To Ponder

"We ascribe beauty to that which is simple; which has no superfluous parts; which exactly answers its end; which stands related to all things; which is the mean of many extremes."

Ralph Waldo Emerson (1803-1882)

To Ponder

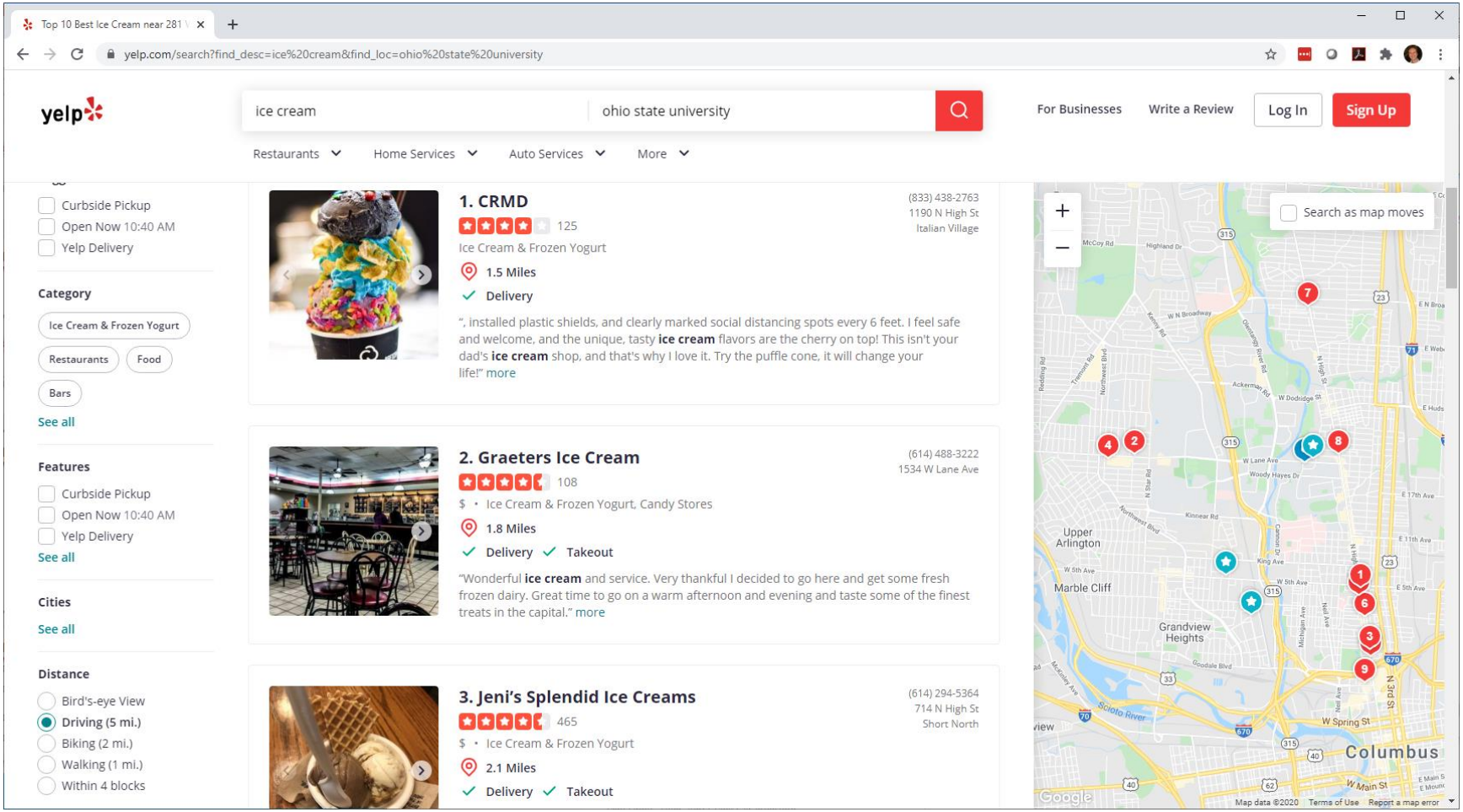
"A distributed system is one in which the failure of a computer you didn't even know existed can render your own computer unusable."

