CS425 – Fall 2017
Boris Glavic
Course Information

Modified from:

Database System Concepts, 6th Ed.

Hi, I am **Boris Glavic, Assistant Professor** in **CS**

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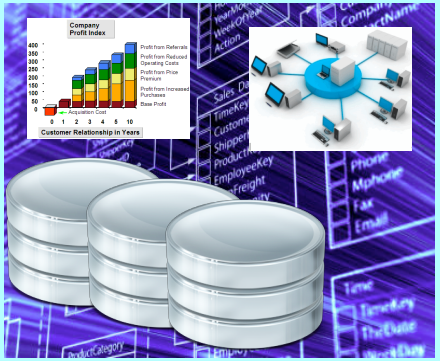
I am a **database** guy!



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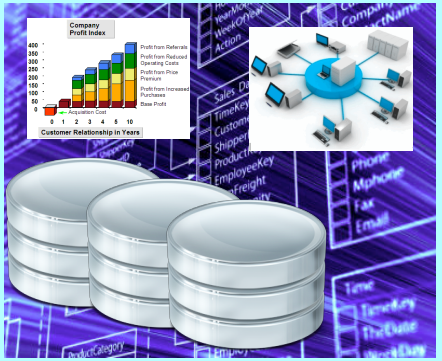

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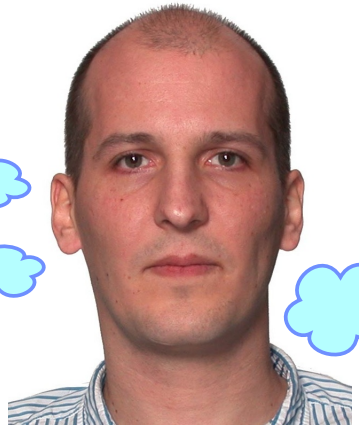


