Software Engineering (Part 1)

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Objectives

- We will cover these software engineering topics:

- Requirements analysis
- Design
- Implementation
- Debugging
- Testing
- Evaluation
- Maintenance
- Process models

Stages of SW dev

How to order the stages

Objectives

Software Engineering lecture slide decks:

Part 1	**Requirements analysis** **Design (general)**
Part 2	Design (object-oriented) Implementation Debugging
Part 3	Testing Evaluation
Part 4	Maintenance Process models

Software Engineering

- Composing code is a part of what a software engineer does
- Let’s consider all of the parts...

You’ve decided to create a software system.
What’s your first step?

Agenda

- **Requirements analysis**
- Design
- Implementation
- Debugging
- Testing
- Evaluation
- Maintenance
- Process models

Requirements Analysis

- ***Requirements analysis***
  - **Who** are the system’s users?
  - **What** should the system do to fulfill the users’ needs?

What kinds of requirements should you gather?

Requirements Analysis: Kinds

- Always:
  - ***Functional*** requirements
- Sometimes:
  - ***Data*** requirements
  - ***Environmental*** requirements
  - ***Usability*** requirements

Yvonne Rogers, Helen Sharp, Jenny Preece. *Interaction Design: Beyond Human-Computer Interaction (3rd Edition)*. Wiley, 2011.

How should you go about gathering those requirements?

Requirements Analysis: Gathering

- Questionnaires
- Interviews
- Focus groups
- Direct observation
- Studying documentation
- Researching similar products

Users visit
the pgmmers

Pgmmers visit
the users

Yvonne Rogers, Helen Sharp, Jenny Preece. *Interaction Design: Beyond Human-Computer Interaction (3rd Edition)*. Wiley, 2011.

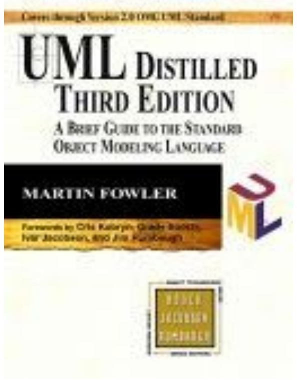
How should you structure the requirements that you’ve gathered?

Requirements Analysis: Structuring

- Create models of the user’s domain
  - A popular set of modeling notations...
  - ***Unified Modeling Language (UML)***

Requirements Analysis: Structuring

- ***Unified Modeling Language (UML)***


Covers through Version 2.0 OMG UML Standard
UML Distilled
Third Edition
A Brief Guide to the Standard
Object Modeling Language
Martin Fowler
Forewords by Cris Kobryn, Grady Booch,
Ivar Jacobson, and Jim Rumbaugh
UML

Grady
Booch

James
Rumbaugh

Ivar
Jacobson

“The three amigos”

Requirements Analysis: Structuring

- Create ***Class Model(s)***
  - A UML notation
  - Describes classes of objects in the user's domain