Leslie Lamport

Web Applications: Overview and Architecture

Lecture 1

Road Map in Pictures: Web App

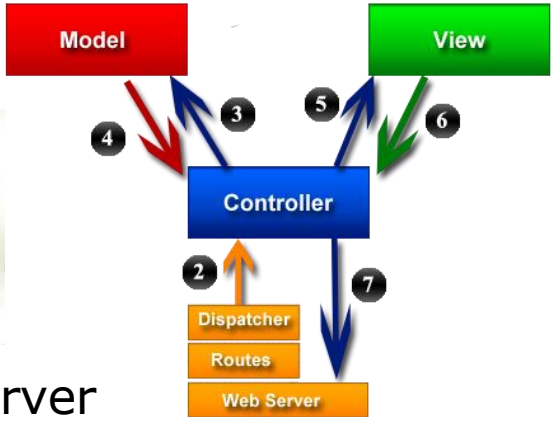


Road Map in Pictures

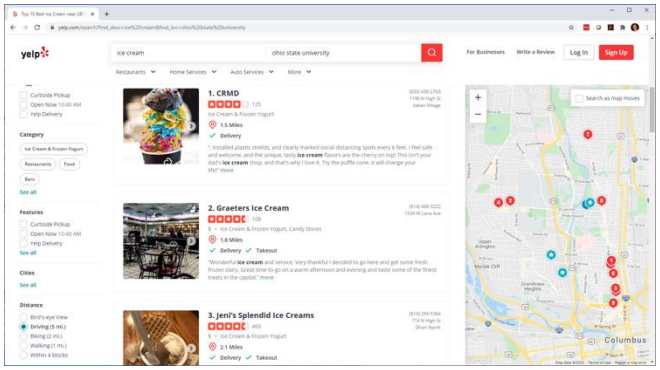
Request

Browser

Web Server



Response



Road Map in Pictures

Request

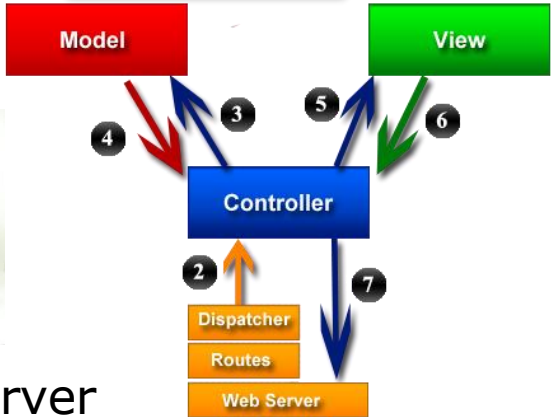
Browser

HTTP

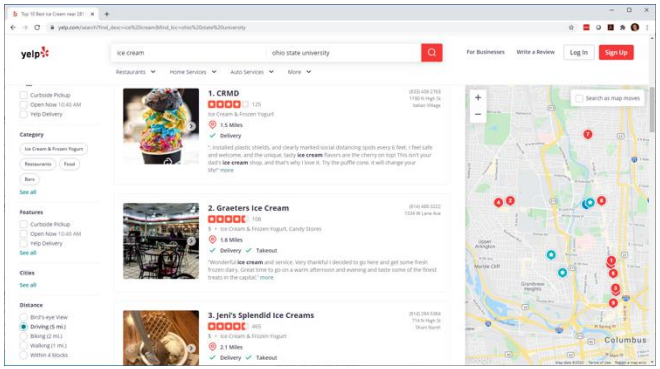
Response

Web Server

Rails



Ruby



HTML

CSS

JavaScript

Road Map: Schedule of Topics

- A Language
  - Ruby
- Foundations
  - Version Control, Networking, Regular Expressions
- Static web pages
  - HTML & CSS
- Dynamic web pages
  - JavaScript
- Framework for web applications
  - Rails
- Applied Topics
  - Security, Encodings

Resources

- Lectures, office hours, meetings
  - Instructor, grader(s)
  - Each other
- Discord Server
  - Q&A and discussion forum
  - News and announcements
- Class website
  - Handouts, lecture notes, lab assignments
  - Syllabus (note exam requirement)
  - Pointers to more resources
- Carmen
  - Grades, deadlines, rubrics

Mens Sana in Corpore Sano

- Running plan for the semester:
  - Run from here to Louisville, KY
  - Equivalently, run 210 miles
  - Equivalently, run 8 marathons

