A Few Words About Me

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1996–2001 Diploma in Physics, U Konstanz
2001–2005 Research assistant, DBIS Group, U Konstanz
2005–2007 Research assistant, Database Group, TU München
Oct 2006 PhD in Computer Science (XML query processing)
2007–2008 Postdoc, IBM T. J. Watson Research Center, NY, USA
since 8/2008 Senior Researcher, Systems Group, ETH Zurich

Topic: Database systems on modern computing hardware, mainly using FPGAs and hardware-accelerated networks
A Motivating Example (Memory Access)

Task: sum up all entries in a two-dimensional array.

Alternative 1:

```c
for (r = 0; r < rows; r++)
    for (c = 0; c < cols; c++)
        sum += src[r * cols + c];
```

Alternative 2:

```c
for (c = 0; c < cols; c++)
    for (r = 0; r < rows; r++)
        sum += src[r * cols + c];
```

Both alternatives touch the same data, but in different order.
A Motivating Example (Memory Access)
A Motivating Example (Multi-Core)

Task: run parallel instances of the query

```
SELECT SUM(lo_revenue) 
  FROM part, lineorder 
  WHERE p_partkey = lo_partkey 
  AND p_category <= 5
```

To implement \( \Join \) use either

- a hash join or
- an index nested loops join.

A Motivating Example (Multi-Core)

Co-run independent instances on different CPU cores.

Concurrent queries may seriously affect each other’s performance.
A Motivating Example (Non-Commodity Hardware)

Task: in a long stream of items, find those items that occur most often.

Algorithm *Space-Saving* (Metwally *et al*., TODS, vol. 31(3), 2006):

```
1  foreach stream item \( x \in S \) do
2      find bin \( b_x \) with \( b_x.item = x \);
3      if such a bin was found then
4          \( b_x.count \leftarrow b_x.count + 1 \);
5      else
6          \( b_{\text{min}} \leftarrow \) bin with minimum count value;
7          \( b_{\text{min}}.count \leftarrow b_{\text{min}}.count + 1 \);
8          \( b_{\text{min}}.item \leftarrow x \);
```
A Motivating Example (Non-Commodity Hardware)

Jens Teubner, René Müller, and Gustavo Alonso. FPGA Acceleration for the Frequent Item Problem. *ICDE 2010.*
Course Content

- Cache Awareness
  - How can we place data in memory and access it in a way that makes optimal use of memory caches?

- Query Execution
  - How can we tune our algorithms to fit modern processor architectures?

- Multi-Core Architectures
  - How can we exploit the parallelism provided by multi-core architectures?

- Specialized Hardware
  - How can we (mis-)use specialized hardware for data processing (e.g., GPUs, FPGAs, modern NICs)?
Course Organization

Lecture:

- Thursdays, 13–15h, Room CAB G 59
- Course website:
  
  http://www.systems.ethz.ch/courses/fall2012/DPMH
  
  Please visit this website regularly. We will frequently post new information during the semester.

Exercises:

- Mondays, 15–16h, Room CAB G 59 (right after lecture)
- Held by Cagri Balkesen (cagri.balkesen@inf.ethz.ch)
- First exercise: today
- Exercise material is part of the course content!
There will be a **written exam** in the **exam session**.

- Duration: 90 min
- More details when the semester end approaches.
Course Setup

- I’d like to make this course highly interactive.
  - Please speak up, discuss, ask questions!

- The material we discuss is relevant in practice.
  - We’ll provide practical examples and exercises.
  - You achieve maximum fun factor if you verify techniques on your machine.
This is **not** a standard course (often even “bleeding edge”).

- There is **no real textbook** for this course. Computer architecture basics are covered in “Computer Architecture: A Quantitative Approach” by Hennessy and Patterson, though.

- I’ll make **lecture slides** available on the web.

- Most material is taken out of **research papers**.
  - I’ll give references to those papers.
  - These are all good and easy-to-read papers.

- If you attended “Architecture & Implementation of DBMS,” you’ll recognize some ideas again.
MonetDB implements many of the techniques we’ll talk about.

- MonetDB is open-source: http://monetdb.cwi.nl/
- Support for SQL and XQuery\(^1\), multi-platform
- Numerous tools to look “under the hood” of MonetDB.
- Primary development: CWI Amsterdam
- Try it out yourself!

\(^1\)http://www.pathfinder-xquery.org/
We want You

**Avalanche** is a related research project within the Systems Group.

- The project is highly active and internationally very successful.
- You could help us:
  - Labs, semester projects, Master projects, etc.
- Approach me if you’d like to contribute to a vibrant project at the forefront of research.

More information about Avalanche:

http://www.systems.ethz.ch/research/projects/avalanche/