Iterating And Testing

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Lecture Goals

- Review material from Chapter 9 of the OO A&D textbook
  - Iteration is fundamental
    - Feature driven development
    - Use case driven development
  - Testing is fundamental
    - Test driven development
    - Proving yourself to the customer
  - Programming by Contract
  - Defensive Programming
- Discuss the examples in Chapter 9
- Emphasize the OO concepts and techniques encountered in Chapter 9

Software Life Cycles (aka Design Methods)

- Software life cycles break up the development process into stages
  - Each stage has a goal and an associated set of tasks and documents
- Traditional stages:
  - analysis, design, imp, test, deploy, maintenance, retirement
- To move forward in a life cycle, two things are fundamental
  - Iteration
    - You won’t get it right the first time; Enables Divide and Conquer
  - Testing
    - How do you show your customer that progress is being achieved?

Goal: Make Customer Happy

- We've given you lots of "tools" over the last nine lectures
  - OO Principles
  - Requirements, Analysis, and Design Techniques
  - Simple Software Life Cycle
    - aka "the three steps to writing great software"
  - Software Architecture Techniques
    - feature lists, use case diagrams, decomposing problem space
- **None of them matter, if you can't keep your customer happy**
  - Iteration and testing provide the means for externalizing results to the customer, demonstrating concrete progress
    - The book equates progress with "test cases applied to working code"

Iteration (I)

- The key question is how do you “organize” your iterations
- Two Approaches
  - Feature Driven Development
    - Pick a specific feature in your app; then plan, analyze, and develop that feature **to completion** in **one** iteration
  - Use Case Driven Development
    - Pick a scenario in a use case (one path) and write code to support that **complete scenario** through the use case in **one** iteration
      - If it makes sense to tackle the entire use case, then do so
- The former focuses on functionality; the latter focuses on tasks
  - The former will often be limited to a single class or a small set of classes
  - The latter may touch a lot of classes on multiple layers of your architecture

Iteration (II)

- Both feature driven development and use case driven development
  - depend on good requirements (which come from the customer)
  - deliver what the customer wants
- In feature driven development, you start with your feature list then
  - pick a feature
  - implement it
  - repeat (until done)
- In use case driven development, you start with your use case diagram
  - pick a use case and write it
  - implement it
  - repeat (until done)

Iteration (III)

- Feature driven development is more granular
  - Works well when you have a lot of different features with minimal overlap
  - Allows you to show working code faster (smaller chunks)
- Use case driven development is more “big picture”
  - Works well when your app has lots of tasks and actors it must support
  - Allows you to show the customer bigger pieces of functionality (i.e. tasks) after each iteration
  - Is user centric; focus is on a single task for a single user on each iteration
- Iterations will likely be shorter for feature driven development (days; weeks) than use case driven development (weeks; months)
  - Consider that in use case driven development, during your FIRST iteration, you may have to develop a user interface, controller classes, model classes, and handle persistence!

Example: Feature Driven Development

Features for Gary's Game System

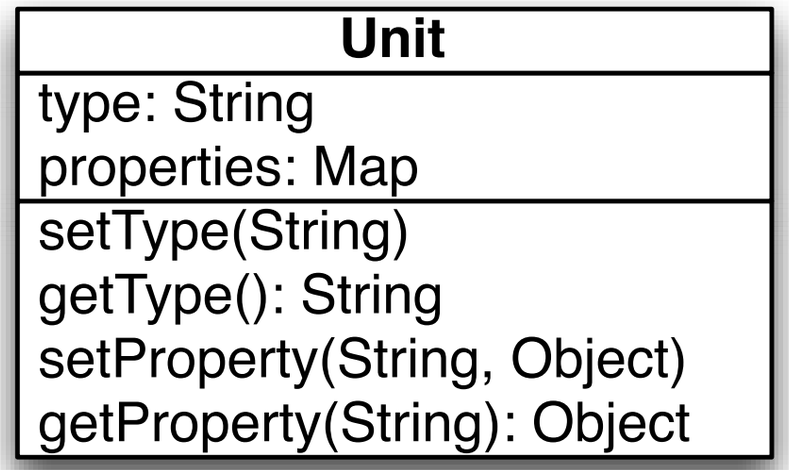
1. Supports different time periods, including fictional periods like sci-fi and fantasy
2. Supports add-on modules for additional campaigns or battle scenarios
3. Supports different types of terrain
4. Supports multiple types of troops or units that are game-specific
5. Each game has a board, made up of square tiles, each with a terrian type.
6. The framework keeps up with whose turn it is an coordinates basic movement

Lets try feature driven development, starting with **feature four** of the Game System Framework

Here's our Unit class from Lec. 11

Unit
type: String properties: Map
setType(String) getType(): String setProperty(String, Object) getProperty(String): Object

Is it complete?



