • **Unstructured Text** – Clinician Notes, Drug Labels, Publications, etc.
    • **Omics Data**

• **Computational Resources**
  - **GPGPU arrays** – Deep Learning, Large scaled simulation and modeling
  - **Traditional Compute Arrays / VM clusters** – Machine Learning, Simulation and Modeling, Databases, etc.
  - **Hadoop-like architectures** – Machine Learning, Analysis/Storage of Sensor Data
  - **Solr/Lucene architectures** – Text Mining / NLP
GT Hadoop V1 Design Parameters

• Started with 8 nodes to achieve minimum parallelism goals

• Preferred frequency over core count for NameNode and Solr

• Balanced frequency and core count for DataNodes
  - Considered single socket E3 v5 series for price (could have bought a much larger cluster)
  - All public clusters that we found used dual-socket servers
  - There is a widely-held belief that Hadoop makes good use of multiple cores/sockets

• 4TB SATA drives represent "good value" at today's prices

• Solr performs best on SSDs
  - Can query multi-terabyte indexes in 100s of milliseconds
Hardware Specifications

• (1) Login/Management/NameNode
  - Dual Intel Xeon E5-2623 v4 2.6GHz, 10M Cache, 4C/8T
  - 64GB DDR4 2400MHz DRAM
  - 4x 1TB 7200RPM Hot-plug SATA Hard Drives (RAID-5)
  - Intel X550 Dual Port 10GBASE-T

• (8) DataNodes
  - Dual Intel Xeon E5-2650 v4 2.2GHz, 30M Cache, 12C/24T
  - 64GB DDR4 2400MHz DRAM
  - 8x 4TB 7200RPM Hot-plug SATA Hard Drives (JBOD)
  - Intel X550 Dual Port 10GBASE-T (bonded)
  - Dual Hot-plug Redundant Power Supplies (1+1), 750W
Hardware Specifications

- (5) Solr Nodes
  - Intel Xeon E3-1270 v5 3.6GHz, 8M Cache, 4C/8T
  - 64GB DDR4 2400MHz DRAM
  - 4x 1TB Samsung 850 Pro SSD drives (RAID-5)

- Network: Dell Force10 S4820T
  - 48 x 10GBASE-T
  - 4 x 40GbE QSFP+
  - 23 production ports + 14 OOB ports + KVM/PDUs/UPS = 41 ports in use
Networking

• Network is often the bottleneck

• 10GbE over copper saves a little on cabling ($8 Cat6 vs. $70 DAC)

• Copper vs SFP+ doesn't seem to impact switch pricing

• We bond both 10GbE interfaces for more bandwidth

• 48-port Top of Rack switch can accommodate 24 hosts
  - With 2U hosts in a 42/48U rack, unlikely to actually fill this switch

• Upgrading to 40GbE would a) double the NIC cost, b) add $100/cable, c) add 20% network switch
Software Infrastructure

• CentOS 7.2 with Cloudera Manager

• PXE Bare Metal Provisioning with Cobbler + Kickstart

• Puppet for Configuration Management