Modernizing the Data Warehouse

The Marriage of Big Data and Relational Technologies

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World-Wide Technical Sales, Big Data
The Evolution of Analytics

- **1960s: Navigational DBMS**
  - IMS (hierarchical)

- **1970s-1980s: Relational DBMS**
  - SQL
  - System R, System Z, DB2

- **1990s: Data Warehouse**
  - Dimensional model, ETL, MDM

- **Today: Big Data/NoSQL**
Pressures on Traditional Relational Stores

- Budgetary constraints
- Technical change/
  Different forms of data
- Regulatory pressures
  (SLAs, Archive, Governance)
The NoSQL Revolution

- Different requirements require different tools
  - Document stores
  - Key/value stores
  - Google BigTable implementations
  - Graph databases

- Values (there are exceptions)
  - Huge data volumes – easy scale-out
  - Semi-structured data
  - Extreme performance
Database Genres
A High-level View

Data Size

Data Complexity

Key/Value
Columnar
Document
Graph
Relational
Traditional Warehousing vs. NoSQL

ACID vs. BASE

- Atomicity
- Consistency
- Isolation
- Durability

- Basically Available
- Soft state
- Eventually consistent
Hadoop – Architecture

- **Master / Slave architecture**

- **Master: NameNode**
  - Manages the file system namespace and metadata
    - FsImage
    - EditLog
  - Regulates access by files by clients

- **Slave: DataNode**
  - Many DataNodes per cluster
  - Manages storage attached to the nodes
  - Periodically reports status to NameNode
  - Data is stored across multiple nodes
  - Nodes and components will fail, so for reliability data is replicated across multiple nodes
Hadoop Distributed File System

- HDFS is designed to support very large files
- Each file is split into blocks
  - Hadoop default: 64MB
  - BigInsights default: 128MB

- Blocks reside on different physical DataNode
- Behind the scenes, 1 HDFS block is supported by multiple operating system blocks

If a file or a chunk of the file is smaller than the block size, only needed space is used. E.g.: a 210MB file is split as follows:

<table>
<thead>
<tr>
<th>64 MB</th>
<th>64 MB</th>
<th>64 MB</th>
<th>18 MB</th>
</tr>
</thead>
</table>

HDFS blocks

OS blocks
MapReduce Explained

- **Hadoop computation model**
  - Data stored in a distributed file system spanning many inexpensive computers
  - Bring function to the data
  - Distribute application to the compute resources where the data is stored

- **Scalable to thousands of nodes and petabytes of data**

```
public static class TokenizerMapper
    extends Mapper<Object, Text, Text, IntWritable> {
    private final static IntWritable one = new IntWritable(1);
    private Text word = new Text();
    public void map(Object key, Text val, Context context)
    StringTokenizer itr = new StringTokenizer(val.toString());
    while (itr.hasMoreTokens()) {
        word.set(itr.nextToken());
        context.write(word, one);
    }
}
```

```
public static class IntSumReducer
    extends Reducer<Text, IntWritable, Text, IntWritable> {
    private IntWritable result = new IntWritable();
    public void reduce(Text key, Iterable<IntWritable> values, Context context) {
        int sum = 0;
        for (IntWritable v : values) {
            sum += v.get();
        }
        context.write(key, result);
    }
}
```

1. **Map Phase**
   (break job into small parts)
2. **Shuffle**
   (transfer interim output for final processing)
3. **Reduce Phase**
   (boil all output down to a single result set)
Next Generation Hadoop

- Beyond MapReduce
- General purpose storage and processing framework
Complementary Analytics

**Traditional Approach**
Structured, analytical, logical

**New Approach**
Creative, holistic thought, intuition

**Structured Repeatable Linear**
- Data Warehouse
  - Transaction Data
  - Internal App Data
  - Mainframe Data
  - OLTP System Data
  - ERP data

**Unstructured Exploratory Iterative**
- NoSQL Hadoop Streams
  - Web Logs
  - Social Data
  - Text Data: emails
  - Sensor data: images
  - RFID

**Enterprise Integration**

**Traditional Sources**
- Internal App Data
- Mainframe Data
- OLTP System Data
- ERP data

**New Sources**
- NoSQL Hadoop Streams
- Web Logs
- Social Data
- Text Data: emails
- Sensor data: images
- RFID
Traditional Data Mining and Exploratory Analysis
Data Governance Maturity Disciplines

- Organizational awareness
- Stewardship
- Policy
- Value creation
- Data risk management
- Security/Privacy/Compliance

