

CIS 110

Introduction to Computer Programming

Adam Mally

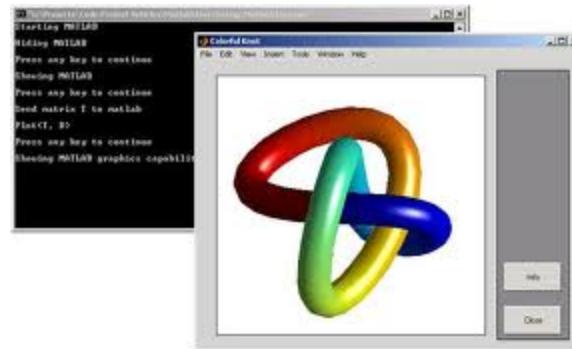
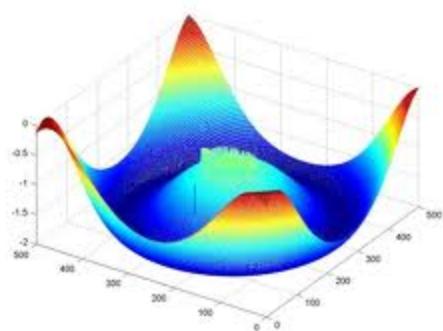
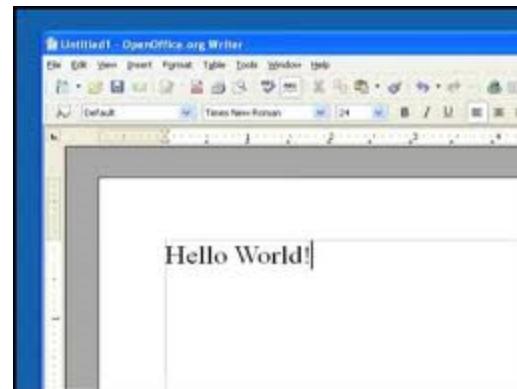
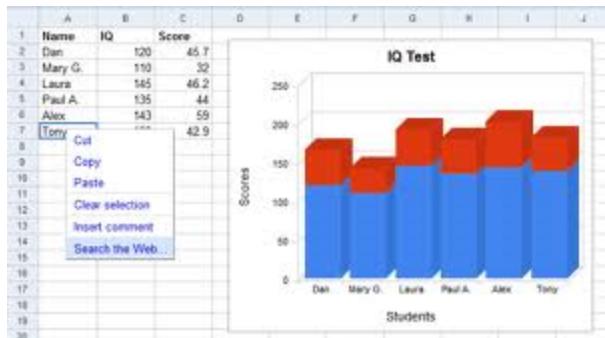
www.cis110.com

What is Computing?

Computing: internet, e-mail, network...



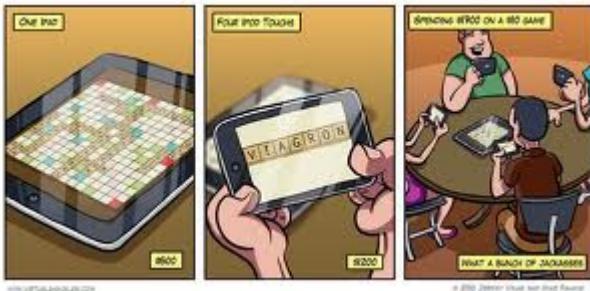
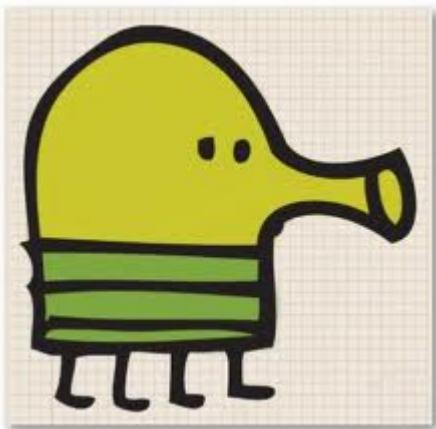
Computing: Productivity...



Computing: Entertainment...



Computing: Entertainment...



