Alfred Nobel’s Interactive Will

TOUCH TO EXPLORE

I am undertaker Alfred Bernhard Nobel. I have always been interested in the development of the different fields of science, and I have made it my life's work to promote peace throughout the world. I therefore stipulate in my Will that a prize shall be awarded each year to the person who shall have done the most or the best work for fraternity between nations, for the purpose of stopping war and promoting concord. The prize shall be administered by a board of five members, one to be chosen in each of the following countries: Sweden, Norway, Denmark, the United Kingdom of Great Britain and Ireland, and the United States of America. The Board of Nobel Prizes shall consist of five members, one to be chosen in each of the following countries: Sweden, Norway, Denmark, the United Kingdom of Great Britain and Ireland, and the United States of America. 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WILL PAGE 1/4

TESTAMENT

I, the undersigned, Alfred Bernhard
Nobel, do hereby, after mature
deliberation, declare the following to be my last Will and Testament
with respect to such property as may be
left by me at the time of my death.

To my nephews, Harry and Ludwig:
Nobel, the sons of my brother Robert Nobel, I bequeath
the use of Two Hundred Thousand Crowns each.

To my nephew Emanuel Nobel, the sum of Three
Hundred Thousand, and to my niece Mina Nobel,
One Hundred Thousand Crowns.

To my brother Robert Nobel’s daughters, Ingeborg
and Tyra, the sum of One Hundred Thousand Crowns each;
Miss Olga Bögel, at present staying
with Mrs Brand, 10 Rue St Ponsfort, Paris, will receive
One Hundred Thousand Francs;
Mrs Sofie Kjær von Kapfer, whose address
is known to the Anglo-Osmanische Bank in Vienna,
is hereby entitled to an annuity of 5000 Francs O.W.,
which is paid by the said Bank, and to this end I have
deposited in this Bank the amount of 150,000 Fl. in Hungarian State Bonds;
Mr Alain Lefebvre, presently living at 28, Rue St Ingbert,
Stockholm, will receive One Hundred Thousand Crowns;
Miss Else Astor, presently living at 10, Rue de Lubeck,
Paris, is entitled to an annuity of Two Thousand
Five Hundred Francs. In addition,
Forty Eight Thousand Francs owned
by her are at present in my custody, and shall be refunded;
Mr Alfred Hammond, Waterford, Texas,
U.S.A., will receive Ten Thousand Dollars;
The Misses Emmy and Marie Weinmann,

ROBERT NOBEL
Alfred Nobel’s brother Robert
Nobel was involved in the early
establishment of the explosives
industry and a pioneer in the oil
industry in Azerbaijan.

EMANUEL NOBEL
Emanuel Nobel was the son of
Alfred Nobel’s brother Ludwig
and took over leadership of the
Nobel brothers’ oil company
after the death of his father.
Lecture 11
Loops

“Life is just one damn thing after another.”
-Mark Twain

“Life isn’t just one damn thing after another… it’s the same damn thing over and over and over again.”
-Edna St. Vincent Millay
Turtle

- Before we see loops, we need some tools
  - Turtle: will draw on the screen for us
    - Based on Seymour Papert’s Logo, a language for beginners
  - PaneOrganizer: instructions for the turtle
    - Reminiscent of our first Robot example...
- Turtles know where they are and what direction they are facing, can move and turn
- Turtles can draw lines behind them as they move around the screen, or just move w/o drawing
- Now let’s look at the Turtle class
Turtle’s Methods (1 of 2)

• TAs have written a `Turtle` class

```java
public class Turtle {
    // instance variables elided
    /* constructor for Turtle instantiates a Polygon representing the Turtle graphically */
    public Turtle() {
        // some code here
    }
    /* reset turtle to center of pane */
    public void home() {
        // some code here
    }
    /* turn right a specified number of degrees */
    public void right(double degrees) {
        // some code here
    }
    /* turn left a specified number of degrees */
    public void left(double degrees) {
        // some code here
    }
    // continued
```
Turtle’s Methods (2 of 2)