Technical Content

- Languages and Technologies
  - HTTP
  - HTML, CSS, JavaScript, JSON
  - Ruby, Ruby on Rails
- Tools and techniques
  - Design patterns (MVC)
  - git, linux
  - Regular expressions, unicode, system time
- Advanced topics
  - Programming languages, networking, cryptography, databases, operating systems

Stability of Content: Concepts

- Conceptual underpinnings will be relevant forever
- In this course:
  - Single-point of control over change
  - Abstraction (vs realization)
  - Design patterns
  - Regular Expressions (the math part)
  - Cryptography (the math part)
  - Motivation for version control
  - Time-space performance trade-offs

Stability of Content: Technology

- Some technologies have been around a long time, and will likely be relevant for many more years
- Examples in this course:
  - Linux
  - SQL
  - HTTP
  - HTML
  - CSS
  - JavaScript

Stability of Content: Tools

- Some tools come and go
- They are useful for getting things done now, but may not be as relevant or fashionable in 10 years
- Examples in this course
  - VS Code
  - git
  - Ruby
- Aside on generative AI: GitHub Copilot

Stability of Content: Framework

- There are many frameworks and libraries for web development
- They come and go so quickly, there is always something new
- Examples:
  - Web frameworks (Rails, Express.js…)
  - Ruby gems (Middleman, Nokogiri, Cucumber…)
  - JavaScript libraries (Angular, React…)
  - HTML/CSS libraries (Bootstrap, Bulma, Tailwind…

Meta Content: Software Eng.

- Lasting relevance
- Project development in the "real world"
  1. Vague open-ended requirements
  2. Large, complex problems
  3. Teams

Topic 1: Vague Requirements

- Two aspects to engineering:
  - Satisfying the constraints (solving the problem)
  - Optimizing the solution (better, faster, cheaper)
- Must first identify and understand the problem
  - Requirements elicitation
- Recognize tradeoffs
  - Improvement in one aspect at the expense of another

Topic 2: Size and Complexity

- "Programming in the large"
  - Does not all fit in one person's head or schedule
  - Interfaces, modules, components, classes
- Design
  - Measure twice, cut once
- Process
  - Agile, waterfall, TDD,…
- Documentation
- Testing

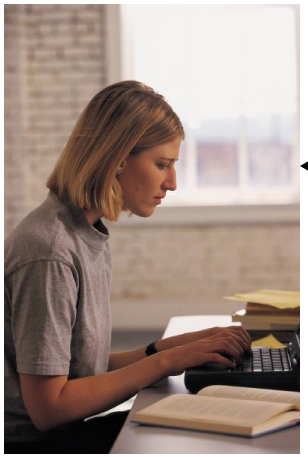
Topic 3: Group Work

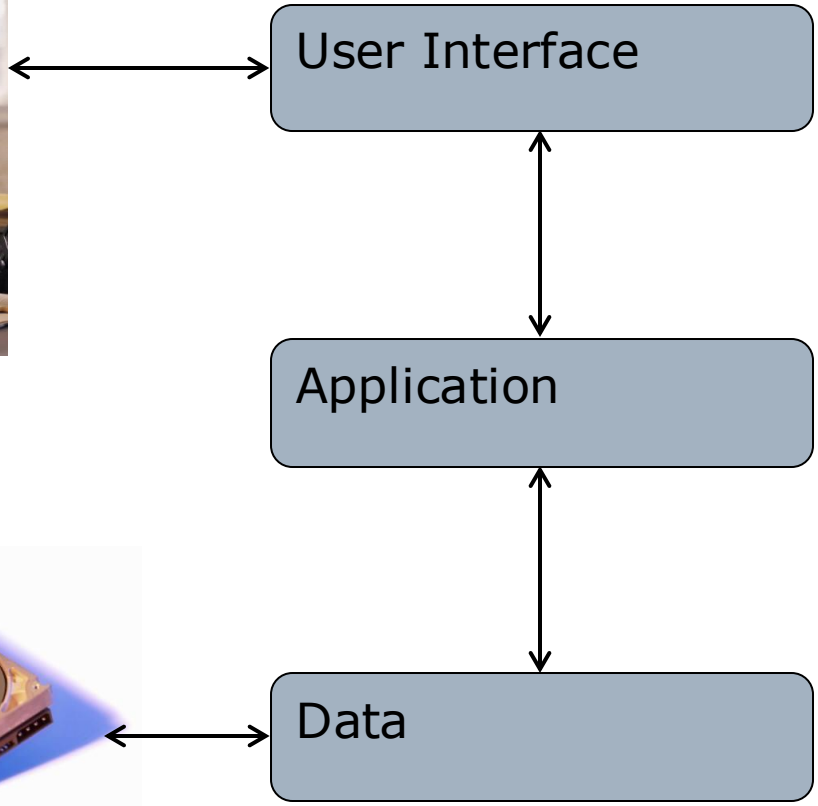
- Naïve view of CS: Lone wolf hacker
- Reality: large multidisciplinary teams
  - Developers, testers, marketing, HR, management, clients
  - Communication skills are critical
- Many challenges
  - Rely on others
  - Compromises become necessary
  - Personalities
- Many rewards
  - Accomplish more
  - Learn more

