Can Great Programmers Be Taught?
Experiences with a Software Design Class

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Q: What is the most important idea in Computer Science?

A: Problem decomposition

... no-one teaches it

Elite programmers are >10x more productive

... no-one teaches elite skills

Teaching Great Programmers

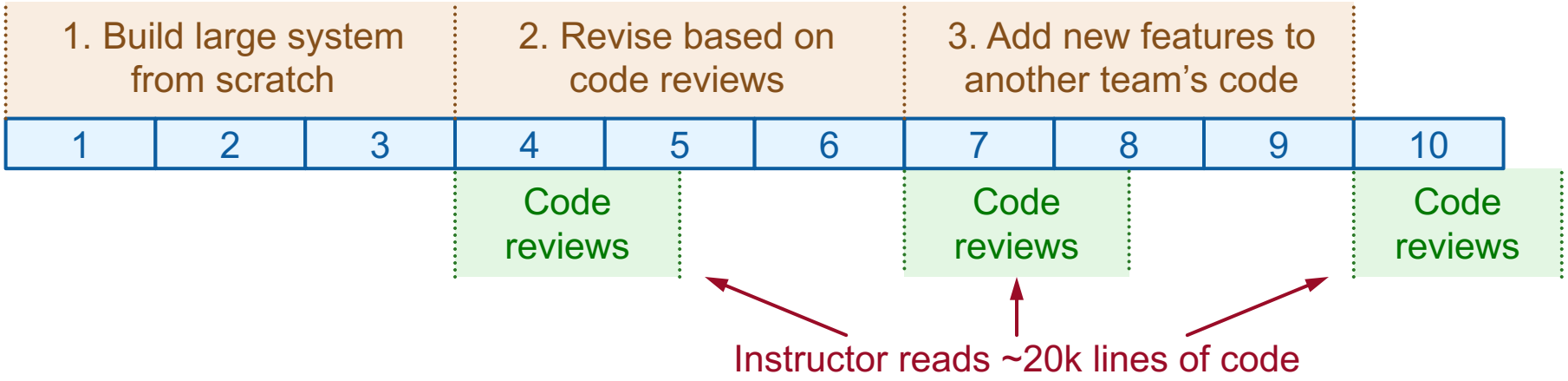
Is it possible?

By whom?

How?

CS 190: Software Design Studio

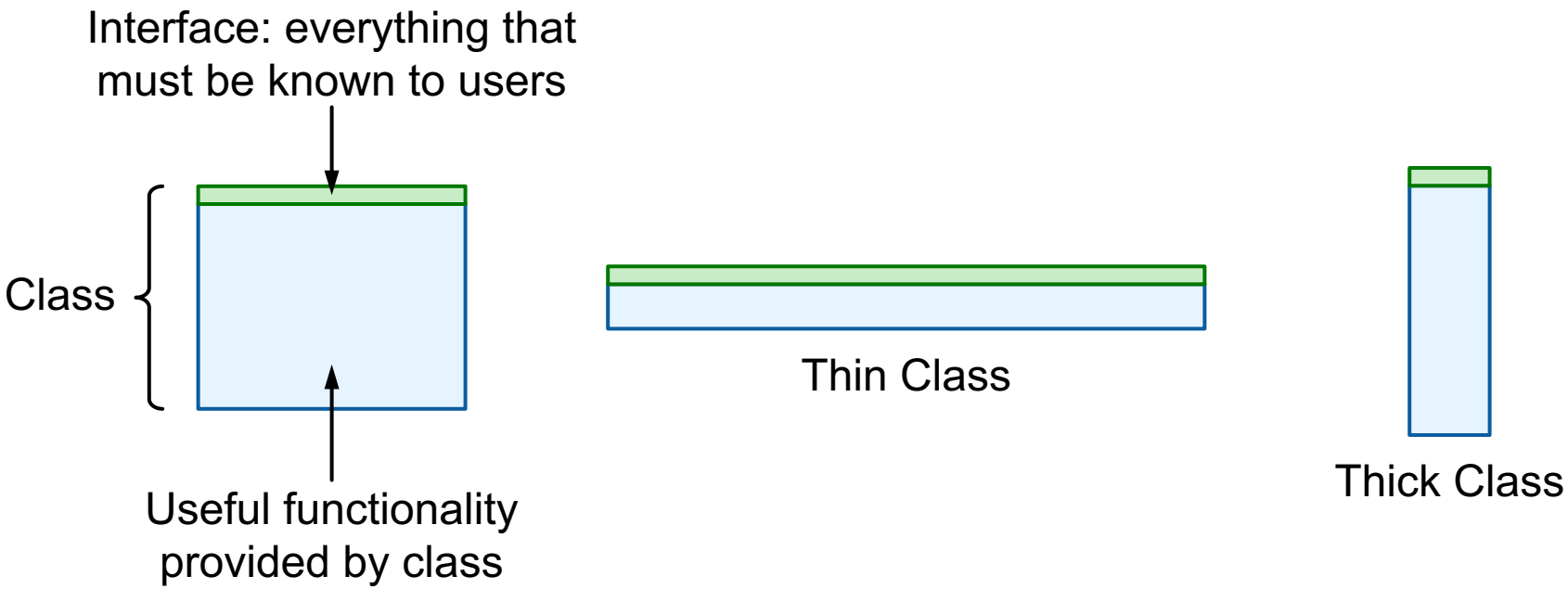
- **Iterative approach: like English writing class:**
  - Write
  - Get feedback
  - Rewrite
- **Small class: ≤ 20 students**