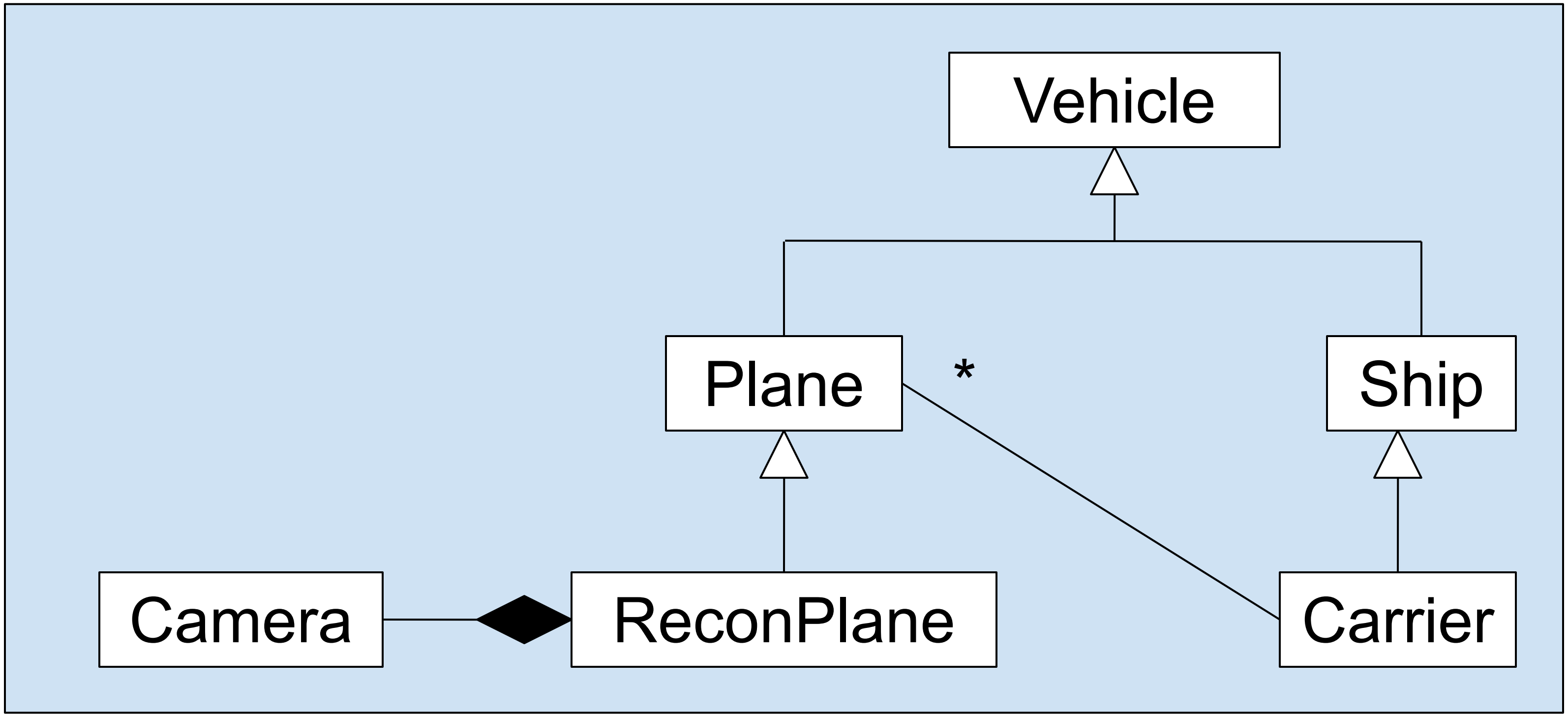
Requirements Analysis: Structuring

Class model example:

△ Inheritance

◆ Composition

— Association



Requirements Analysis: Structuring

- Create ***Scenarios***
  - A story describing a user interaction with the (anticipated) system to achieve some goal

Requirements Analysis: Structuring

- Create ***Wireframes*** and ***Storyboards***
  - Low-tech
  - High-tech

Requirements Analysis: Structuring

- Create (tentative) ***database schema***
  - Tables, fields
  - Relationships among tables
    - Primary and foreign keys

Requirements Analysis: Structuring

- Create ***Prototype(s)***
  - Low-fidelity
  - High-fidelity

You probably can’t fulfill all of the user’s requirements. And you certainly can’t fulfill all of the user’s requirements right away. How should you prioritize the requirements?

Requirements Analysis: Prioritizing

- The ***MoSCoW method***
  - Define each system feature as:
    - **M**: must have
    - **S**: should have
    - **C**: could have
    - **W**: won’t have (this time)

Requirements Analysis: Conclusion

- In the **academic** world:
  - Student programmers often are given requirements
- In the “**real**” world:
  - (Senior) programmers often must know how to **gather**, **structure**, and **prioritize** requirements

You’ve determined the kinds of requirements that are relevant, gathered them, structured them, and prioritized them. What should you do next?

Agenda

- Requirements analysis
- **Design**
- Implementation
- Debugging
- Testing
- Evaluation
- Maintenance
- Process models

Design

- ***Design***
  - **How** should the system work?

How should you specify the system’s design?

Design: Use Cases

- Create ***use cases***
  - A use case is an elaboration of a scenario
  - A use case is *detailed* enough to be testable by QA engineers

Design: Models

- Create ***Specification Class Model(s)***
  - Conceptual class model (deja vu)
    - Models concepts/classes in the user's domain
  - Specification class model
    - Models concepts/classes in the program

What heuristics should you keep in mind when designing the system?