SE In This Course…

- Group work! You will be in 2 groups:
  - A "home group" for projects
  - A "technology team" for tasks
- Multidisciplinary teams
  - Tech teams cut across project groups
- Open-ended projects
- Communication skills
  - Presentations to class

Architecture: Desktop App





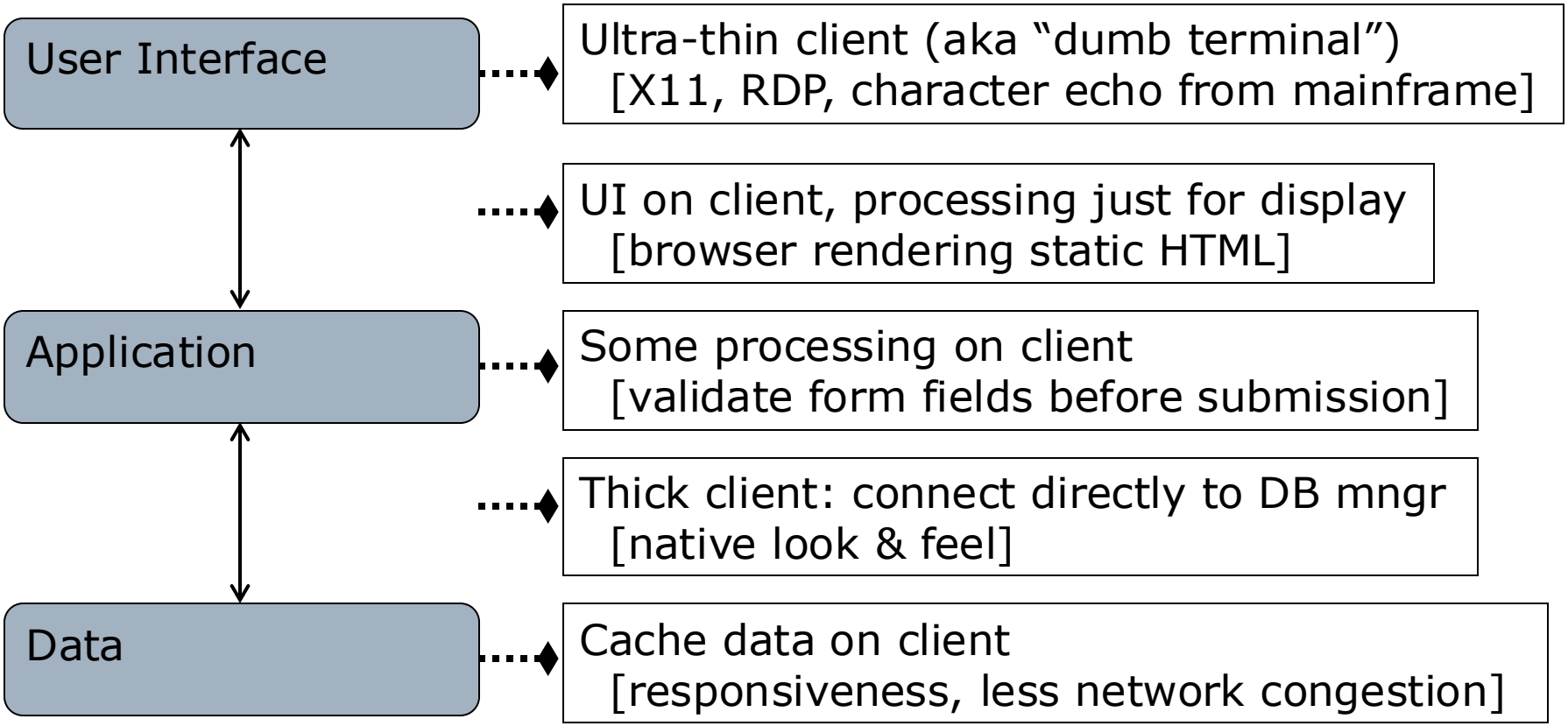
Graphical events (mouse moves, button pushed)