“Computer science is no more
about computers than
astronomy is about telescopes”

- Edsger Dijkstra

Cutting Edge Computer Science

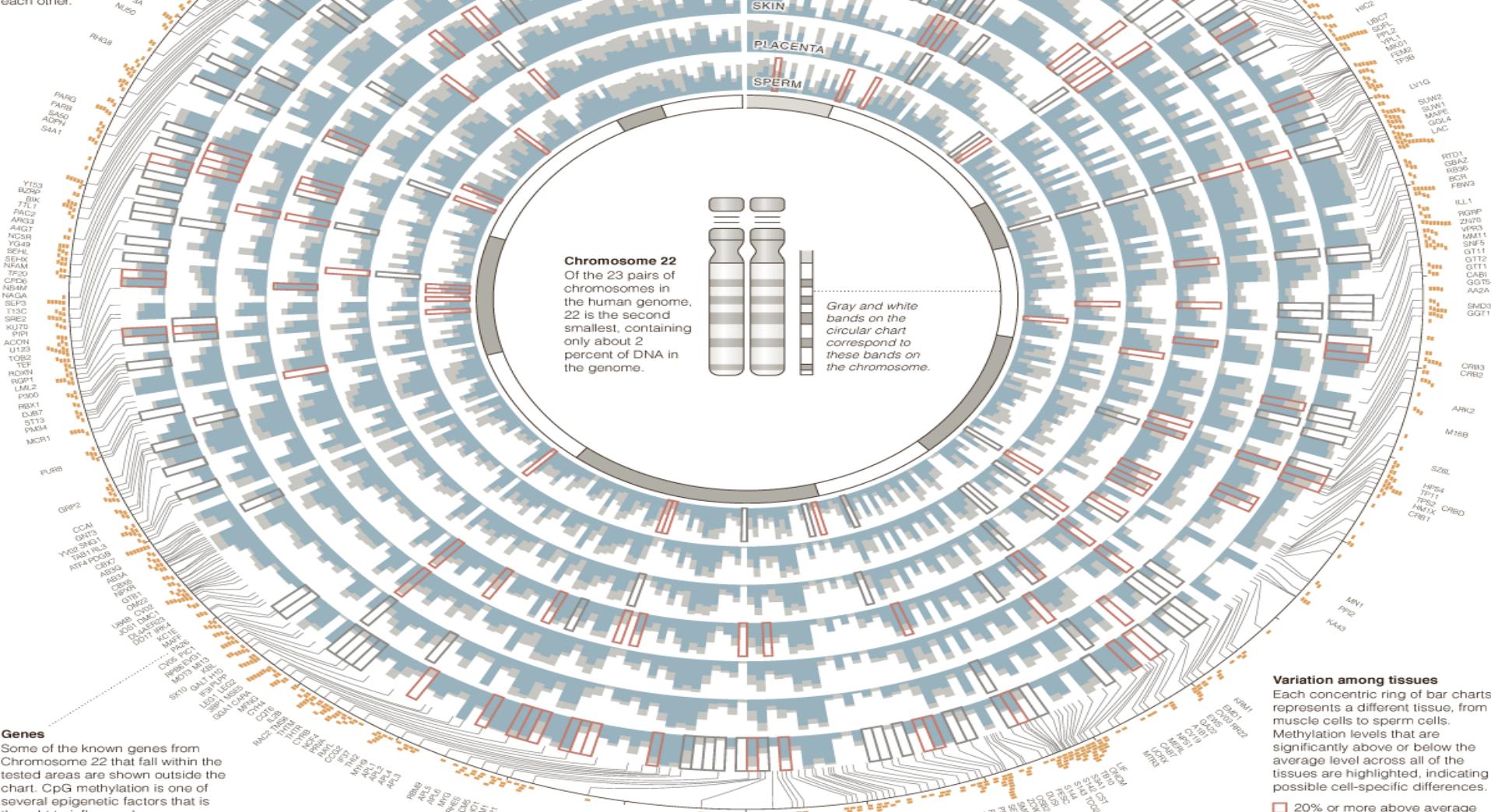
Mapping the Epigenome

DNA contains the genetic blueprint for all human cells, but the reading and execution of the blueprint inside each cell is controlled in part by chemical markers attached to the DNA. Scientists have begun to map some of these epigenetic markers, including CpG methylation.



CpG methylation

DNA is a code written with four letters: **A**, **T**, **C** and **G**, each standing for one nucleotide. In CpG methylation, a small marker called a methyl group attaches to the DNA at a CpG site, where a **C** and a **G** nucleotide sit next to each other.



Genes

Some of the known genes from Chromosome 22 that fall within the tested areas are shown outside the chart. CpG methylation is one of several epigenetic factors that is used to control gene expression.