The book returns to Gary's vision statement and discovers that our initial design work missed some requirements!

1. Each unit has game-specific properties (**done, well maybe**)
2. Each unit can move from one tile to another on the board (**punt**)
3. Units can be grouped together into armies (**whoops!**)

Skipping A Section

Unit
type: String properties: Map
setType(String) getType(): String setProperty(String, Object) getProperty(String): Object

vs.

Unit
type: String id: int name: String weapons: Weapon [*] properties: Map
setType(String) getType(): String geId(): int setName(String) getName(): String addWeapon(Weapon) getWeapons(): Weapon [*] setProperty(String, Object) getProperty(String): Object

The book has a section on whether Unit needs to be redesigned, pulling properties common to all Units out of the properties Map.

The point is to examine the trade-offs with each of these design choices and to emphasize the need to always evaluate your past design decisions. Questions?

How to Show Progress?

- Tests!
  - As we iterate on our design/code, we can demonstrate progress to our customer with test cases applied to working code
- Different types of tests
  - **Unit tests**: applied to individual classes
  - **Integration tests**: applied to groups of classes that interact to implement a particular scenario or task
  - **System tests**: applied to the entire system to determine if it meets its requirements
- Test driven development
  - All production code is written to make failing test cases pass
  - Means: write test case first, have it fail, then write code that makes it pass

Tests for Unit

- Test that you can set a property to a particular value and then retrieve that specific value for that property at a later time
- Test that a property value can be changed
- Test retrieving a value for an undefined property
  - Need to define what happens in this instance
- You should test your software for every possible usage (that you can identify)
- Be sure to test incorrect usage; it will help you **design your approach to error handling** and it will help you catch bugs early

Anatomy of a Test Case/Test Run

- The parts of a test care are
  - A name
  - A description
  - A specified input
  - An expected output
- The parts of a test run are
  - Code to execute test cases
  - A pass/fail value for each test
- Test process
  - Run test cases, fix problems, repeat until all tests pass

Demonstration

- Source for Unit
- Source code for each test
- Source code for testing framework

- Note: book has an excellent method for developing your test suite
  - Table based approach that uses the columns
    - id, description, input, expected output, and starting state
    - With respect to latter, test cases typically require initialization
      - e.g. to test client-server interaction, a server must be initialized

How do we predict expected output?

- Most of the time it falls out from the functionality
- But, sometimes, it depends on the **contract** of the class
  - especially with respect to error handling
- Programming by Contract (aka Design by Contract)
  - When you program by contract, you and your software's users are agreeing that your software will behave in a certain way
    - Such as returning "null" for non-existent properties
    - We could throw an exception instead
  - Programming by Contract is about trusting programmers to use your API correctly
- Unit's Contract
  - Hey, you look pretty smart. I'm going to return null values for non-existent properties. You can handle the null values, OK?

The alternative? Don't Trust Your Users

- Defensive programming
  - If you don't trust your software's users, you must adopt a coding style called defensive programming
    - in which all input is suspect and errors are handled via exceptions
  - Defensive programming assumes the worst and tries to protect itself against misuse and/or bad data
    - Sometimes this is appropriate, for instance, when your software is available to the general public via a Web browser
- Defensive version of getProperty()