Processing, Calculating

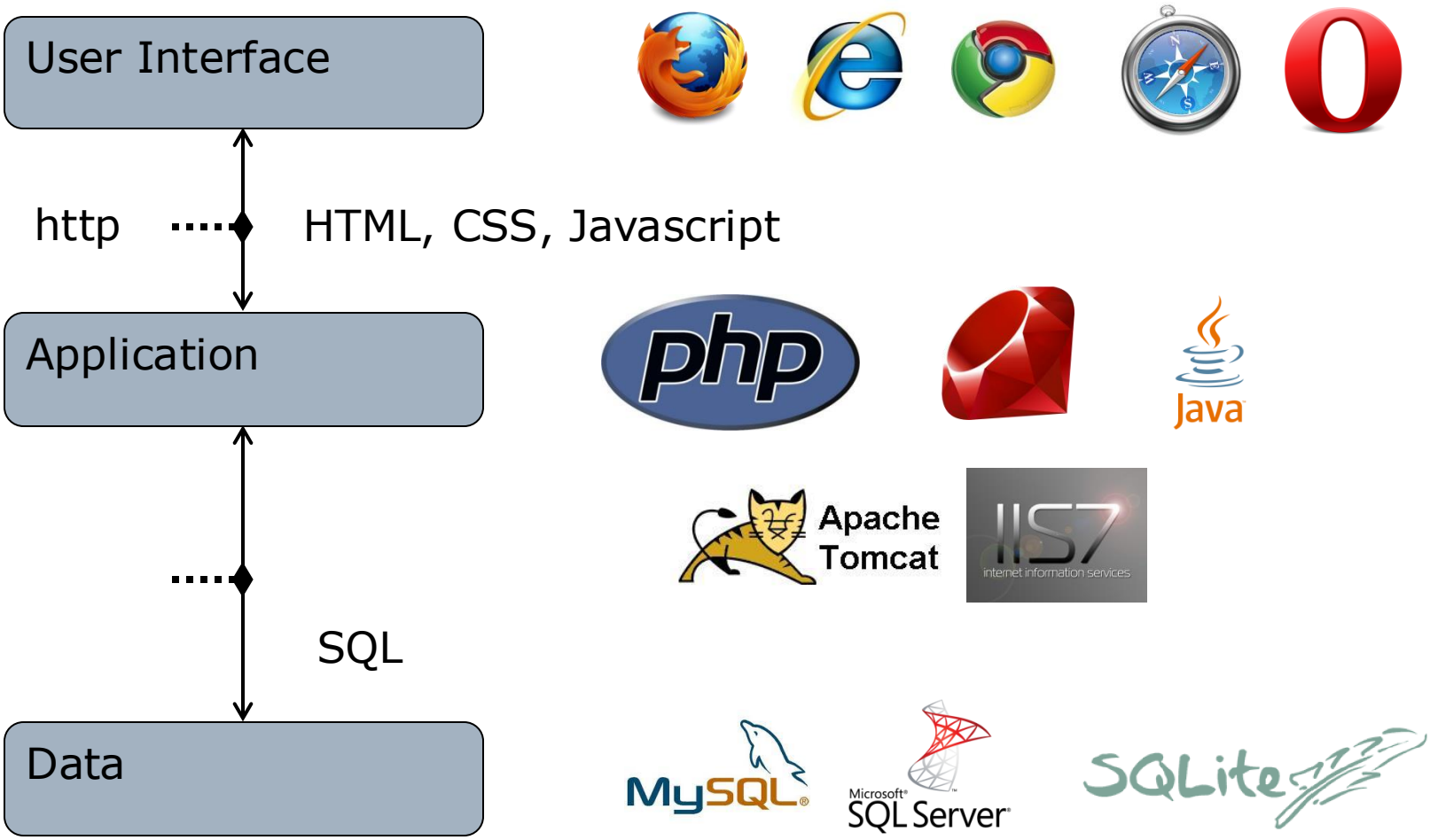
Persistence, Transactions, Triggers

Client-Server App: 2-Tier

Where should we cut?