/* move forward a specified distance, drawing a line as the turtle moves */
public void forward(int distance) {
    // some code here
}

/* move backward a specified distance, drawing a line as the turtle moves */
public void back(int distance) {
    // some code here
}

/* move turtle to a specified position without drawing a line */
public void setLocation(Point2D loc) {
    // some code here
}

/* return turtle’s location */
public Point2D getLocation() {
    // some code here
}

/* returns the Polygon contained in Turtle class so that we can graphically add it in the P.O. */
public Node getNode() {
    // some code here
}
Drawing with **Turtle**

- Need class to tell **Turtle** how to draw some basic shapes
- First, determine what shapes we want
  - this lecture: square, random walk
  - next lecture: recursive spiral, tree, fractal

- How will we code it?
  - create **PaneOrganizer** class which defines methods for drawing each shape
  - the **PaneOrganizer** also instantiates the root Pane that the **Turtle** will draw on and contains the **Turtle**
  - **Turtle** is a wrapper class that contains a polygon (a triangle) and defines methods for how the **Turtle** will move; it can also return the shape as a node via **getNode**
Drawing with Turtle

- Time for some code!

```java
public class PaneOrganizer {

    private Turtle _turtle; // draws each pattern
    private Pane _root;

    public PaneOrganizer() {
        _root = new Pane();
        _turtle = new Turtle();
        _root.getChildren().add(_turtle.getNode());
    }
    // methods for each geometric pattern to follow...
```

*getNode* just returns the triangle contained in Turtle class so it can be added to the Scene Graph – see this week’s [lab](#) for more extensive discussion.
A Repetitive Solution

- Let’s write the `drawSquare` method in the `PaneOrganizer` class
- Brute force: write line of code for each side

```java
public void drawSquare(int sideLen) {
    _turtle.forward(sideLen);
    _turtle.right(90);
    _turtle.forward(sideLen);
    _turtle.right(90);
    _turtle.forward(sideLen);
    _turtle.right(90);
    _turtle.forward(sideLen);
    _turtle.right(90);
    _turtle.forward(sideLen);
    _turtle.right(90);
}
```
A Repetitive Solution

- What if we wanted to make a more general method that handles regular shapes such as pentagons or octagons?
  - need to call forward and right for each side
  - cannot fix how many sides we need in generic method
  - note that we’re using the Turtle’s primitive methods to generate higher-level shapes that are normally already defined in JavaFX

- There must be an easier way!
Looping

- Execute a section of code repeatedly
  - uses booleans (true and false) as loop conditions; when boolean is false, loop condition equals exit condition and loop is terminated
  - as with conditionals, code in the loop can be a single line or many lines enclosed in curly braces
  - section of code executed is called loop’s body
Looping

- Three loop structures in Java
  - `while` loop
  - `do while` loop
  - `for` loop
- Differ in relation between body and loop condition, as well as length of execution
  - `do while` loops execute body and then test condition; others test condition before executing body
  - `for` loops run for a predetermined number of iterations; others run for indefinite amount of time
- Let’s look at `while` loop first
The **while** loop

- Execute **while** certain condition is true
  - tests loop condition *before* executing body
  - if loop condition is *false* first time through, body is not executed at all

```java
while (<loop condition>) {
    <loop body>
}
```
The **while** loop

- **Examples of loop conditions:**

  ```java
  numClasses < 6
  peopleStanding <= maxPeople
  this.checkAmount() <= acctBalance
  this.isSquare() //predicate, a method that returns a boolean
  ```

- Follow the same rules as conditions for **if-else** statements

- Multiple conditions can be combined using logical operators (**and**, **or**, **not**)

  ```java
  (numClasses >= 3) && (numClasses <=5)
  (peopleStanding <= maxPeople) || (maxPeople < 50)
  ```
A **while** Flowchart

- **while** loops continue **while** loop condition is **true**
- Loop condition can be any boolean expression
A **while** Flowchart

- **while** loops continue **while** loop condition is **true**
- Loop condition can be any boolean expression

---

**Flowchart**

- **Walk into the Ratty.**
- **Is The Ratty open?**
  - **Yes** → **Get more food.**
  - **No** → **Go to Jo’s.**
All Flow of Control Structures: 1-in, 1-out

- Benefits of predictable flow of control:
  - much easier debugging
  - compiler can optimize much better
- Contrast with “spaghetti” code produced by having *go to* construct which allows for jumping to another line of code
  - *Go To Statement Considered Harmful* letter by Edsger Dijkstra, 1968
- “Go to”-less programming called “structured programming”, took a while to get traction
So, just how bad is `goto`?