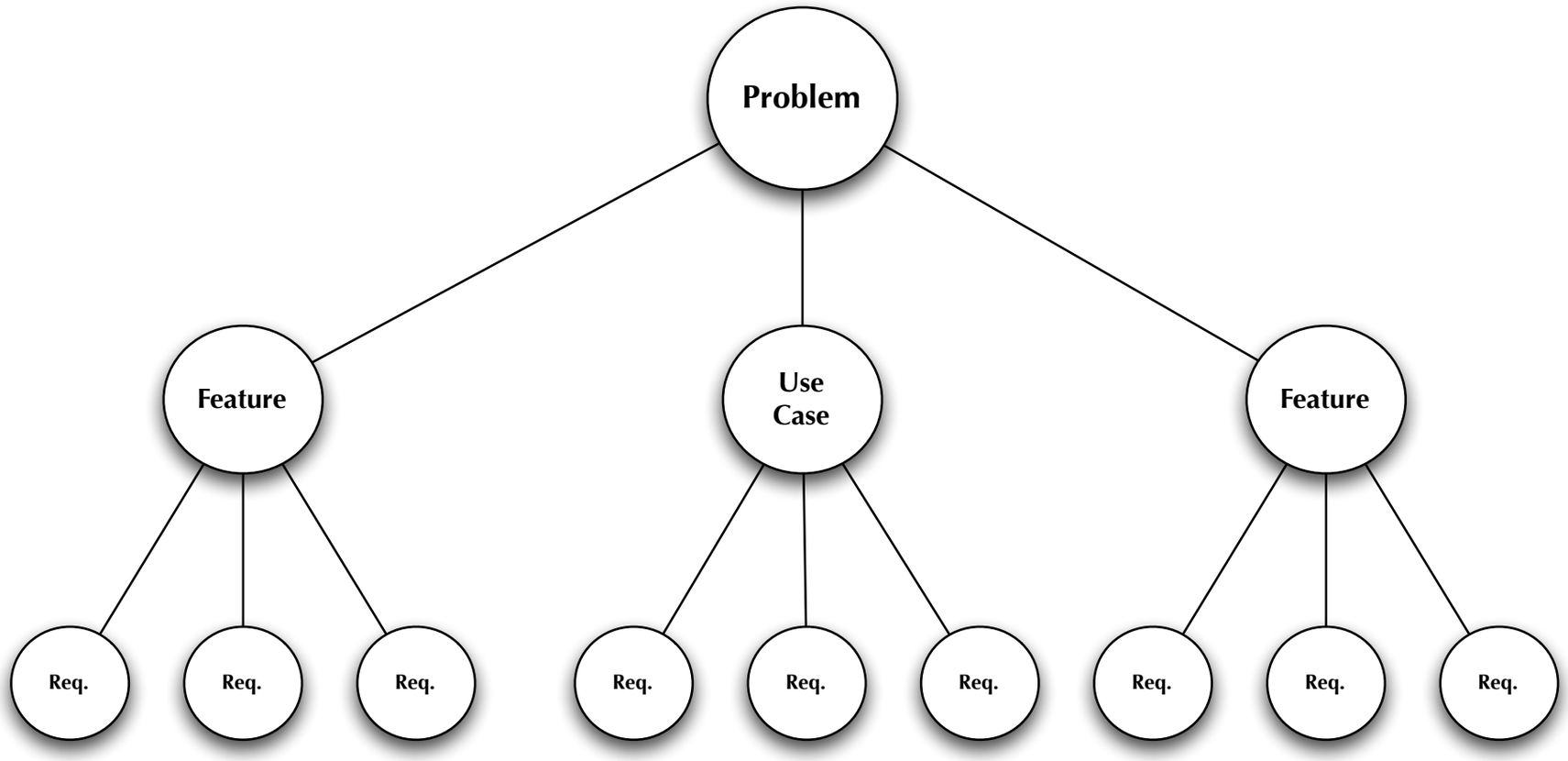
```
 1 public Object getProperty(String property) throws IllegalAccessException {
 2     if (properties == null) {
 3         throw new IllegalAccessException("Unit properties not initialized.");
 4     }
 5     Object value = properties.get(property);
 6     if (value == null) {
 7         throw new IllegalAccessException("Non-Existent Property.");
 8     }
 9     return value;
10 }
```

The Trade-Offs

- When you are programming by contract, you're working with client code to **agree** on how you'll handle problem situations
  - Pick a style and stick with it
- When you're programming defensively, you're making sure the client gets a "**safe**" response, **no matter what the client wants** to have happen
  - This style results in more work for the client programmer
    - API code contains checked exceptions that require explicit exception handlers
    - API results are carefully examined and validated before used

Feature 2: Unit Movement

- We already decided to punt on unit movement back in lecture 11
  - Since we made that decision at the architecture level, the same decision applies at the feature level
  - This is typical in problem decomposition, decisions made at higher levels can influence the work and decisions made at lower levels



Feature 3: Supporting Unit Groups

- Create UnitGroup Class
- Create Test Cases

Unit Group
units: Map
addUnit(Unit) removeUnit(int) removeUnit(Unit) getUnit(int): Unit getUnits(): Unit[*]

Description	Input	Expected Output	Starting State
Add Unit to Group	Unit with Id of 100	UnitGroup with single Unit	UnitGroup with no members
Get Unit by ID	100	Unit with Id of 100	UnitGroup containing Unit 100
Get All Units	N/A	List of Units	UnitGroup with >1 members
…	…	…	…

Wrapping Up

- Software Life Cycles
    - Iteration and testing are fundamental to achieving progress
- Development Approaches
    - Use case driven development: implement single use case, repeat
    - Feature driven development: implement single feature, repeat
    - Test driven development: write a test first, watch it fail, write code, watch test pass
- Programming Practices
    - Programming by Contract: agreement about how software behaves
    - Defensive Programming: Trust No One; extensive error/data checking

Coming Up Next

- Lecture 15: Putting It All Together
  - Read Chapter 10 of the OO A&D book
- Lecture 16: OO Design Methods
  - None; Will compare textbook's life cycle with other design methods