- Data architecture
- Data quality
- Business glossary/metadata
- Information lifecycle management
- Audit and reporting
Data Governance Maturity Disciplines

NoSQL Challenges

- Organizational awareness
- Stewardship
- Policy
- Value creation
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- Data architecture
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Traditional Analytics

Data types
- Transaction and application data

Operational systems

Staging area

Enterprise Warehouse

Data Marts

Information Movement and Transformation

Actionable insight
- Predictive analytics and modeling
- Reporting and analysis

Archive
IBM Big Data Architecture Vision

All Data Sources

- Raw Data
- Structured Data
- Text Analytics
- Data Mining
- Entity Analytics
- Machine Learning

Information Ingestion and Operational Information
- Stream Processing
- Data Integration
- Master Data

Big Data Ecosystem

- Real-time Analytic Zone
  - Video/Audio
  - Network/Sensor
  - Entity Analytics
  - Predictive

- Landing Area, Analytics Zone and Archive
  - Discovery
  - Deep Reflection
  - Operational
  - Predictive

- Exploration, Integrated Warehouse, and Mart Zones

Streams

Analytic Applications

- Intelligence Analysis
- Decision Management
- BI and Predictive Analytics
- Analytic Applications

Information Governance, Security and Business Continuity
Analytics for Data-in-Motion

- Scale-out architecture for massive linear scalability
- Sophisticated analytics with pre-built toolkits & accelerators
- Comprehensive development tools to build applications with minimal learning

Real time delivery

- Powerful Analytics
- Traditional / Non-traditional data sources
- Algorithmic Trading
- Cyber Security
- Government / Law enforcement
- Smart Grid
- Telco Churn Prediction
- ICU Monitoring
- Environment Monitoring

- Microsecond Latency
- Millions of events per second

Video, audio, networks, social media, etc
BigInsights: IBM’s Hadoop Distribution

- **Analysis**
  - Native SQL interface
  - Native R interface
  - Text analysis toolkit
  - Social analysis toolkit
  - Spreadsheet style analysis GUI

- **Development lifecycle**
  - Cluster aware Eclipse plug-ins
  - App Store for Hadoop

- **Data Exploration**
  - Indexing and faceted search
  - Search-based applications

- **Management**
  - Enterprise file system
    - Advanced replication
    - Multi-temp storage
    - POSIX controls
  - Grid management
    - Mature resource manager
    - Multi-tenant workload support

- **Baked-in security**
  - LDAP
  - Role-based authorization
  - Perimeter security with reverse-proxy
**Big SQL**

- **Architecture**
  - IBM Optimizer + IBM Compiler + IBM Runtime => Ported to Hadoop
  - Nodes integrated in Hadoop cluster, direct access to Hadoop data
  - Queries Hadoop data – no proprietary data format
  - MapReduce run-time also available for query execution

- **Benefits**
  - Extensive SQL support (ANSI, IBM, Oracle, Teradata)
  - Performance: Maturity – 30 years of engineering
  - Federated joins between relational systems and Hadoop
  - Security: Row and column access control
Deep Statistical Analysis: Big R

- **Fit-for-purpose architecture for deep statistical analysis**
  - Problems involving small data sets (10GB): R
  - Problems involving partitioned data sets (e.g. 32 x 10GB): BigR
  - Problems involving large data sets: (TB range): BigR using SystemML

- **R integration in BigInsights**
  - R code can be deployed against data stored in BigInsights
  - Big R: partitioning larger data sets and executing R code against them
  - Seamless access to data in BigInsights
  - Enterprise friendly license (no GPL)

- **SystemML**
  - Some data sets cannot be logically partitioned: too big for R
  - Engine designed for massive scale on Hadoop
  - Numerically accurate results
  - Provide an R interface for SystemML
Big Match

Find and Integrate Master Data in Big Data Sources

- **How It Works**
  - Probabilistic matching on big data platform (BigInsights-Hadoop)
  - Matching at a higher volume
  - Matching of a wider variety of data sets

- **Client Value**
  - Find master data within big data sources
  - Get an answer faster – enable real-time matching at big data volumes

- **Building Big Data Confidence**
  - Provides more context by detecting master entities faster
Unique Data Matching Capabilities for Hadoop

Probabilistic matching engine and pre-built algorithms integrated into BigInsights for linking all data related to a customer natively within Hadoop

