Day 8

COMP1006/1406
Summer 2016

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Carleton University

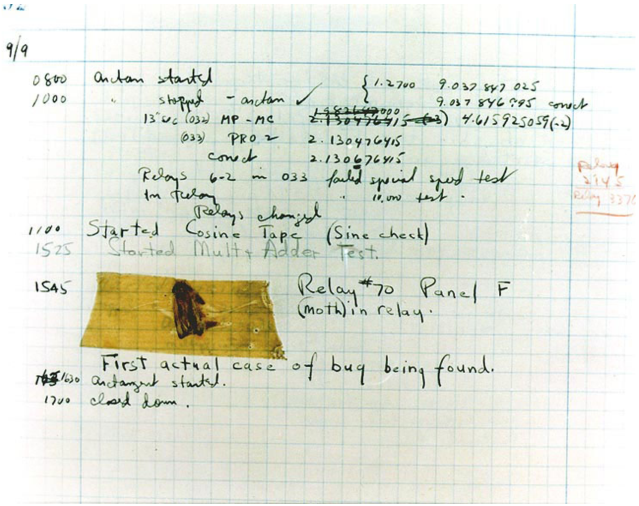
today's agenda

- assignments
    - Assignment 4 is out and due on Tuesday
- Bugs and Exception handling

Bugs...

often use the word `bug` when there is a problem with our program

Bugs...



9/9

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1000 " stopped - antan ✓ {1.2700 9.037 847 025
{ 9.037 846 995 conect

13" uc (032) MP - MC ~~1.982147000~~ ~~2.130476415 (-3)~~ 4.615925059(-2)

(033) PRO 2 2.130476415

conect 2.130676415

Relays 6-2 in 033 failed special speed test

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Relays changed

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First actual case of bug being found.

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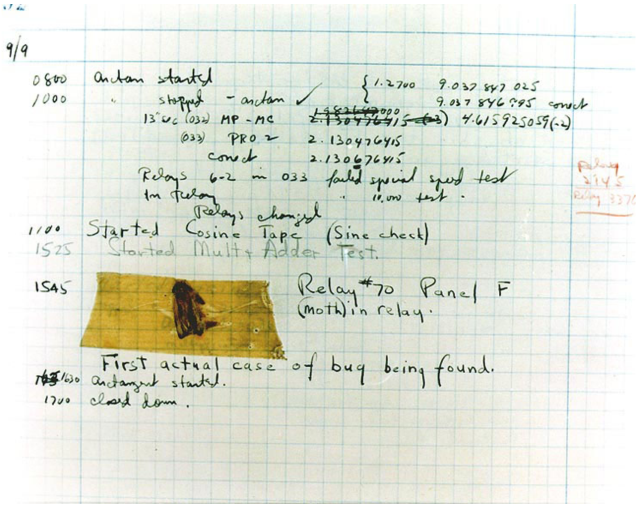
1700 closed down.

Relay 2145
Relay 3370

Bugs...



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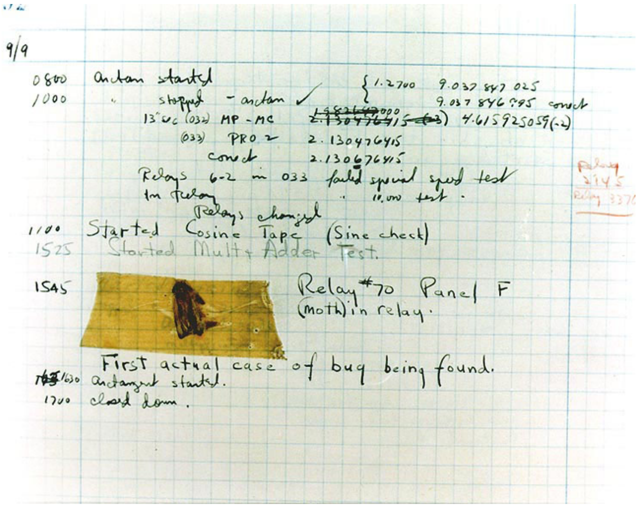