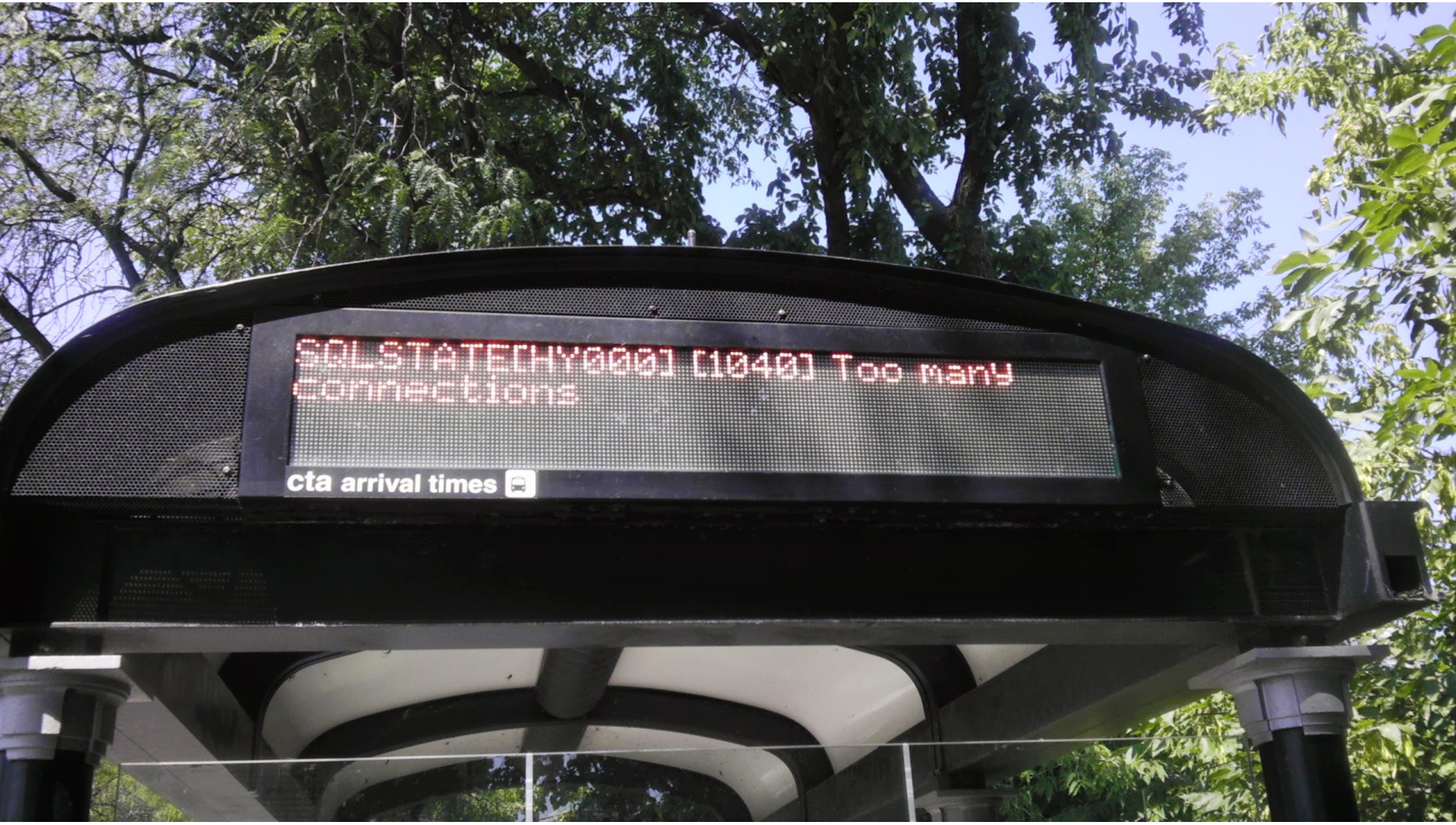
I will teach you:
database stuff

Why are Databases Important?

- **What do Databases do?**

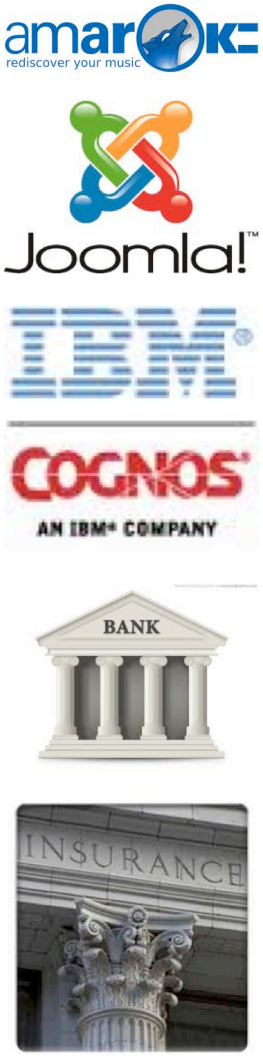
1. Provide persistent storage 提供稳定数据
2. Efficient declarative access to data -> Querying 有效提取 / 质询
3. Protection from hardware/software failures what is hardware software failures
4. Safe concurrent access to data 同时访问多个数据

What happens if you do not pay attention?



Who uses Databases?

- Most big software systems involve DBs!
  - Business Intelligence ⇒ e.g., IBM Cognos
  - Web based systems
  - …
- **You!** (desktop software)
  - Your music player ⇒ e.g., Amarok
  - Your Web Content Management System
  - Your email client
  - Half of the apps on your phone
  - …
- Every big company
  - Banks
  - Insurance
  - Government
  - Google, …



Who Produces Databases?

- **Traditional relational database systems is big business**
  - IBM ⇒ DB2
  - Oracle ⇒ Oracle ☺
  - Microsoft ⇒ SQLServer
  - Open Source ⇒ MySQL, Postgres, SQLite, …
- **Emerging distributed systems with DB characteristics and Big Data**
  - Cloud storage and Key-value stores ⇒Amazon S3, Google Big Table, . . .
  - Big Data Analytics ⇒Hadoop, Google Map & Reduce, . . .
  - SQL on Distributed Platforms ⇒ Hive, Tenzing, …

Why are Database Interesting (for Students)?

- **The pragmatic perspective**
  - Background in databases makes you competitive in the job market ;-)
- **Systems and theoretical research**
  - Database research has a strong systems aspect
    - Hacking complex and large systems
    - Low-level optimization
      - cache-conscious algorithms
      - Exploit modern hardware
  - Databases have a strong theoretical foundation
    - Complexity of query answering
    - Expressiveness of query languages
    - Concurrency theory
    - …

Why are Database Interesting (for Students)?

- Connection to many CS fields
  - Distributed systems
    - Getting more and more important
  - Compilers
  - Modeling
  - AI and machine learning
    - Data mining
  - Operating and file systems
  - Hardware
    - Hardware-software co-design

Webpage and Faculty

- **Course Info**
  - **Course Webpage**: http://cs.iit.edu/~cs425
  - **Google Group**: https://groups.google.com/d/forum/cs425-2017-fall-group
    - Used for announcements
    - Use it to discuss with me, TA, and fellow students
  - **Syllabus:** http://cs.iit.edu/~cs425/files/syllabus.pdf
  - **Git Repos**: https://github.com/IITDBGroup/cs425
- **Faculty**
  - **Boris Glavic** (http://cs.iit.edu/~glavic)
  - **Email:** bglavic@iit.edu
  - **Phone**: 312.567.5205
  - **Office**: Stuart Building, room 226C
  - **Office Hours**: Mondays, 12pm-1pm (and by appointment)