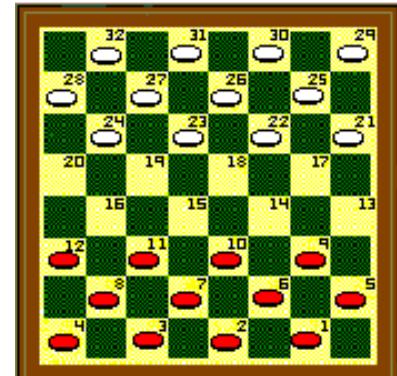
Variation among tissues

Each concentric ring of bar charts represents a different tissue, from muscle cells to sperm cells. Methylation levels that are significantly above or below the average level across all of the tissues are highlighted, indicating possible cell-specific differences.

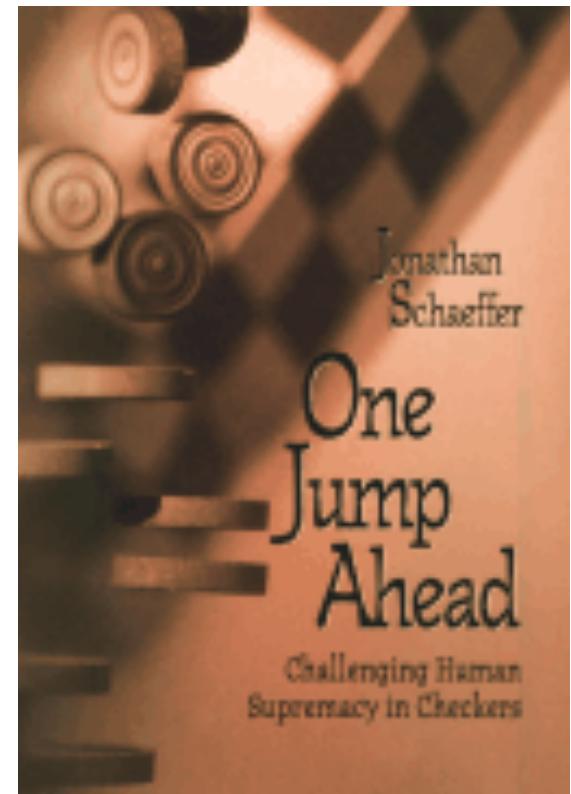
Chinook

- Chinook is the World Man-Machine Checkers Champion, developed by researchers at the University of Alberta.
- It earned this title by competing in human tournaments, winning the right to play for the (human) world championship, and eventually defeating the best players in the world.
- Visit <http://www.cs.ualberta.ca/~chinook/> to play a version of Chinook over the Internet.
- The developers have fully analyzed the game of checkers and have the complete game tree for it.
 - Perfect play on both sides results in a tie.
- “One Jump Ahead: Challenging Human Supremacy in Checkers” Jonathan Schaeffer, University of Alberta (496 pages, Springer. \$34.95, 1998).

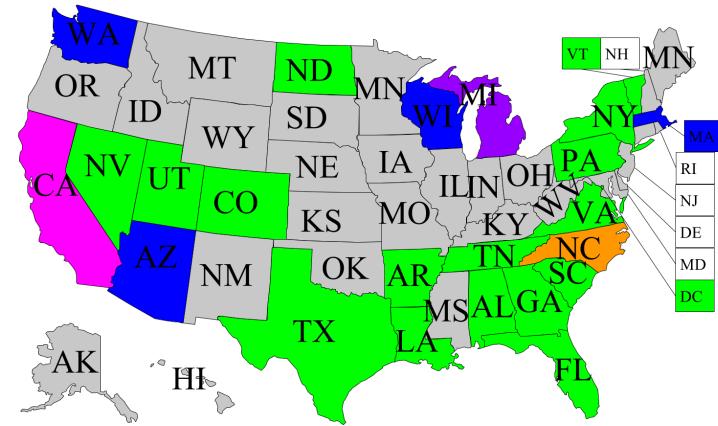
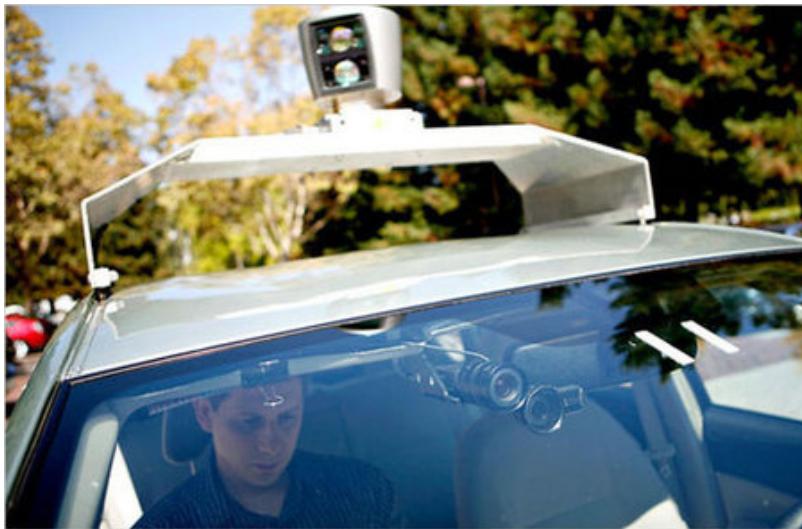
The board set for play