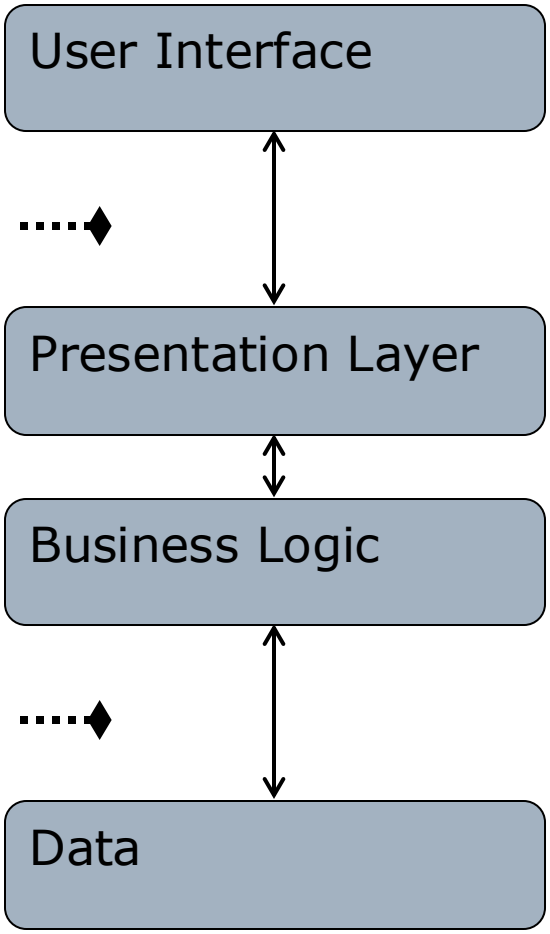
Basic Web App Skeleton: 3-Tier



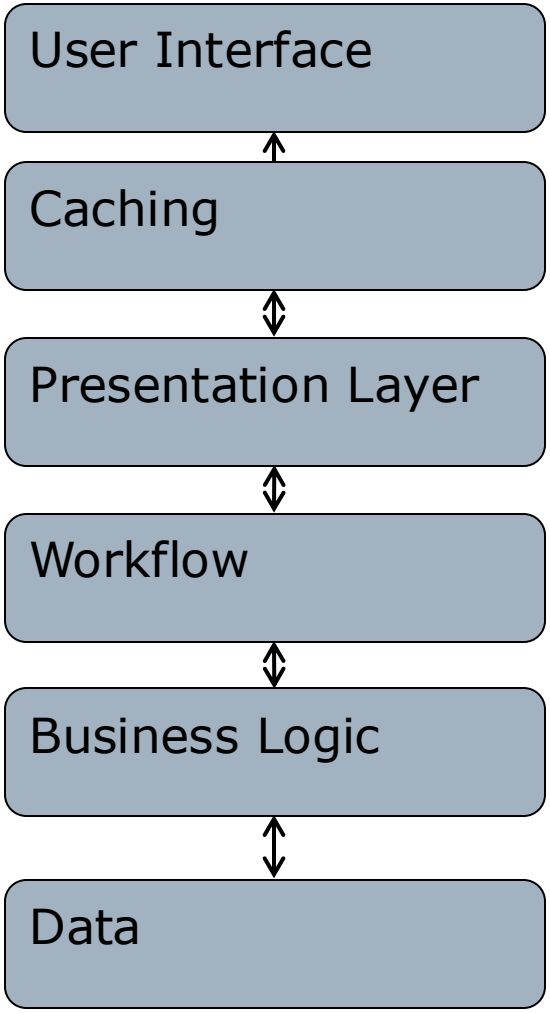
Advantages over Thick Clients

- Performance
  - 1 (expensive) network call to app layer results in many calls to data layer
  - Compute-intensive part on faster machine
- Flexibility
  - Update app logic without changing client
- Robustness
  - Transactions, logging at app level
- Security
  - Login, authentication, encryption all better at app level than data level

Web App Skeleton: 4-Tier



Web App Skeleton: n-Tier…



Summary

- Technical aspects of course content
  - Many different web technologies
  - Rapidly evolving landscape
- Meta content: Software engineering
  - Vague requirements
  - Large systems
  - Teams
- 2-, 3-, 4-, n-Tier Architectures