Design: Heuristics

- Use **design heuristics**
  - Some are general
  - Some are specific to OO pgmming

Design: General Heuristic 1

- (Kernighan) **Detect** errors low; **handle** errors high
- (Dondero) **Detect** errors low; **handle** errors as low as you can

Brian W. Kernighan and Rob Pike.
The Practice of Programming.
Addison-Wesley. Reading, MA, 1999.

Design: General Heuristic 1

(A) Asgt 1: database.py

```
def get_overviews(query):
    …
    try:
        Use the database.
    except Exception as ex:
        Write error msg to stderr.
        sys.exit(1)
    …
    Return the class overviews.
```

Design: General Heuristic 1

(B) Asgt 1: database.py

```
def get_overviews(query):
    …
    Use the database.
    …
    Return the class overviews.
```

Design: General Heuristic 2

- Seek ***strong cohesion*** within modules
  - The components (fields, functions/methods) of a module should be related to each other
  - Empirically: not significant

Design: General Heuristic 2

(A) Asgt 1: database.py

```
def get_overviews(query):
    …
    Use the database.
    …
    Return the class overviews.

def write_overviews(classes):
    …
    Write the class overviews to stdout.
```

Design: General Heuristic 2

(B) Asgt 1: database.py

```
def get_overviews(query):
    …
    Use the database.
    …
    Return the class overviews

def get_details(classid):
    …
    Use the database.
    …
    Return the class details.
```

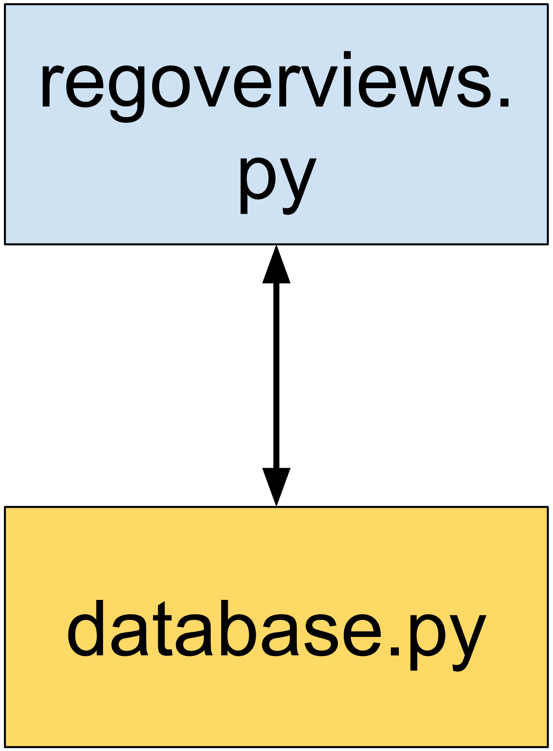
Design: General Heuristic 3

- Seek ***weak coupling*** among modules
  - Minimize interfaces
  - Encapsulate data
  - Hide design decisions

  - Empirically: **significant**

Design: General Heuristic 3

Asgt 1:



regoverviews.py

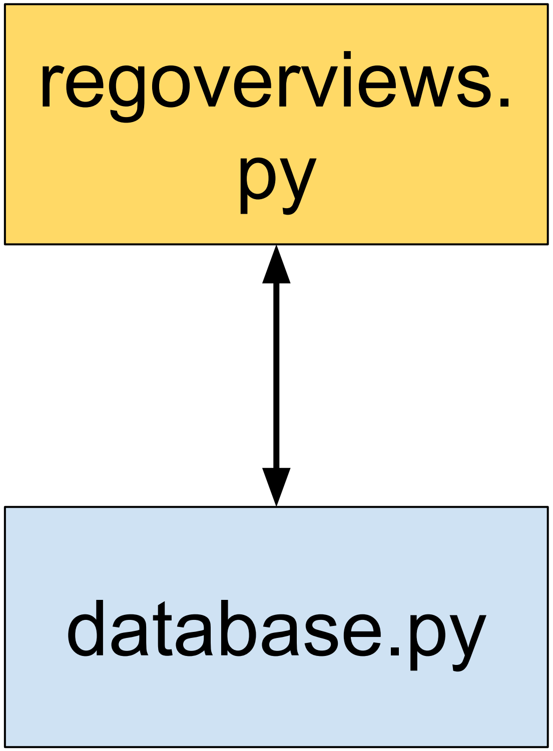
database.py

Hides design decisions

- Which DBMS?
- What table schema?
- …

Design: General Heuristic 3

Asgt 1:



Hides design decisions

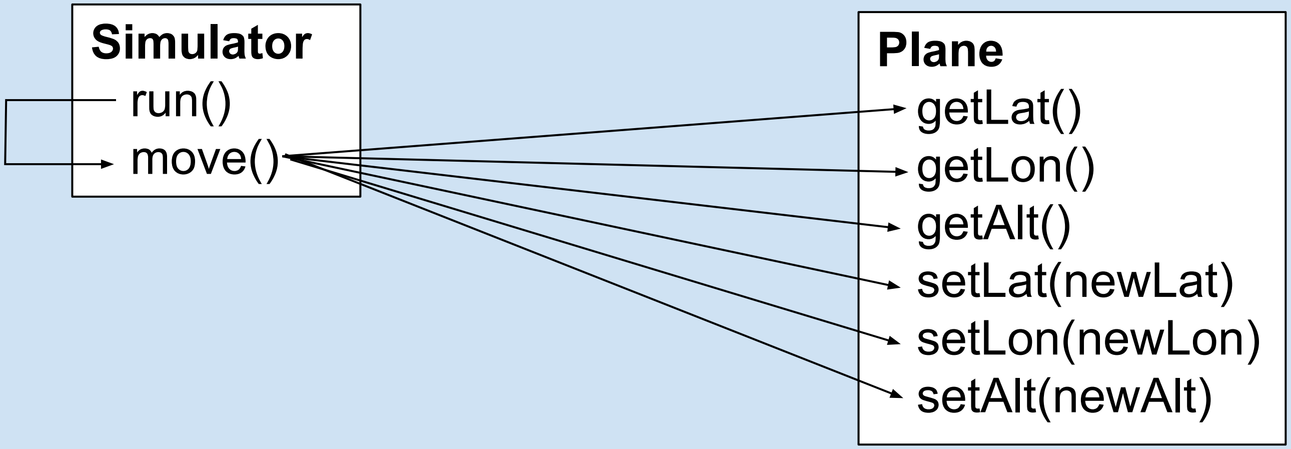
- Command-line UI?
- Web app UI?
- Desktop/laptop UI?
- …

Design: General Heuristic 3.1

- Seek weak ***design-time coupling***

Design: General Heuristic 3.1

Strong design-time coupling



Simulator
run()
move()

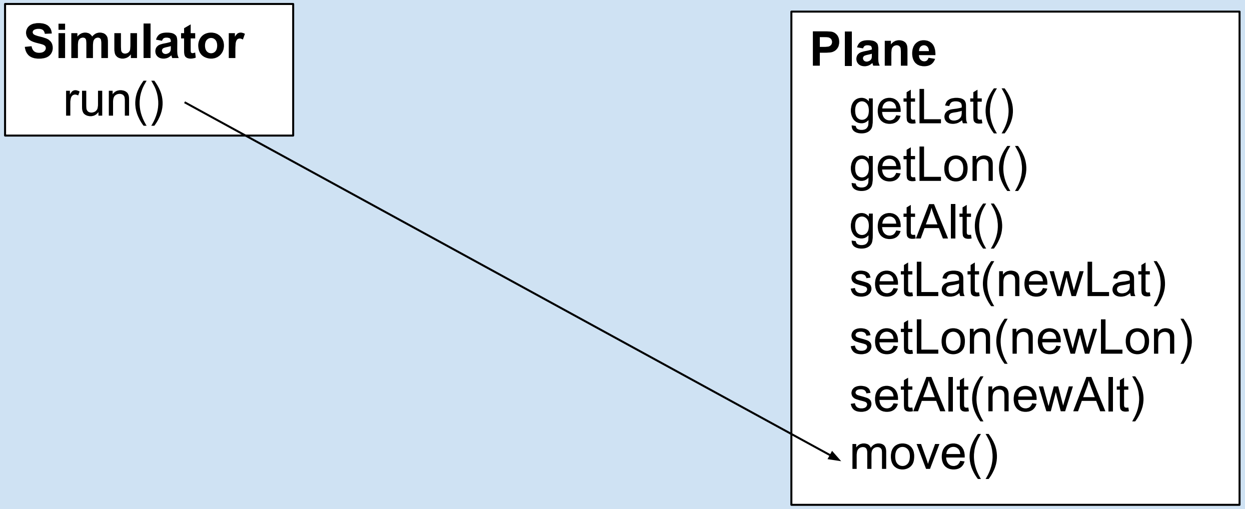
Plane
getLat()
getLon()
getAlt()
setLat(newLat)
setLon(newLon)
setAlt(newAlt)

Simulator calls **many** methods in Plane

No!