Red to play



Autonomous Cars



Legend

With Driver: [Enacted](#) | [Executive Order](#) | [In Progress](#)

Driverless: [Enacted](#) | [Executive Order](#) | [In Progress](#)

Driverless assuming already enacted with driver

As of 2016



2011 Jeopardy!



- In February 2011, IBM Watson bested Brad Rutter (biggest all-time money winner) and Ken Jennings (longest winning streak)
- IBM is currently applying Watson's technology to medical diagnosis and legal research

Robot Soccer



Aibo League



UPennalizers
Robot Soccer Team

Areas in Computer Science



Artificial
Intelligence



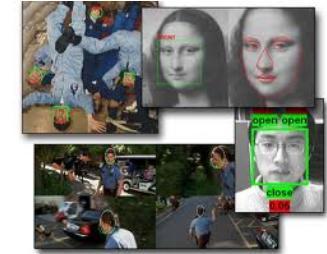
Robotics



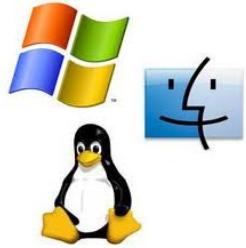
Human-Computer
Interaction



Computer
Graphics



Computer
Vision



Operating
Systems



Computer
Networking



Databases



Computer
Security



Ubiquitous
Computing

What is Computer Science?

Computer science is the study of solving problems using computation

- Computers are part of it, but the emphasis is on the problem solving aspect



Computer scientists work across disciplines:

Mathematics

Biology (bioinformatics)