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- bug is an error in our code (or hardware)
- debugging is a methodical process of finding and reducing the number of bugs

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  - `these are definitely your fault`

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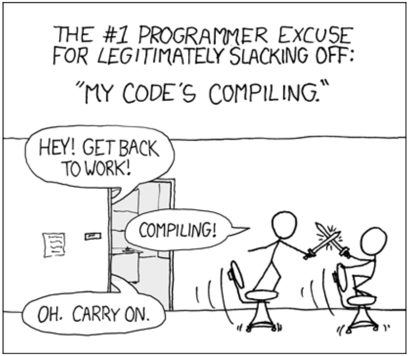

xkcd - 303

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  - serious bugs may require rethinking your code/objects

Bugs...

part of the problem is that we don't live in a perfect world...

- people do not follow API specifications (preconditions)
- people do weird things with your code...
- files get corrupted

you have no control over how people use your code
you have no control over the universe your code is running in

- need to write `robust` code
- **robustness** is the ability of the code to cope with errors during execution and cope with erroneous input (from wiki)

Bugs...

we could write code to check for all possibilities in our code

- **error-checking** is code added to your code to look for bad data
- **error-handling** is what you do when bad data is found

  $\Longrightarrow$ everything needs to be an `Object`

in Java we use `Exceptions`...

- an **Exception** is an error that occurs in your code
- **Exception Handling** is what you do when an exception is found

goal of using exceptions

- you want your program to die gracefully
- you want to program to recover from bad data if possible

Exceptions...

in Java, exceptions are `objects`

- the JVM automatically does this, or
- you explicitly do this in your code, or
- another method will explicitly do this

in Java, thrown exceptions are always `caught`

- explicitly caught by your code, or
- delegated to someone else to be caught, or
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in Java, thrown exceptions are always `caught`

- explicitly caught by your code, or (graceful)
- delegated to someone else to be caught, or (potentially graceful)
- caught by the JVM if everyone delegates (ugly)

Exceptions...

in Java, exceptions are `objects`

Error Class

- unrecoverable errors
  - `java.lang.StackOverflowError`
  - `java.lang.OutOfMemoryError`
- you do not generally catch these yourself
  (you fix your code so it doesn't happen again!)

Exceptions...

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Exception Class

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    - `IllegalAccessException` (try to violate access modifier)
      `FileNotFoundException` (file is not found)

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- **checked** exceptions (`Exception Class`)
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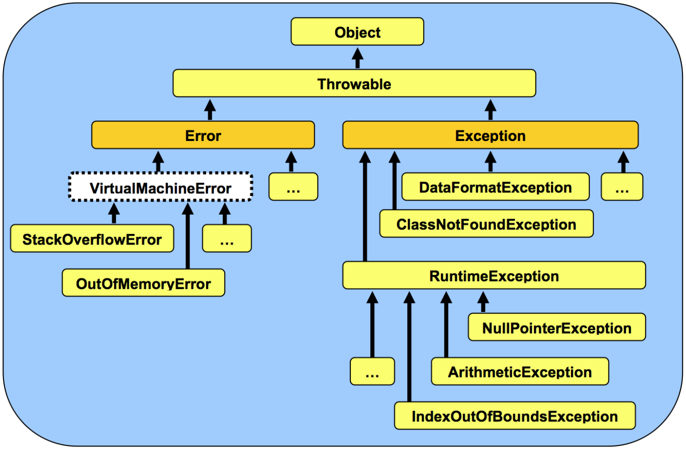
    (if there is a throw there must be a catch)
  - `IllegalAccessException` (try to violate access modifier)
    `FileNotFoundException` (file is not found)
- **unchecked** exceptions (`RuntimeException` subclass)
  - compiler does not check for a catch
    (typically left for JVM to crash program)
  - you should rethink your code to avoid these...
  - `ArtithmeticException` (divide by zero for example)
    `NullpointerException`
    `IndexOutOfBoundsException`

Exceptions...