Design: General Heuristic 3.1

Weak design-time coupling



Simulator
run()

Plane
getLat()
getLon()
getAlt()
setLat(newLat)
setLon(newLon)
setAlt(newAlt)
move()

Yes!

Simulator calls **few** methods in Plane

Design: General Heuristic 3.1

(A) Asgt1: database.py

```
class Database:
    …
    def connect():
        …
    def get_overviews(query):
        …
    def get_details(classid):
        …
    def disconnect():
        …
```

Design: General Heuristic 3.1

(B) Asgt1: database.py

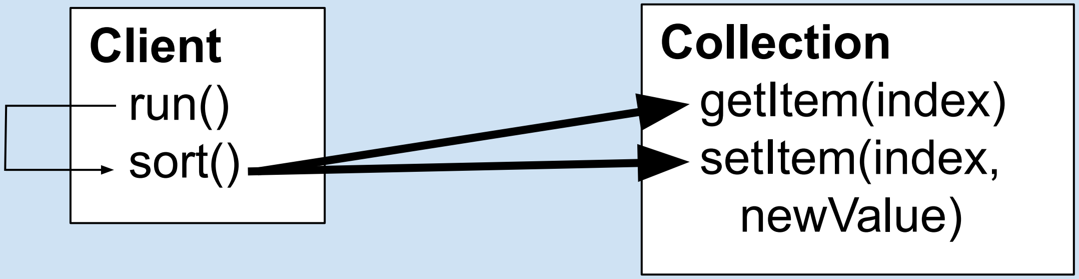
```
def get_overviews(query):
    Connect to the database.
    Perform the query.
    Disconnect from the database.
    Return the class overviews.

def get_cetails(classid):
    Connect to the database.
    Perform the query.
    Disconnect from the database.
    Return the class details.
```

Design: General Heuristic 3.2

- Seek weak ***run-time coupling***

Design: General Heuristic 3.2

Strong run-time coupling



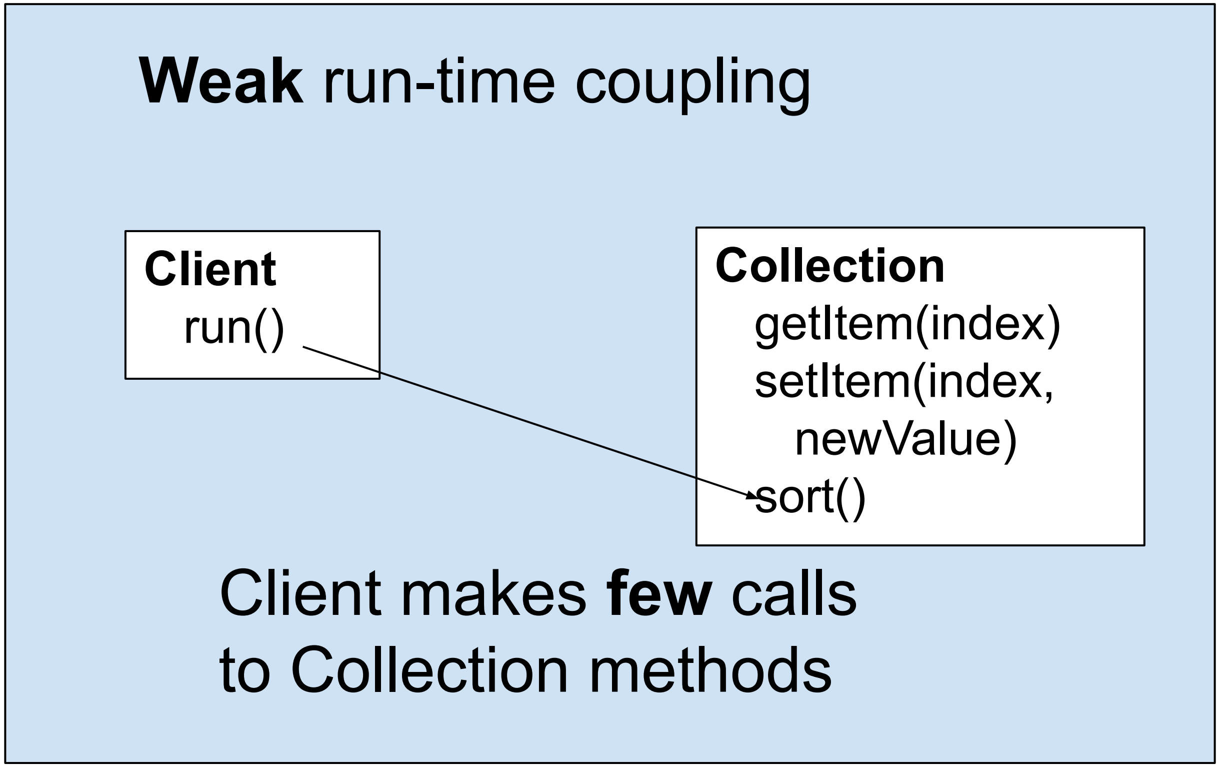
Client
run()
sort()