Chemistry

Physics

Geology

Geoscience

Archeology

Psychology

Sociology

Cognitive Science

Medicine/Surgery

Engineering

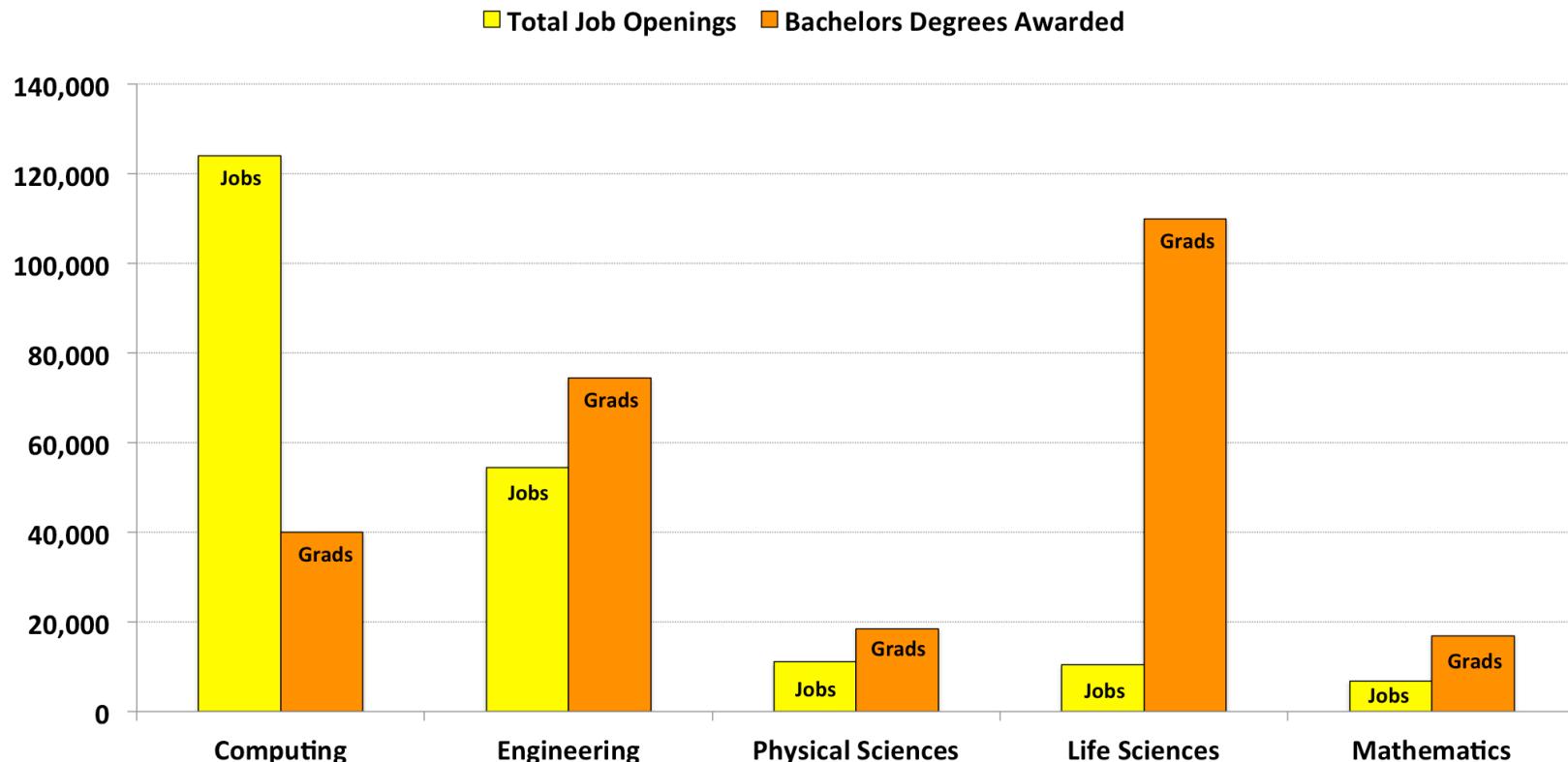
Linguistics

Art

...

Computing is important

Annual Total U.S. STEM Jobs Thru 2022 vs. Recent College Grads

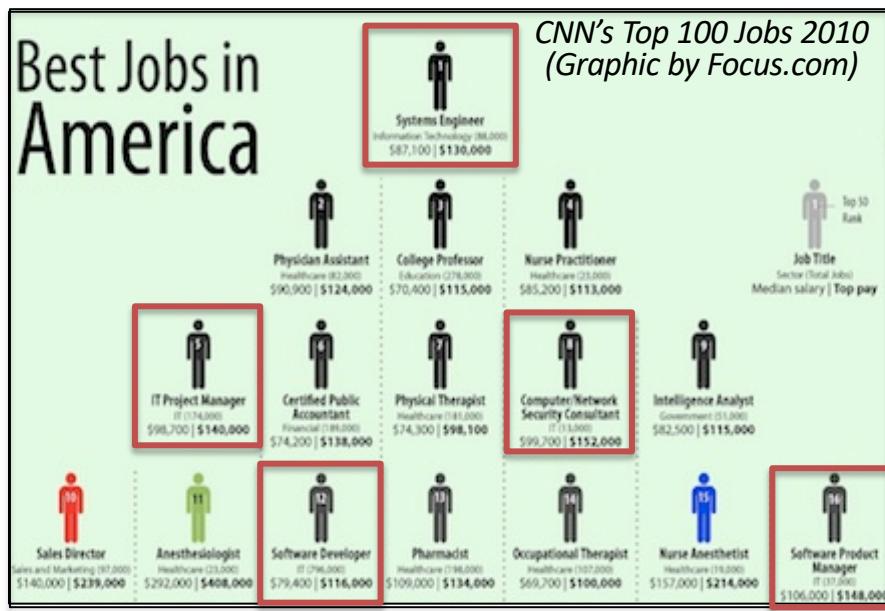


Data Sources: US-BLS Employment Projections, 2012-2022 (www.bls.gov/emp/ep_table_102.htm)

National Science Foundation NCSES (www.nsf.gov/statistics/nsf13327/pdf/tab26.pdf,tab33.pdf,tab34.pdf,tab35.pdf,tab46.pdf)

Computing is Consistently Ranked Among the Best Occupations

CS-Related Jobs Highlighted in Red



CS Careers Rank Highly In:

- Job satisfaction
- Salary
- Work/life balance
- Growth potential
- Employment rate
- Work environment

Computer science tops list of best major for jobs

BY RACHEL GOTTFRIED

Computer science graduates now get more offers of employment than any other major. This is the first time since 2008 that computer science has topped the list; previously, accounting majors had the highest offer rate.

In 2011, 56.2% of computer science majors received job offers, compared to only 53.8% of accounting majors. The offer rate for computer science majors increased 13.8% this year from the previous year.

Computer science and accounting majors are in high demand because both are needed in a wide range of industries.



Architects
J.M.

