

Exceptions

Slides derived from the work of Dr. Amy McGovern and Dr. Deborah Trytten

Notes

- Project 1 submission and grading
 - Code reviews are required
- Project 2 released on Wednesday
- Exam in two weeks

Challenges to Building Robust Software

Software will often be used in conditions that you (the designer) cannot precisely anticipate

- A user might enter data that is incorrect
- A user programmer might create or manipulate objects in incorrect ways
- Programmatic operations might fail
- System errors might occur

We need to address all of these

Techniques for Highlighting Errors

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When an error in a method occurs, we can use:

- `System.out.println()`
 - Create a log file that keeps track of every important event/operation inside your code (including errors). Log4J is a tool for doing this...
- Return a value that indicates an error
- `System.exit()`: halt execution of your program

Techniques for Highlighting Errors

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- `System.exit()`: halt execution of your program

None of these techniques allows a program to robustly take corrective action

Exceptions

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 - NullPointerException
 - IndexOutOfBoundsException
 - IOException
- These cause your program to halt
 - Show the file and line number where the failure occurred
 - Show the “stack trace” – the nested list of method calls that has brought us to the failure

Examples

- Method calls on uninstantiated objects
- Creating arrays of negative size

Syntax

```
try
{
    // some code that could throw an exception
}
catch (ExceptionName e)
{
    // Fix the problem here
}
```

If you're not going to fix the problem there is no reason to catch the Exception

Throwing Exceptions

When an Exception is thrown:

- Execution stops immediately
- JVM examines the call stack for a matching *catch* statement
- Execution continues within the body of the matching catch statement
- Then: execution continues *after* the try-catch

Throwing Exceptions

- The catch statement should be placed at a point where the program can address the issue (we call this *handling the exception*)
- Exceptions not caught within the method cause the search to continue in the next higher method
- Exceptions not caught by any method in the call stack cause the program to halt

Hierarchy of Exception Classes

Object

- Throwable
 - Exception
 - RuntimeException
 - NullPointerException
 - ArithmeticException
 - ArrayIndexOutOfBoundsException
 - IOException
 - Error

Error Class

- See API
- When these occur, we generally accept that we cannot recover
- Instead, we try to gracefully clean things up before halting
 - Save critical data to files
 - Alert the user

RuntimeException

Most often caused by programming errors

- **Unchecked exception**: we don't have to explicitly address these in code unless we want to (so, no “throws” statements necessary)
- Usually a sign that we need to debug our code
- Example: ArrayList API (get, set)

Not RuntimeExceptions

- All exceptions that are not RuntimeExceptions are **checked exceptions**
- Any method that can throw one of these exceptions must declare this in the method prototype (throws NameOfException)
- Any method that calls one of these methods:
 - Must address the exception with a try/catch
 - or also throw the exception

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If you're not going to fix the problem there is no reason to catch the Exception

Remember...

- RuntimeExceptions: Unchecked
- Other Exceptions: Checked

Creating Our Own Exceptions

- Only create a new exception if there isn't already one that does the job
- Extend an existing class
 - Often Exception or RuntimeException
 - Which is best?
- Implement the constructors
- Can add our own data!

Example: Prompting the User for an Array Size

Prompting the User for an Array Size

- Create an `IllegalSizeException`
- Prompt the user for a size
- If the given value is non-positive, then throw our new Exception
- When the Exception is received, then keep prompting for an array size

Back to: Prompting the User for an Array Size

What about when the user enters a non-number?

Back to: Prompting the User for an Array Size

What about when the user enters a non-number?

- We can also throw an exception under these conditions

Best Practices

- Don't overuse Exceptions:
 - If your code can detect and address the error right then and there, don't throw
 - Only use if interrupting the flow of the code is the right way to address the problem
- Only introduce new Exception classes when necessary
- If you are receiving unchecked exceptions, then address the bug – don't ask your code to recover

Multiple Catch Blocks

- Searched in order
- First one to match “wins” and no others are checked

```
try
{
}
catch (RuntimeException e)
{
}
catch (ArithmeticException e)
{
}
```

Finally Blocks: Cleaning Up

Guaranteed to execute finally block after the try block:

- Even if an exception occurs within the try
- Even if the try includes a “return”

```
try
{
}
catch (RuntimeException e)
{
}
finally
{
}
```

Rethrowing Exceptions

Sometimes your catch can't address the Exception

- Rethrow original Exception object
- or create a new one to throw...

```
try
{
}
catch (RuntimeException e)
{
    throw e;
    or
    throw new MyException("foo");
}
```

Nesting Exceptions

When an exception is thrown:

- JVM starts at the top of the call stack
- Finds the try closest to the top of the stack
- If a catch statement matches, then the corresponding block is executed and then execution continues after that try/catch
- If no match: search the call stack for the next try

Nesting Exceptions

Search of the call stack continues until:

- The JVM leaves `main()` – causing a program halt
- A catch matches

