Common misconceptions

- Database people are SQL freaks!
- Database systems have gone commercial for more than 40 years! What else is there to research?
- Database is a business application. Narrow, Boring.

Rebuttal 1
Misconception: Database people are SQL freaks!
- We are true believers of the importance of abstraction and semantics (which are far more important than syntax)
- Rising human costs and increasing system complexities only make this importance grow over time
- Looking for the "right" high-level abstraction for emerging applications continues to be an active area of research

Rebuttal 2
Misconception: Database systems have gone commercial for more than 40 years! What else is there to research?
- (BTW, Relatively few changes to SQL over the years = we really got the abstraction right!)
- Stuff underneath the hood has been and will be changing a lot => must adapt to new technology trends
- Besides, much of database research has gone beyond relational databases to data management in general...
**Data processing on SSDs**
- **Solid State Drives** promise much faster and "greener" data access than hard disks
  - Random reads are just as fast as sequential reads
  - Overwriting data is much, much slower than reads and writes that do not overwrite
- Many assumptions made in the design of the data structures, algorithms, and software architecture of databases are now invalid!

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**Sensors in Duke Forest**
- Use wireless sensor networks to study how environment affects tree growth in Duke forest
- Model-based data suppression and model-driven data analysis and recovery

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**RIOT**
- **R**: a popular open-source language/environment for statistical computing
  - Seriously challenged by big-data problems
- **RIOT**
  - Attains efficiency without explicit user intervention
  - Smarter I/Os, parallelism
  - Runs legacy code with little or minimal modification
  - Blurs the boundary between host language and backend processing

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**Additional resources**
- **CPS 116**: undergrad-level database course, for acquiring more background
  - Focuses on using data management systems and techniques effectively
  - Relational, XML; fundamentals of database system internals; overview of various topics
- **CPS 216**: grad-level database course, as gateway to research
  - Focuses on building database systems and developing new, scalable data processing techniques
  - Principles and internals of database and massive data-intensive systems; selection of latest research topics
  - You will find it useful/interesting even if you are not a database student

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**Rebuttal 3**
- **Misconception**: Database is a business application. Narrow. Boring.
  - We do anything data-intensive these days—be it commercial, scientific, or societal
    - Web, sensor networks, data-driven system management, data-intensive statistical computing, computational journalism, etc.
  - We collaborate a lot with other computer scientists
    - E.g., Pankaj Agarwal, Jeff Chase, Kamesh Munagala
  - And statisticians, ecologists, immunologists...
  - And researchers from leading industry research labs

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**Additional resources (cont’d)**
- **CPS 296**: topics (vary across offerings)
  - **CPS 296**: this coming Spring (Database and Programming Languages: Crossing the Chasm) will explore new abstractions and techniques for building data-driven and data-intensive applications
    - Handling impedance mismatches between programming paradigms
    - Abstractions and primitives for data parallelism
    - New, data-centric declarative languages for domains such as networking and system management
- Monthly dbgroup meetings to discuss new research developments and trends
  - Watch for my email announcement
Research in My Group

- Experiment-driven system management
- Big-data processing and Cloud computing
- Querying a system (diagnosis, forecasting, ...)

- Graduate students I work with at Duke:
  - Nedyalko Borisov
  - Azbayar Demberel (Jeff Chase’s student)
  - Herodotos Herodotou
  - Harold Lim (Jeff Chase’s student)
  - Risi Thonangi (Jun Yang’s student)
  - Vamsidhar Thummala

Response Surfaces

- TPC-H 4 GB database, 1 GB memory, Query 18

Plan Selected by Query Optimizer

Better Plan

Better Plan

Experiment-driven Management
Where to Run Experiments?

Home/Garage Abstraction

Where to Run Experiments?

Home/Garage Abstraction

Workbench API

Experiment-driven Mgmt: Why Now?

• Trend 1: Increasing use of data management platforms by unsophisticated users
  – Web 2.0, Facebook apps, ...
• Trend 2: Good admins scarce and expensive
• Trend 3: Cheap, pay-as-you-go resources with cloud computing

Back of the Envelope Calculation

Research in My Group

• Experiment-driven system management
• Big-data processing and Cloud computing
• Querying a system (diagnosis, forecasting, ...)

<table>
<thead>
<tr>
<th>Operation in API</th>
<th>Time (seconds)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create Container</td>
<td>610</td>
<td>Create a new garage (one time process)</td>
</tr>
<tr>
<td>Clone Container</td>
<td>17</td>
<td>Clone a garage from already existing one</td>
</tr>
<tr>
<td>Boot Container</td>
<td>19</td>
<td>Boot garage from halt state</td>
</tr>
<tr>
<td>Halt Container</td>
<td>2</td>
<td>Stop garage and release resources</td>
</tr>
<tr>
<td>Reboot Container</td>
<td>2</td>
<td>Reboot the garage</td>
</tr>
<tr>
<td>Snapshot R DB (5GB, 20GB)</td>
<td>7, 11</td>
<td>Create read-only snapshot of the database</td>
</tr>
<tr>
<td>Snapshot-RW DB (5GB, 20GB)</td>
<td>29, 62</td>
<td>Create read-write snapshot of database</td>
</tr>
</tbody>
</table>

Back of the Envelope Calculation

- DBAs cost $300/day; Consultants cost $100/hr
- 1 Day of experiments give a wealth of info.
  - TPC-H, TPC-W, RUBiS workloads; 10-30 conf. params
- Cost of running these experiments for 1 day on Amazon Web Serv.
  - Server: $10/day
  - Storage: $0.4/day
  - I/O: $5/day
- TOTAL: $15/day
Big Data

- Metrics on eBay's main Teradata data warehouse include:
  - >2 petabytes of user data
  - 10s of 1000s of users
  - Millions of queries per day
  - 72 nodes
  - 140 GB/sec of I/O, or 2 GB/node/sec at peak
  - 100s of production databases being fed in

- Metrics on eBay's Greenplum data warehouse/mart:
  - 6.5 petabytes of user data
  - 17 trillion records
  - 150 billion new records/day → 50 terabytes/day
  - 96 nodes
  - 200 MB/node/sec of I/O
  - 4.5 petabytes of storage, 70% compression
  - A small number of concurrent users

Two Schools in Big Data Processing

- The world born from Parallel Databases
  - Teradata, Oracle RAC, HP’s NeoView, ...
  - New kids on the block: AsterData, Greenplum, ...

- The world born from Google’s MapReduce
  - Hadoop (originally from Yahoo!)
  - HDFS (originally from Yahoo!)
  - Hive (Facebook)
  - Pig (Yahoo!)
  - ...

Tons of Interesting Problems

- Efficient query processing over MapReduce
- Query should go on even if nodes fail
- Tuning, problem diagnosis, ...
- Elastic computing
- Data partitioning, placement, and rebalancing
- Adaptive processing
- Scheduling
- ...

Research in My Group

- Experiment-driven system management
- Big-data processing and Cloud computing
- Querying a system (diagnosis, forecasting, ...)

Databases on SANs

Database often run on Storage
Area Networks
Makes problem diagnosis hard