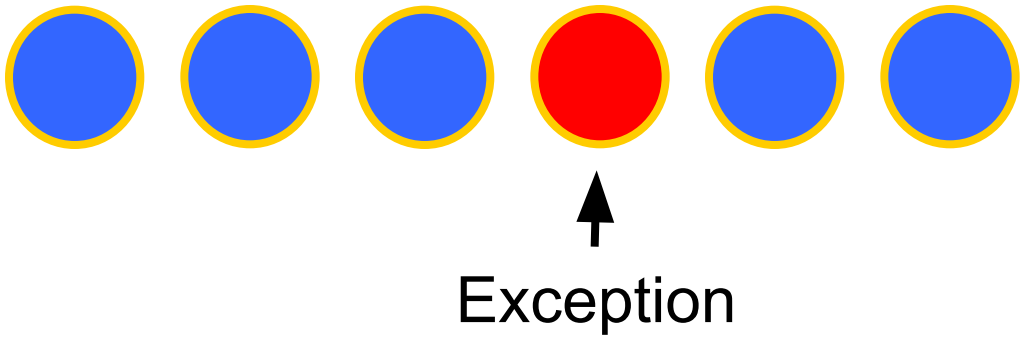
Exceptions



Exceptions Overview

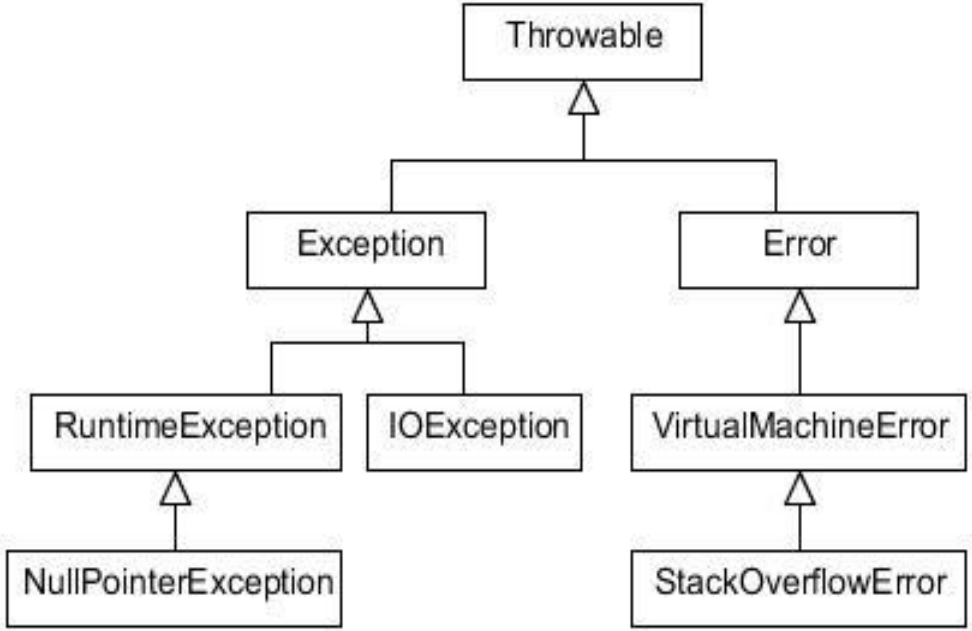
- Exceptional Situations
- Syntax of `Try`, `Catch`, `Throw`
- Defining and Using Your Own Exceptions

Exceptional Situations

- Exceptions model atypical situations
  - errors in computation or data
  - invalid method parameters
  - failure to complete task
- Exceptions provide the programmer with information regarding problems
  - ex, `NullPointerException`s indicate an action on `null` reference
  - some must be handled, others do not (next slide)
- Can handle exceptions by *catching* them
  - respond to exceptions usefully
  - see how to do this in a few slides . . .
- Exceptions allow a method to delegate to caller (method that called the one *throwing* the exception) how the exception is to be handled

Exceptional Situations in Java

- `Exception`s are classes that extend `Throwable`
  - come in two types:
    - those that must be handled somehow (wel see how soon), such as `IOException` – e.g., an issue reading a file
    - those that do not; e.g., `RuntimeException`s such as `NullPointerException`
- `Error`s (far less common, FYI only)
  - could be indirectly caused by your code (such as using up all available memory); could be entirely unrelated
  - you should not attempt to handle these



Exception Handling Syntax (1/2)

- Until now, you have had no control over coping with exceptions. With a **`catch`** statement, you have the chance to implement your own exception handling
- Process for handling exceptions
  - *try* some code, *catch* exception thrown by tried code, *finally*, "clean up" if necessary
  - **`try`**, **`catch`**, and **`finally`** are reserved words
- **`try`** denotes code that may throw an exception
  - place questionable code within a *try block*
  - a *try block* must be immediately followed by a *catch block* unlike an **`if`** w/o **`else`**
  - thus, **`try-catch`** blocks always occurs as pairs
- **`catch`** exception thrown in **`try`** block and write special code to handle it
  - catch blocks distinguished by **type** of exception
  - can have several *catch blocks*, each specifying a particular type of exception
  - Once an exception is handled, execution continues after the catch block
- **`finally`** (optional)
  - special block of code that is executed whether or not an exception is thrown
  - follows *catch block*

Exception Handling Syntax (2/2)