---

I could restructure the program's flow.

Or use one little 'goto' instead.

Eh, screw good practice. How bad can it be?

```
go to main_sub3;
```

*Compile*

---

Dinosaur: What is this `goto` anyway?

Developer: It's a way to switch execution flow.

Dinosaur: I don't understand.
Syntax: Random Walk Using \texttt{while}

- Method of \texttt{PaneOrganizer} class:
  - draws random lines while turtle is within its pane
    
    ```java
    public void randomWalk() {
        // while _turtle’s position is inside its
        // pane, move _turtle randomly
        while (_root.contains(_turtle.getLocation())) {
            _turtle.forward ((int) (Math.random()*15)); // cast to [0-14]
            _turtle.right ((int) (Math.random()*360)); //cast to [0-359]
        }
    }
    ```

- On last step of walk, \texttt{_turtle} will move forward out of pane
  - the line is \textit{clipped} by JavaFx since we don’t explicitly tell it to wrap around
  - no point in continuing to walk outside the pane
The **do while** Loop

- **do while** always executes loop body at least once by switching order of test and body
- The **<loop condition>** is a boolean expression

```
<previous statement>
<loop body>
Is <loop condition> true?

Yes

No

<rest of program>
```
Example: Another Random Walk

- Method of PaneOrganizer class:
  - draws random lines while turtle is within pane
  - starts turtle in center of root pane, so first step guaranteed to be within pane

```java
public void centeredRandomWalk() {
    // moves turtle to Pane’s center
    _turtle.home();

    // moves turtle randomly within pane
    do {
        _turtle.forward((int)(Math.random() * 15));
        _turtle.right((int)(Math.random() * 360));
    } while (_root.contains(_turtle.getLocation()));
}
```

Note the semicolon at the end of while statement
do while vs. while

● In both loops:
  o stops executing body if loop condition is false
  o must make sure loop condition becomes false by some computations to avoid an “infinite loop”
  o infinite loop means your loop condition will never turn false- i.e., exit condition never occurs (and your program “freezes up”!)
do while vs. while

- **do while**
  - body always executed at least once
  - loop condition tested at bottom of loop

- **while**
  - may not execute at all
  - loop condition tested before body; loop condition variables must be set before loop entry
  - useful for screening bad data that might cause statements within loop to fail (e.g. `while (ref != null)`)  

What is the difference between these two?

```java
while (_andyIsAway) {
    _tas.takeADayOff();
}
```

*Condition tested before body*

```java
do {
    _tas.takeADayOff();
} while(_andyIsAway);
```

*Body executes before condition is tested; TA’s take off at least one day*
for loops

- Most specialized loop construct: typically used to execute loop body a *predetermined* number of times
  - *while* and *do while* loops can execute body for undetermined number of times; based on *boolean*

```java
for (<init-expr>; <loop condition>; <update>) {
  <loop body>
}
```

- `<init-expr>`
  - expression for setting initial value of loop counter (traditionally use single char. identifier; e.g., `i`)
  - executed at start of loop code, i.e., only once, not for each time through the loop
for loops

- Most specialized loop construct: typically used to execute loop body a *predetermined* number of times
  - *while* and *do while* loops can execute body for undetermined number of times; based on *boolean*
    
    ```
    for (<init-expr>; <loop condition>; <update>) {
        <loop body>
    }
    ```

- `<loop condition>`
  - *true* or *false*
  - test involves loop counter to determine if loop should execute
  - checked at start of every loop (including the first)
for loops