TAs

- TAs
  - TBA

Workload and Grading

- **Exams**
  - Midterm (25%)
  - Final (35%)
- **Homework Assignments** (preparation for exams!) – 20%
  - HW1 (Relational algebra)
  - HW2 (SQL)
  - HW3 (Database modeling)
- **Course Project** (20%)
  - In groups of 3 students
  - Given an example application (e.g., ticketing system)
    - Develop a database model
    - Derive a database schema from the model
    - Implement the application accessing the database

Course Objectives

- Understand the underlying ideas of database systems
- Understand the **relational data model**
- Be able to write and understand **SQL** queries and data definition statements
- Understand **relational algebra** and its connection to SQL
- Understand how to **write programs that access a database server**
- Understand the **ER model** used in database design
- Understand **normalization** of database schemata
- Be able to **create a database design** from a requirement analysis for a specific domain
- Know basic **index structures** and understand their importance
- Have a basic understanding of relational database concepts such as **concurrency control**, **recovery**, **query processing**, and **access control**

PostgreSQL

- In this course we will use PostgreSQL, a powerful open source database management system
  - https://www.postgresql.org/

Course Project

- Forming groups
  - Your responsibility!
  - Inform me + TA
  - Deadline: TBA
- Git repositories
  - Create an account on Bitbucket.org (https://bitbucket.org/) using your IIT email
  - We will create a repository for each student
  - Use it to exchange code with your fellow group members
  - The project has to be submitted via the group repository
- Timeline:
  - Brainstorming on application (by Sep 11th)
  - Design database model (by Nov 12th)
  - Derive relational model (by Nov 25th)
  - Implement application (by end of the semester)

Fraud and Late Assignments

- All work has to be original!
  - Cheating = 0 points for assignment/exam
  - Possibly E in course and further administrative sanctions
  - Every dishonesty will be reported to office of academic honesty
- Late policy:
  - -20% per day
  - No exceptions!
- Course projects:
  - Every student has to contribute in **every** phase of the project!
  - **Don't let others freeload on you hard work!**
    - Inform me or TA immediately

Reading and Prerequisites

- **Textbook:** Silberschatz, Korth and Sudarsham
  - ***Database System Concepts, 6th edition***
  - McGraw Hill
  - publication date:2006,
  - ISBN 0-13-0-13-142938-8.
- Prerequisites:
  - CS 331 or CS401 or CS403

Self-study

- **I expect you to learn by yourself how to effectively use the following technologies**
  - **Git –** a version control system
    - You have to submit your project through git and should also use git to collaborate with your project group members
    - We provide some useful examples/scripts through git
  - **Docker** – a virtualization platform (think VMs, but more lightweight)
    - The easiest way to get postgres running is by using the docker image we provide
  - **PostgreSQL**
    - I expect you to learn how to start/stop/configure a postgres server and how to connect to a running postgres server
- **Help is on the way!**
  - https://github.com/IITDBGroup/cs425

PostgreSQL Overview

- **Client/Server Architecture**
  - Postgres Cluster
    - A directory on the machine running the server that stores data and configuration files
  - Postgres Server
    - A postgres server handles the data of single cluster
    - Clients connect to the server via network (TCP/IP)
      - Send commands and receive results
  - Clients
    - GUI clients: e.g., PGAdmin (https://www.pgadmin.org/)
    - CLI clients: e.g., the built-in **psql** tool
    - Programming Language Libraries
      - Java: JDBC (https://jdbc.postgresql.org/)
      - Python: pyscopg (http://initd.org/psycopg/)
      - …

Get Your Hands Dirty

- **Get a working version of the PostgreSQL server**
  - Your options
    - **Install locally**
      - Installer packages for windows exists
      - Most Linux distributions have a postgres package
      - Installation from source is not that hard
    - **Get our docker image (docker pull iitdbgroup/cs425)**
      - It's an extension of the official postgres image which loads our running example university database
- **Validate your installation**
  - Create a database cluster (the directory PostgreSQL uses to store data)
  - Check that you can start/stop the server
  - Check that you can connect to the running server using **psql** or any other client
- https://github.com/IITDBGroup/cs425

Jupyther notebook

- **Jupyther notebooks**
  - Notebooks mix documentation and code
  - Over the course of the class I will put SQL examples we discuss in class into a notebook that is shared through the class repository:
    - classnotebook-2017-Fall/CS425-2017-Notebook.ipynb
- **Find the classnotebook**
  - https://github.com/IITDBGroup/cs425

Outline

- Introduction
- Relational Data Model
- Formal Relational Languages (relational algebra)
- SQL
- Database Design
- Transaction Processing, Recovery, and Concurrency Control
- Storage and File Structures
- Indexing and Hashing
- Query Processing and Optimization