...many different companies ... need to hire computer scientists.
They aren't tied to one particular industry.

"There are many different companies that need to hire computer scientists," said Mimi Collins, director of communications at the National Association of Colleges and Employers.

"They aren't tied to one particular industry—majors like nursing do not enjoy that benefit."

Although this is good news for computer science grads, it might not be for the computer industry. According to Collins, "One computer science graduate may have 10 offers as opposed to one accounting graduate that's getting five offers." So, computer science majors may be getting more offers, but this is only because there is a shortage of people who graduate with such a degree.

According to Collins, companies like to hire recent graduates because they have the latest skills.

"Things change very quickly, especially in computer science," said Collins. "Many organizations have a formal track where they want to bring in new college graduates and train them the way they want them to be trained."

Annabelle Evans graduated as a computer science major from the University of Southern California in 2008. "When I picked my major, I knew there wouldn't be a lack of jobs as a computer scientist, and that was part of the appeal," she said. Evans now works at Google.

Administrivia

Overview

CIS 110: Introduction to Programming and Computer Science

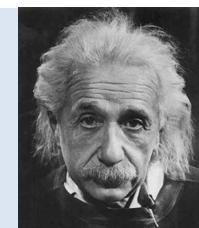
Goals:

- How can we use computers to solve problems?
- How can we formulate problems so that we can solve them via computation?

Topics:

- **Programming** in Java
- Computer organization and assembly language
- **Applications** to science, engineering, and art

“Computers are incredibly fast, accurate, and stupid; humans are incredibly slow, inaccurate, and brilliant; together they are powerful beyond imagination.” – Albert Einstein



The Basics

Instructor: Adam Mally

- Adam's Regular Office Hours: Thursdays and Fridays 3pm to 4pm EDT
- Please do not email; post a private message to Piazza instead with a subject starting with “[PROF]”

TA Office Hours:

- Help with debugging
- Bring your laptop or use lab computers
- All office hours are posted on Piazza and the course web site
- Enter the office hours queue here
 - Put a link to your own Zoom meeting room in the Topic section
- Only use Piazza, office hours, or email to contact your TAs

Full details: www.cis110.com

Grading

Grade Breakdown:

Homeworks: 60%

Exam 1: 15%

Exam 2: 15%

Attendance/Record Viewing: 10%

Exam 1: Thursday June 11 on Canvas

Exam 2: Wednesday July 1 on Canvas

Notes:

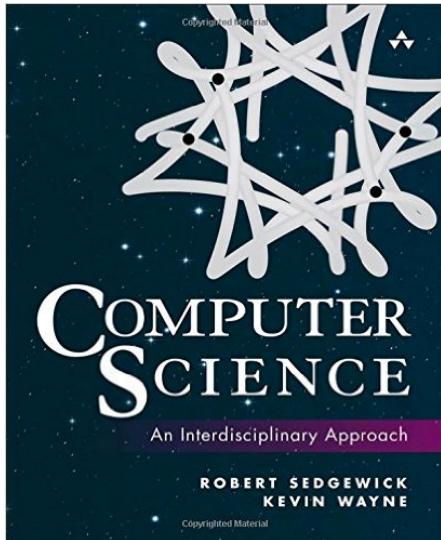
- You can check your grades on GradeScope

Course Materials

Course Website: www.cis110.com

- Programming assignments and checklists
- Assignment submission & grades
- Lecture slides
- Discussion board (Piazza)

Textbook: Sedgewick and Wayne



skim before lecture;
read thoroughly afterwards

Homework Programming Assignments

Due: 11:59pm on Monday/Tuesday nights on GradeScope

- ◆ 4 late days to use throughout semester (max 2 per homework)
- ◆ No other late submissions allowed
- ◆ See course webpage for other policies

Computing equipment:

- Your desktop/laptop
- Setting up the software will be described in HW0

Advice

- ◆ Start on HWs early! Debugging can take time.
- ◆ Back up your work like crazy.
- ◆ Office hours are less crowded if you attend shortly after assignments are released
- ◆ Do not hesitate to ask for help. If you have been trying to debug something for an hour and are getting frustrated, remember that we are there to help you.
- ◆ Your best sources for help are the instructors, the TAs and Piazza.
- ◆ Please read and follow the collaboration policy
- ◆ Do not use Stack Overflow or other online discussion boards