- Most specialized loop construct: typically used to execute loop body a *predetermined* number of times
  - *while* and *do while* loops can execute body for undetermined number of times; based on boolean
    
    ```
    for (<init-expr>; <loop condition>; <update>) {
        <loop body>
    }
    ```
  
- `<update>`
  - expression that modifies loop counter
  - run at end of every `<loop body>`, just before returning to the top of the loop
**drawSquare Revisited**

- Better way of drawing square than explicitly drawing each side:

```java
public void drawSquare(int sideLen) {
    /* start with integer i initialized to 0;
     * execute as long as i < 4; each execution
     * increments i by 1 */
    for (int i = 0; i < 4; i++) {
        _turtle.forward(sideLen);
        _turtle.right(90);
    }
}
```
for Flowchart

- **for** loop has four parts
  - initialize value of counter
  - test loop condition
  - loop body
  - counter update

<init-counter> 

Is <loop condition> true?

Yes

<loop body> 

<update-counter> 

No

<rest of program>
**for Flowchart**

- **for loop** has four parts
  - initialize value of counter
  - test loop condition
  - loop body
  - counter update

```plaintext
Go to SciLi first floor

Is floor less than 14?

Yes → “Read a book”

No

Go home

Go up one floor
```
Choosing the Right Loop (1/2)

- **for** loop is called a *definite* loop because you can typically predict how many times it will loop.

- **while** and **do while** loops are *indefinite* loops, as you do not know when they will end.

- **for** loop is typically used for math-related loops like counting finite sums.
Choosing the Right Loop (2/2)

- **while** loop is good for situations where boolean condition could turn false at any time.

- **do while** loop is used in same type of situation as **while** loop, but when code should execute at least once.

- *When more than one type of loop will solve problem, use the cleanest, simplest one.*
Syntax: Nested Loops

- Loops, as with if statements, can be nested!
- Example: drawFilledSquare

```java
public void drawFilledSquare(int sideLen){
    // fill in concentric squares
    for (int i = 0; i < (sideLen/2); i++){
        // drawSquare contains a loop
        this.drawSquare(sideLen - (2*i));
        /* note we can use loop counter in
           body but never reset it there! */
        // position turtle for next iteration
        _turtle.right(90);
        _turtle.forward(1);
        _turtle.left(90);
        _turtle.forward(1);
    }
}
```

- What does this do?
  - decrementing sideLen by 2 each iteration to guarantee that each “inner square” drawn by drawSquare(...) is exactly one unit away on either side from square immediately “outside” of it (hence, one+one = two)
Syntax for Nested Loops Explained

- Turtle is represented by ▲
- What is the outer loop doing?
  - first draws outer square

△ Turtle starts upright!
▸ Rotate 90 degrees right!
▸ Move forward 1 unit!
△ Rotate 90 degrees left!
▸ Move forward 1 unit!

`drawFilledSquare` draws concentric squares; each individual square is drawn using the nested loop

- note diagram is misleading in that lines should be a pixel unit wide so the filled square will look solid
Decrementing Counter

- We can count backwards in our loop too
  - just change the counter update expression
  - in fact, we can update however we want
    ```java
    public void countDownSeconds()
    {
        /*change counter to decrement, and change the loop condition accordingly */
        for(int i = 5; i > 0; i--)
        {
            timer.display(i);
        }
    }
    ```

- `for` loops end in one of two ways
  - when counter value equals limit (for `<` or `>`)  
  - when counter value “goes past” limit (for `<=` or `>=`) 
  - thus, `countDownSeconds()` would display 6 seconds if used `i >= 0`
    (bad idea because movie should play on the 0^{th} second, post-loop)
  - Beware of such “off-by-one” errors!
break

- **break** causes immediate exit from a flow-of-control structure (e.g. `while`, `do while`, `for`, `switch`)

- Example:

  ```java
  for (int i = 0; i < 10; i++){
      if(_cookieJar.getNumberOfCookies() == 0){
          break;  //If there are no cookies left, we should break out of the loop!
      }
      this.eatACookie();
  }
  //Execution continues here after loop is done or after break statement is executed
  ```