What are the Secrets?

- **A few (somewhat vague) overall concepts**
  - “Working” isn’t good enough: must minimize complexity
  - Complexity comes from dependencies and obscurity
  - Strategic vs. tactical programming
  - Classes should be thick
  - Generic classes are simpler
  - New layer, new abstraction
  - Comments should describe things that are not obvious from the code
  - Define errors out of existence
  - The Martyr Principle
- **Most constructive in the context of code reviews**
- **Course is more about red flags than recipes**

Classes Should be Thick



Reformulation of classic Parnas paper:
"On the Criteria to be Used in Decomposing Systems into Modules"

Typical Thin Method

```
private void addNullValueForAttribute(String attribute) {
    data.put(attribute, null);
}
```

Classes Should be Thick, cont'd

- **Common wisdom: "classes and methods should be short"**
- **Result: classitis**
- **Rampant in Java world:**

```
FileInputStream fileStream =
        new FileInputStream(fileName);
BufferedInputStream bufferedStream =
        new BufferedInputStream(fileStream);
ObjectInputStream objectStream =
        new ObjectInputStream(bufferedStream);
```

- **Length isn't the big issue, it's abstraction**

A Thick Interface

- **Unix file I/O:**

```
int open(const char* path, int flags, mode_t permissions) );
int close(int fd);
ssize_t read(int fd, void* buffer, size_t count);
ssize_t write(int fd, const void* buffer, size_t count);
off_t lseek(int fd, off_t offset, int referencePosition;
```

- **Hidden below the interface:**
  - On-disk representation, disk block allocation
  - Directory management, path lookup
  - Permission management
  - Disk scheduling
  - Block caching
  - Device independence

Define Errors Out of Existence

- **Exceptions: a huge source of complexity**
- **Common wisdom: detect and throw as many errors as possible**
- **Better approach: define semantics to eliminate exceptions**
- **Example mistakes:**
  - Tcl `unset` command
    (throws exception if variable doesn't exist)
  - Windows: can't delete file if open

Overall goal: minimize the number of places where exceptions must be handled

Is the Course Working?

- **Hard to know: ask students in 5-10 years?**
- **Just the first step towards becoming a great programmer**
- **Good energy in class:**
  - Tone of discussions changes halfway through
  - Students are thinking about their code in new ways
- **Interesting challenges for me:**
  - What causes complexity?
  - How to design simple code?
- **Discovering new ideas from reading students' code**
  - Specialized → complicated
  - Generic → simple

Software Design Book

- **My sabbatical project: capture ideas from CS190**
  - Reach more people
  - Start a discussion
  - Define terminology
- **Relatively short (~120 pages)**
- **Status:**
  - First draft complete
  - About to get first round of reviews & comments
  - Self-publish by end of 2017?

Will the design ideas make sense standalone, without code reviews?

Conclusion

- **It is possible to teach software design**
  - But not currently scalable
- **Principles gradually emerging**
- **Need more experience, input**

Questions/Discussion