Collection
getItem(index)
setItem(index, newValue)

No!

Client makes **many** calls
to Collection methods

Design: General Heuristic 3.2



Weak run-time coupling

Client
run()

Collection
getItem(index)
setItem(index, newValue)
sort()

Client makes **few** calls to Collection methods

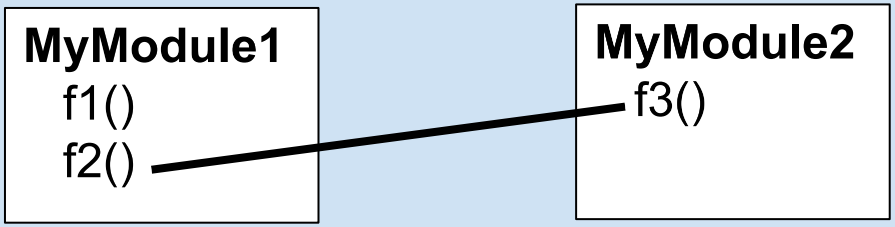
Yes!

Design: General Heuristic 3.3

- Seek weak ***maintenance-time coupling***

Design: General Heuristic 3.3

Strong maintenance-time coupling



Maintenance programmer changes MyModule1 and MyModule2 together frequently

No!

Design: General Heuristic 3.3

Weak maintenance-time coupling

MyModule1
f1()

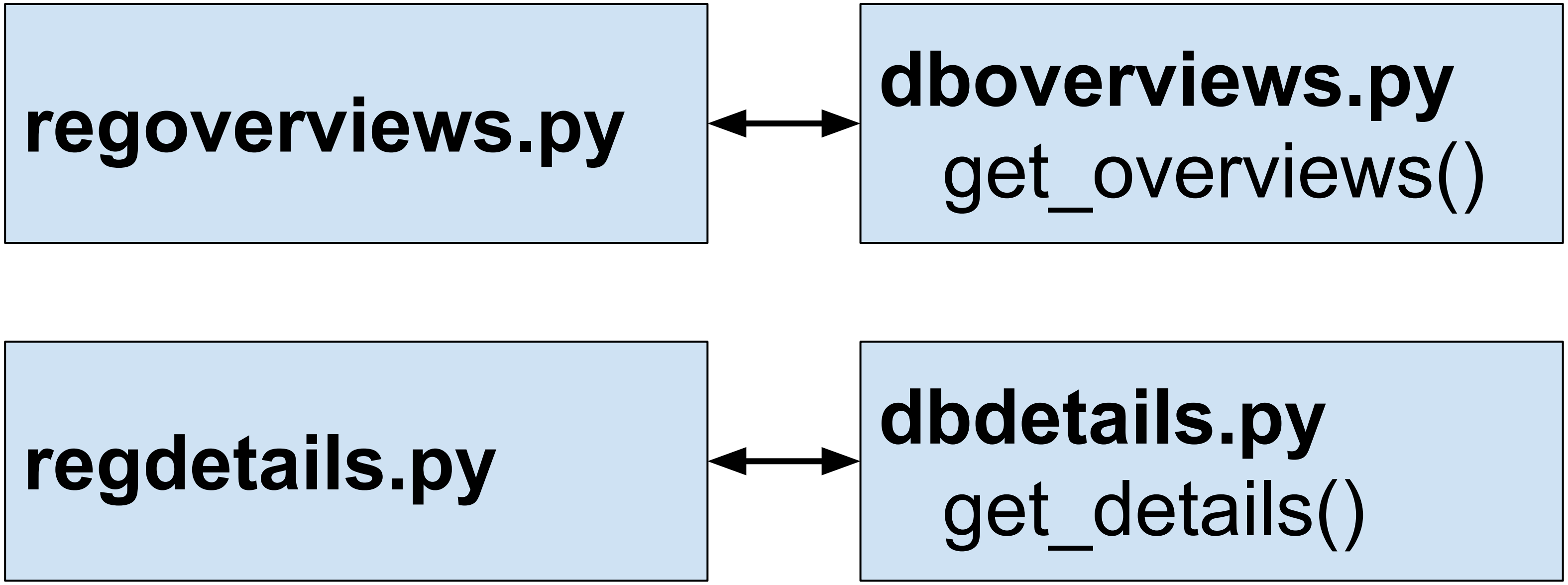
MyModule2
f2()
f3()