- Execution continues with first line of code after structure

- There are other ways to do this loop…
continue

- When used in `while`, `for`, or `do while` structures, `continue` skips remaining statements in body of that structure and proceeds with next iteration of loop
  - useful if there is list of data that you are looping over and you want to skip processing of data that is somehow “not allowed”
- In `while` and `do while` structures, execution continues by evaluating loop-continuation condition
- In `for` structure, execution continues by incrementing counter and then evaluating loop condition
Example

```java
// We’d like to try on shirts that hang on a rack
for (int i = 0; i < 20; i++) {
    if (!rack.isShirtOnHanger(i)) {
        // If there’s no shirt on the current hanger, skip to the next iteration
        continue;
    }
    // Only do this if there’s a shirt on the hanger
    Shirt shirtToTry = rack.shirtOnHanger(i); // get the shirt
    this.tryOnShirt(shirtToTry); // try on shirt
}
// more code here
```
Boolean Flags

- A boolean flag is a boolean variable that denotes a condition (e.g., `isDone`, `isWorking`, `isAvailable`)
  - set in one place, tested in another
  - similar to boolean methods, often starts with “is” or “has” by convention

- Boolean flags can also be used as loop condition

- Example (implementing a `for` loop, using `while`):

  ```java
  boolean isDone = false;
  int i = 0;
  while (!isDone){
      i++;
      if(i == 5){
          isDone = true;
      }
  }
  ```

- Notice that boolean flag is set within loop
  - in previous slides, all checking was done through delegation (to methods that returned booleans)
  - here, we do it ourselves (not practical)
Empty Intervals

- Example scenario: we want to keep a running sum of a sequence of numbers
- What happens if we try to add integers in this loop?

```java
public int sum() {
    int tempSum = 0;
    for (int i = 1; i < 1; i++) {
        tempSum += i;
    }
    return tempSum;
}
```

- Answer: body of loop is not executed
- Why?
  - boolean is false for initial counter value
Correct Example

● What about this loop?

/*This method sums all numbers from 1 up to and including 10 */
public int sum() {
    int tempSum = 0;
    for (int i = 1; i <= 10; i++) {
        tempSum += i;
    }
    return tempSum;
}

● It will work!
Off-by-one Errors

- Occur when loop executes one too many or one too few times
- Example: add even integers from 2 to some `number`, inclusive

```java
... count = 2; result = 0; while (count < number) {
    result += count;
    count += 2;
}
```

- Produces incorrect result if `number` is assigned an even value. Values from 2 to `number-2` will be added (i.e. `number` is excluded)

- Should be:

```java
while (count <= number) {
    ...
}
```

- Now, value of `number` is included in summation
Syntax: Other Loop Errors

- Make sure test variables have proper values before loop is entered

  ```
  ... 
  product = 0;
  do {
      product *= 2;
  } while (product < 100);
  /* What will happen here? */
  ```

- Make sure tests check proper conditions

  ```
  ... 
  for (int i = 1; i != 100; i += 2) {
      // do something here
  }
  /* Will we ever get here? */
  ```
Syntax: Other Loop Errors

- **ALWAYS HAND SIMULATE** first, last, and typical cases through a loop to avoid off-by-one or infinite loop errors
  - the first and last cases of a loop’s execution are called boundary conditions or edge cases
  - hand simulation doesn’t just apply to loops – use it for everything! Trust us – it saves debugging time!
Which loop to use?

- You want to shoot 12 baskets
- Your job is to stand at the end of the bowling alley and pick up all the pins, one by one, that have been knocked over
- Ask a question and keep asking while the answer is incorrect
- Sleep until your clock reads 7:00AM or later
Announcements

• Cartoon Competition
  o Every year, we pick some of the most ambitious and creative cartoons to showcase in class. Winners get to grab lunch with Andy!

• Stricter Hours
  o Please read all the resources before coming to TA hours – else we will have to turn you away.

• Cartoon DQs due tomorrow @10pm
  o Cartoon early hand-in Thursday 10/22 @ 11:59pm
  o Cartoon regular hand-in Friday 10/23 @10pm