- Here's the basic syntax:

```
// Somewhere in your program…
try {
  // Code "in question"
}
catch (most_specific_exception_type
  name) {
  // Code in response to exception
}
...
finally {
  // Code guaranteed to be executed
  after try
  // (and previous catches)
}
```

- All parts enclosed in curly braces `{}`
- `try` block comes first
- `catch` block comes after try
  - put exception in parentheses as in method definition
  - you can also have multiple catch blocks
  - formal parameter of type `java.lang.Exception` is the most general and would catch all exceptions (because they are all subclasses)
- `finally` block always comes last

Exception Handling Example 1

- A method call within a `try` block may set off a chain of method calls, the last of which throws an exception
  - Andy tells Wendy to `getADrink()`; Wendy tells Sam to `getADrink()`. Sam is asleep and throws a `DrinkNotAvailableException` which is defined elsewhere
  - This exception is not a subclass of `RuntimeException`, so it should be caught)

```
public class Andy {
 // Properties, constructor, methods
 //to teach, kayak, eat Chinese food,
 //etc. elided ;)
     public void getWater() {
       try {
        // getADrink() might throw a
        //DrinkNotAvailableException so
        //we have to put it in a try block
        _water = _wendy.getADrink();
      }
      catch(DrinkNotAvailableException e){
        this.fire(_wendy);
      }
      }
}
```

Exception Handling Example 2

- `try-catch` blocks can be nested!
  - If Andy's call to Wendy to `getADrink()` throws `DrinkNotAvailableException`, he can ask Michelle to `getADrink()`.
- Exception Resolution
  - similar to method resolution in inheritance hierarchies: starts with the method that throws exception
  - work back up the chain of method calls until a `try-catch` block is found for that exception (or a superclass of that exception)
    - so, you do not necessarily have to `try` and `catch` every exception at every level of calling
    - if an exception must be caught, then you'd better be sure that you catch the exception at some point!
    - if exception is not caught, program will crash or not perform as expected

```
public class Andy {
  // other code elided
  public void getWater() {
    try {
      _water = _wendy.getADrink();
    }
    catch (DrinkNotAvailableException e) {
      this.fire(_wendy);
      try {
        _water = _michelle.getADrink();
      }
      catch(DrinkNotAvailableException e
       this.fire(_michelle);
      }
    }
  }
}
```

Defining Your Own Exceptions

- You can define and throw your own specialized exceptions:

```
throw new DataOutOfBoundsException(…);
throw new QueueEmptyException(…);
```

- Useful for responding to special cases, not covered by pre-defined exceptions
  - you can **`throw`** an exception for a different class to **`catch`**
  - a method of error handling
- For example:

```
public class DataOutOfBoundsException extends Exception {
  public DataOutOfBoundsException(String dataName){
    super("Data value " + dataName + " is out of bounds.");
  }
}
```

- The class **`Exception`** has a method **`getMessage()`**.The **`String`** passed to **`super`** is printed to the output window for debugging when **`getMessage()`** is called by the user

Using Your Own Exceptions (1/2)

- Every method that throws `Exceptions` that are not subclasses of `RuntimeException` must declare what exceptions it throws in method declaration
- `setAge()` is throwing the exception, and we'll see in the next slide that the exception will be caught in the method that calls `setAge()`

```
// Defined in the Person class
public void setAge(int age) throws
  DataOutOfBoundsException {
  if (age < 0 || age > 120){
    throw new
  DataOutOfBoundsException(age+"");
  }
  // age+"": converts age from int to
  //String
  //Note the constructor takes in a
  //String for message printing
  _age = age;
}
```

Using Your Own Exceptions (2/2)

- Method that calls `setAge()` should have a `try` block surrounding the method call and an accompanying `catch` block to handle `DataOutOfBoundsException`

```
public void clonePerson() {
  Person clone = new Person();
  int random = (int)(Math.random() * 1000);
  try {
    clone.setAge(random);
  }
  catch (DataOutOfBoundsException e) {
    System.out.println(e.getMessage()); // gets the message describing
                                        // the exception that occurred
  }
}
```

QueueEmptyException

- Create your own `QueueEmptyException`:
  - Subclass `RuntimeException`, so that every time `dequeue()` is called, we don't need to surround it with a `try-catch` block – same idea behind `ArrayIndexOutOfBoundsException`
  - If the exception indicates an actual problem, then don't catch it! It should halt the execution of the program

```
public class QueueEmptyException extends
  RuntimeException {
  public QueueEmptyException() {
    super("Queue is empty");
  }
}

public class Queue<Type> {
  // QueueEmptyException is a
  // RuntimeException, so we don't need
  //to write "throws" in the method
  // declaration
  public Type dequeue() {
    if (this.isEmpty()){
      throw new QueueEmptyException();
    }
   //Remaining dequeue() code goes here
  }
}
```

Exceptions: Pros and Cons

- Pros:
  - cleaner code: rather than returning a `boolean` up chain of calls to check for exceptional cases, throw an exception!
  - use return value for meaningful data, not error checking
  - factor out error-checking code into one class, so it can be reused
- Cons:
  - throwing exceptions requires extra computation
  - can become messy if not used sparingly
  - can accidentally cover up serious exceptions, such as `NullPointerException` by catching them

In conclusion

- Words of Wisdom:
  - Never try to “fix up” your program by catching all exceptions
    - “Oh… `NullPointerException`… let me just catch it, so the TAs won’t know I have buggy code! Hahahaha!!!”
  - Best to throw an exception when an error occurs that you cannot deal with yourself, but can be better handled by some method on the stack