Getting Started in Java

CIS 110

Your First Program

A screenshot of an Integrated Development Environment (IDE) showing a Java file named `HelloWorld.java`. The code contains a simple `Hello World` application. The IDE has a toolbar with standard file operations like New, Open, Save, Cut, Copy, Paste, Undo, Redo, Find, Compile, Reset, Run, Test, and Javadoc. Below the toolbar is a code editor window displaying the following Java code:

```
1 public class HelloWorld {  
2     public static void main(String[] args) {  
3         System.out.println("Hello, World");  
4     }  
5 }  
6
```

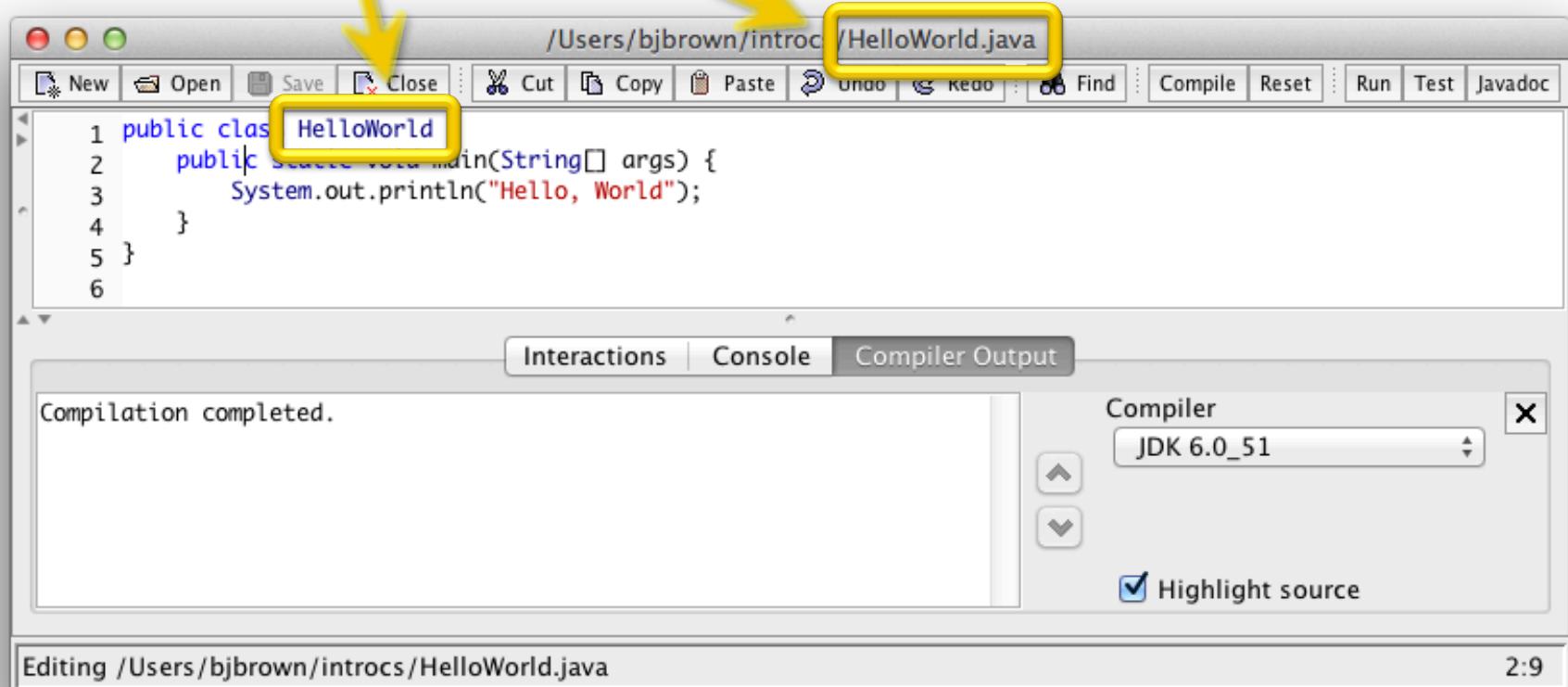
Below the code editor is a tab bar with three tabs: Interactions, Console, and Compiler Output. The Compiler Output tab is selected and shows the message "Compilation completed.". To the right of the code editor is a panel titled "Compiler" which specifies "JDK 6.0_51". There is also a checked checkbox labeled "Highlight source". At the bottom of the IDE window, it says "Editing /Users/bjbrown/introcs/HelloWorld.java" and the time "2:9".