Object
Throwable
Error
Exception
VirtualMachineError
...
DataFormatException
...
StackOverflowError
...
ClassNotFoundException
OutOfMemoryError
RuntimeException
NullPointerException
...
ArithmeticException
IndexOutOfBoundsException

let’s take a break...
for 1.2 minutes

Exceptions...

new Java keywords

- `throws`
  - used in method declaration
  - says that this method is delegating this exception
- `try`/`catch`/`finally`
  - used to execute code and handle exceptions thrown
  - "try" to execute this code...
    "catch" any thrown exceptions and handle them
    "finally" execute some code after everything is done
- `throw`
  - explicitly throw an exception

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      or
      calls a method that might
        ...
          ...
            ...
              explicitly throw a java.io.FileNotFoundException object

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let’s look at an example

Try/Catch

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}
catch(RuntimeException re){
  block of code
  to execute if exception is caught
}
```

Note: this won't compile

Try/Catch

- use `throws` to delegate exception handling
- use `try` and `catch` to handle the exception yourself

let's look at the same example...

Try/Catch

order matters! class hierarchy matters!

$$\begin{tikzcd}
\boxed{\texttt{java.lang.Object}} \\
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\boxed{\texttt{java.lang.Exception}} \arrow[u] \\
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```
try{
   block of code to try
}
catch(IOException ioe){
   block of code to
   execute if exception
   thrown
}
catch(RuntimeException re){
   block of code to
   execute if exception
   thrown
}
catch(Exception e){
   block of code to
   execute if exception
   thrown
}
```

```
{
   block of code to try
}
if (IOException is thrown){
   block of code to
   execute if exception
   thrown
}
else if (RuntimeException){
   block of code to
   execute if exception
   thrown
}
else if (Exception){
   block of code to
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```

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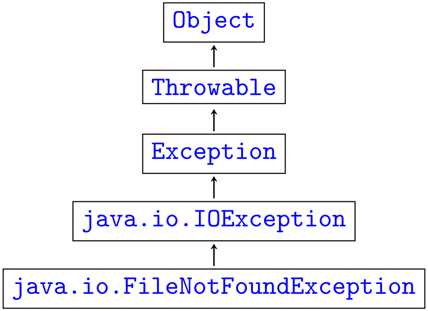
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try{
  block of code to try
}
catch(Throwable e){
  block of code
  to execute if exception is caught
}
finally{                                        // like a funny else
  block of code to execute
  REGARDLESS of what happens above
}
```

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  creates a new Exception object and throws it
- `throw e;`
  throws an existing exception
  (`e` must be a `Throwable` object)

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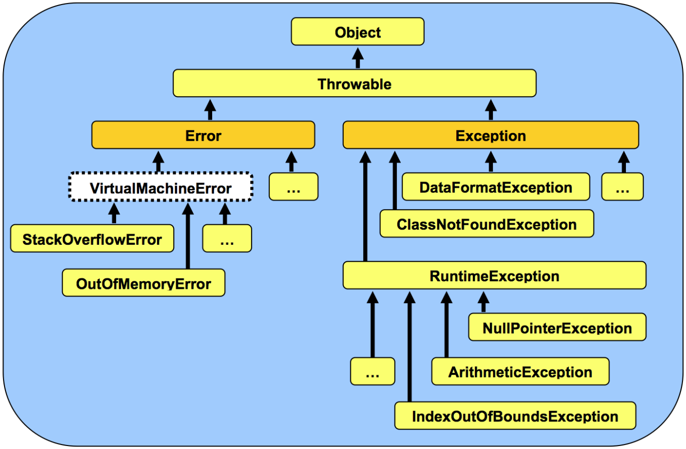

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```
public class BadCardRankException extends Exception {

    public BadCardRankException(){
        super("Rank of card is invalid");
    }
  }
```

Throwable

the `Throwable` class is the root of all exceptions in Java

- `toString()`
  - returns short description of this object
- `getMessage()`
  - returns the message as input with the constructor
- `printStackTrace()`
  - prints the stack trace to standard error