What Does ‘Big Data’ Mean and Who Will Win?

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The Meaning of Big Data - 3 V’s

• Big Volume
  – With simple (SQL) analytics
  – With complex (non-SQL) analytics

• Big Velocity
  – Drink from the fire hose

• Big Variety
  – Large number of diverse data sources to integrate
Big Volume - Little Analytics

- Well addressed by data warehouse crowd
- Who are pretty good at SQL analytics on
  - Hundreds of nodes
  - Petabytes of data
The Participants

• Row storage and row executor
  – Microsoft Madison, DB2, Netezza, Oracle(!)

• Column store grafted onto a row executor (wannabees)
  – Terradata/Asterdata, EMC/Greenplum

• Column store and column executor
  – HP/Vertica, Sybase/IQ, Paracel

Oracle Exadata is not:
  a column store
  a scalable shared-nothing architecture
Performance

- Row stores -- x1
- Column stores -- x50
- Wannabees -- x5 (???)
Big Data - Big Analytics

• Complex math operations (machine learning, clustering, trend detection, ....)
  – In your market, the world of the “quants”
  – Mostly specified as linear algebra on array data

• A dozen or so common ‘inner loops’
  – Matrix multiply
  – QR decomposition
  – SVD decomposition
  – Linear regression
Big Data - Big Analytics
An Example

- Consider closing price on all trading days for the last 5 years for two stocks A and B

- What is the covariance between the two time-series?

\[
\frac{1}{N} \times \sum (A_j - \text{mean}(A)) \times (B_j - \text{mean}(B))
\]
Now Make It Interesting ...

- Do this for all pairs of 4000 stocks
  - The data is the following 4000 x 1000 matrix

<table>
<thead>
<tr>
<th>Stock</th>
<th>t₁</th>
<th>t₂</th>
<th>t₃</th>
<th>t₄</th>
<th>t₅</th>
<th>t₆</th>
<th>t₇</th>
<th>….</th>
<th>t₁₀₀₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>S₁</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Hourly data?  All securities?
Array Answer

• Ignoring the \((1/N)\) and subtracting off the means ....

\[
\text{Stock} \cdot \text{Stock}^T
\]

• Now try it for companies headquartered in Charlotte!
Goal

- Good data management
- Integrated with complex analytics
  - Specified as arrays, not tables
Solution Options

- SAS et. al
  - Weak or non-existent data management
- SAS plus RDBMS
  - No integration
- RDBMS plus user-defined functions
  - Slowwww (X10 to X100)
- Array DBMS
  - Check out SciDB.org
Hadoop.....

- Simple analytics
  - X100 times a parallel DBMS
- Complex analytics (Mahout or roll-your-own)
  - X100 times Scalapack
- Parallel programming
  - Parallel grep (great)
  - Everything else (awful)
- Hadoop lacks
  - Stateful computations
  - Point-to-point communication
Big Velocity

- Trading volume on Wall Street going through the roof
- Breaking all their infrastructure
- And it will just get worse
Big Velocity

- Sensor tagging everything of value sends velocity through the roof
  - E.g. car insurance

- Smart phones as a mobile platform sends velocity through the roof

- State of multi-player internet games must be recorded - sends velocity through the roof
Two Different Solutions

• Big pattern - little state (electronic trading)
  - Find me a ‘strawberry’ followed within 100 msec by a ‘banana’

• Complex event processing (CEP) is focused on this problem
  - Patterns in a firehose

P.S. I started StreamBase but I have no current relationship with the company
Two Different Solutions

- Big state - little pattern
  - For every security, assemble my real-time global position
  - And alert me if my exposure is greater than X

- Looks like high performance OLTP
  - Want to update a database at very high speed
My Suspicion

- Your have 3-4 Big state - little pattern problems for every one Big pattern - little state problem
New OLTP

• You need to **ingest** a fire hose in real-time

• You need to perform high volume OLTP

• You often need **real-time** analytics
Solution Choices

• Old SQL
  – The elephants
  – Slowwww (X 50)
  – Non-starter

• No SQL
  – 75 or so vendors giving up both SQL and ACID

• New SQL
  – Retain SQL and ACID but go fast with a new architecture
No SQL

• Give up SQL
  - Interesting to note that Cassandra and Mongo are moving to (yup) SQL

• Give up ACID
  - If you need ACID, this is a decision to tear your hair out by doing it in user code
  - Can you guarantee you won’t need ACID tomorrow?
VoltDB: an example of New SQL

- A main memory SQL engine
- Open source
- Shared nothing, Linux, TCP/IP on jelly beans
- Light-weight transactions
  - Run-to-completion with no locking
- Single-threaded
  - Multi-core by splitting main memory
- About 100x RDBMS on TPC-C
Big Variety

- Typical enterprise has 5000 operational systems
  - Only a few get into the data warehouse
  - What about the rest?

- And what about all the rest of your data?
  - Spreadsheets
  - Access data bases
  - Web pages

- And public data from the web?
The World of Data Integration

the rest of your data
enterprise
data warehouse
text
Summary

- The rest of your data (public and private)
  - Is a treasure trove of incredibly valuable information
  - Largely untapped
Data Tamer

• Integrate the rest of your data

• Has to
  – Be scalable to 1000s of sites
  – Deal with incomplete, conflicting, and incorrect data
  – Be incremental

• Task is never done
Data Tamer in a Nutshell

- Apply machine learning and statistics to perform automatic:
  - Discovery of structure
  - Entity resolution
  - Transformation

- With a human assist if necessary
  - WYSIWYG tool (Wrangler)
Data Tamer

- MIT research project

- Looking for more integration problems
  - Wanna partner?
Take away

- One size does not fit all

- Plan on (say) 6 DBMS architectures
  - Use the right tool for the job

- Elephants are not competitive
  - At anything
  - Have a bad ‘innovator’s dilemma’ problem