Maintenance programmer changes MyModule1 and MyModule2 together **infrequently**

Yes!

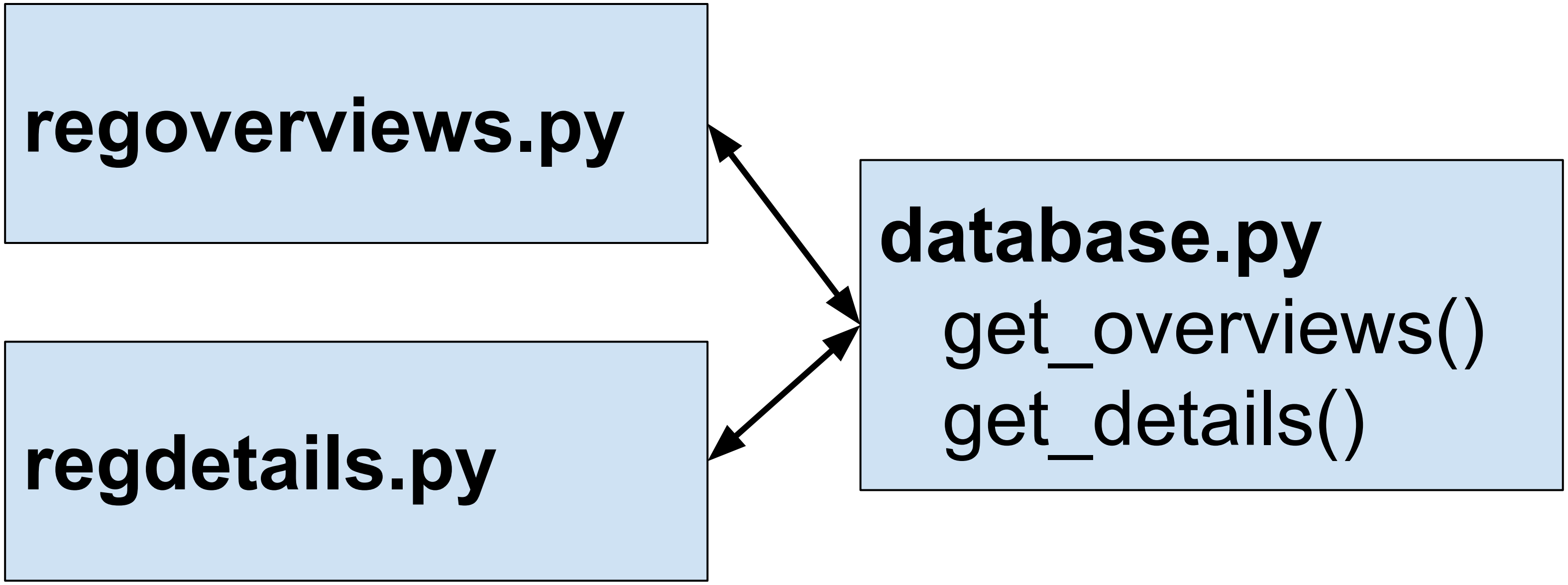
Design: General Heuristic 3.3

(A) Asgt 1:



Design: General Heuristic 3.3

(B) Asgt 1:



regoverviews.py

regdetails.py

database.py
get_overviews()
get_details()

Continued in
Software Engineering (Part 2)…