**Internal / Structured**

- Chris.johnson@cj.net
- C. Johnson
  - 123 Main Street
  - 512-545-1234
- Chris Johnston
  - 123 Main Street
  - 512-554-1234
  - Shipping: 456 Pine Ave
- C. Johnson
  - 125 Main Street
  - 512-554-1234
- C. Johnson
  - Main Street
  - 512-554-1234

**External / Unstructured**

- ChrisJohnson65
  - "Likes" Clothes, Camping Gear
- Christine Johnson
  - Married
  - 1 child
  - 4/15/74
- @ChristyJohnson65
- Christy65
  - Mail Order responder
  - Specialty Apparel Partner Sales data
- Christy65
  - Circle / Network data

**Increased Value of Customer only if...**

Big Match matches all these records

**Predictive analytics and modeling**

VIP: Gold
Customer Sat: 80%
Influence Score: 8/10
**Match and Search Differentiators – Fuzzy Matching**

- Comprehensive library of fuzzy matching techniques
- Scored against probabilistic weights based on value frequencies in your data

<table>
<thead>
<tr>
<th>Phonetics</th>
<th>Synonyms</th>
<th>Abbreviations</th>
<th>Concatenation</th>
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</thead>
<tbody>
<tr>
<td>Mohammed vs. Mahmoud</td>
<td>Andrew = Andy</td>
<td>AIG = American International Group Road = Rd</td>
<td>Van de Velde = Vandevelde</td>
</tr>
<tr>
<td></td>
<td>George = Jorge</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1st = First</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Edit Distance</th>
<th>Transliteration</th>
<th>Date Similarity</th>
<th>Proximity</th>
</tr>
</thead>
<tbody>
<tr>
<td>867-5309 ~ 876-5309</td>
<td>Toyota = トヨダ</td>
<td>01/01/1973 ~ 01/02/1973</td>
<td>Geocodes and great-circle distance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Typographical Errors</th>
<th>Noise Words</th>
<th>Misalignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Smith vs. John Smith</td>
<td>Initiate Inc. = Initiate</td>
<td>Kim Jung-il = Kim il Jung</td>
</tr>
</tbody>
</table>
Logical Data Warehouse – Schema Areas

- **Landing Area**
  - Data Sandbox Areas
  - Self-Provisioning Data (Mixture: Raw & Modeled)

- **Integrating Warehouse & Marts Zone**
  - Data Delta
  - Detailed System of Record Data (Y)
  - Data Delta
  - Detailed System of Record Data (M)

- **Deep Data Zone**
  - Detailed Data Aggregates (Years)
  - Dimensional Data (Years)
  - Subject Data Users
    - User Reports & Dashboards
    - User Guided & Advanced Analytics

- **Exploration Zone**
  - Data Exploration
  - Data Prediction (More Refined Data)
    - Visualization, Data Mining & Exploration
    - Analytical or Predictive Models

- **Data Scientists**
  - Analytical or Predictive Models

- **Subject Data Users**
  - User Reports & Dashboards
  - User Guided & Advanced Analytics

- **Logical Data Warehouse**
  - Summary Data Aggregates (Years)
  - Detailed System of Record Data (Y) (Modeled, Years)
  - Data Delta (ELT)
  - Detailed System of Record Data (M) (Raw, Years) (Modeled, Years)
  - Self-Provisioning Data (Mixture: Raw & Modeled)
THINK BIG
BigInsights Enterprise Edition Components

IBM InfoSphere BigInsights

Visualization & Discovery
- BigSheets
- Governance Catalog
- Data Explorer
- Dashboard / visualization
- Cognos
- Solr/Lucene

Application Support and Development Tooling
- Eclipse
- App infrastructure
- Big SQL
- Jaql
- MapReduce
- Pig
- Hive
- Oozie

Advanced Analytics Engines
- Text Processing Engine and Extractor Library (AQL+HIL)
- Big R / SystemML
- R

Cluster Optimization and Management
- Integrated Installer
- Admin Console
- Enhanced Monitoring
- Splittable Text Compression
- ZooKeeper
- Avro
- Derby

Runtime
- MapReduce
- Adaptive MapReduce
- Platform Symphony

Data Store
- HBase

File System
- HDFS
- GPFS-FPO

Data Ingest Tools
- JDBC
- Teradata
- Netezza
- DB2
- Streams
- Data Click
- Gnip
- BoardReader
- Flume
- Nutch
- Sqoop

Security
- Private firewall
- LDAP or Kerberos
- PAM

IBM InfoSphere BigInsights Components

Open Source

IBM