Section 1.1

Your First Program

Program Name



```
1 public class HelloWorld
2     public static void main(String[] args) {
3         System.out.println("Hello, World");
4     }
5 }
6
```

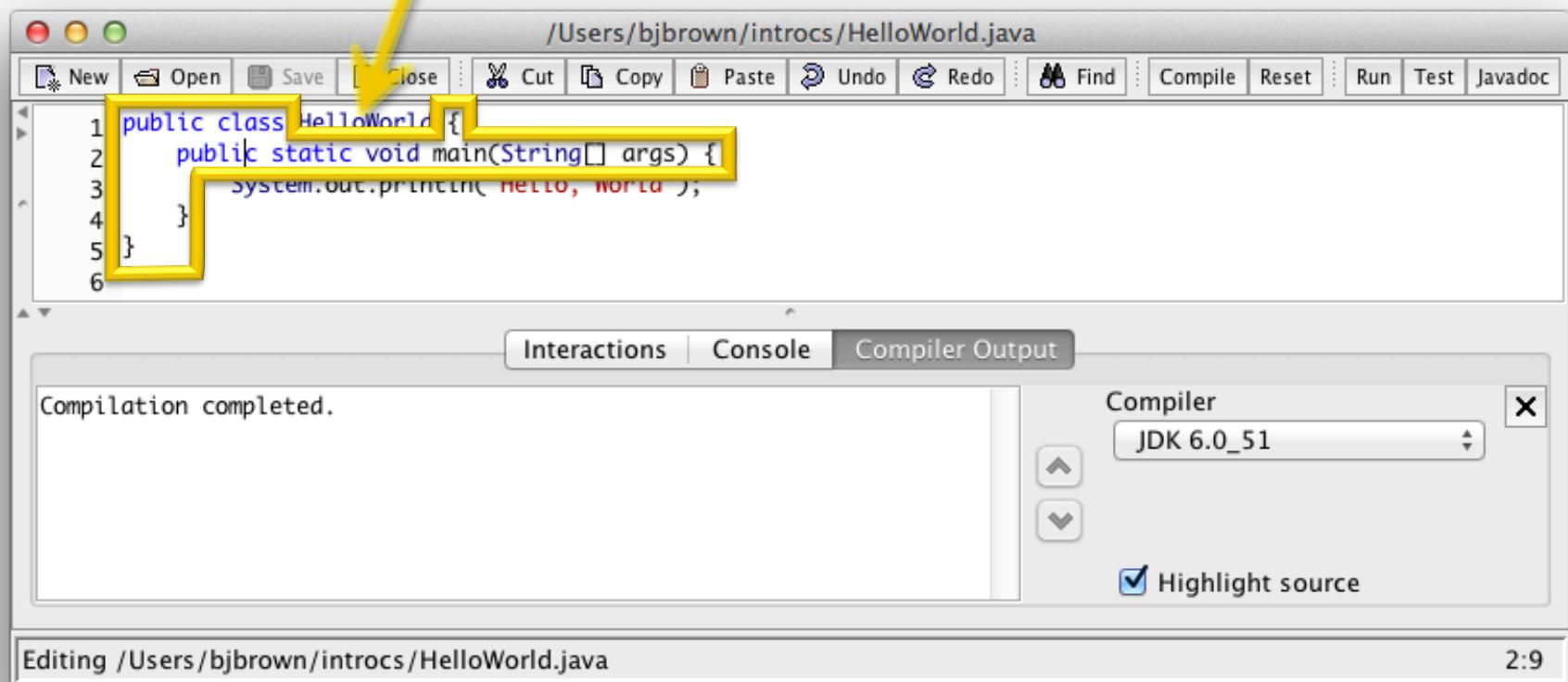
The screenshot shows a Java code editor window. The title bar displays the path "/Users/bjbrown/introcs/" followed by the file name "HelloWorld.java". The file content is a simple Java program named "HelloWorld" that prints "Hello, World" to the console. Two yellow arrows point from the "Program Name" text above to the class name "HelloWorld" in the code and the file name "HelloWorld.java" in the title bar. The code editor interface includes a toolbar with standard file operations like New, Open, Save, Close, Cut, Copy, Paste, Undo, Redo, Find, Compile, Reset, Run, Test, and Javadoc. Below the code editor are tabs for Interactions, Console, and Compiler Output, with the Compiler tab selected. A status bar at the bottom indicates "Editing /Users/bjbrown/introcs/HelloWorld.java" and the time "2:9". On the right side, there is a Compiler settings panel showing "JDK 6.0_51" and a checked checkbox for "Highlight source".



Section 1.1

Your First Program

Scaffolding



```
public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello, World");
    }
}
```

The screenshot shows a Java code editor window titled "/Users/bjbrown/introcs/HelloWorld.java". The code in the editor is:

```
public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello, World");
    }
}
```

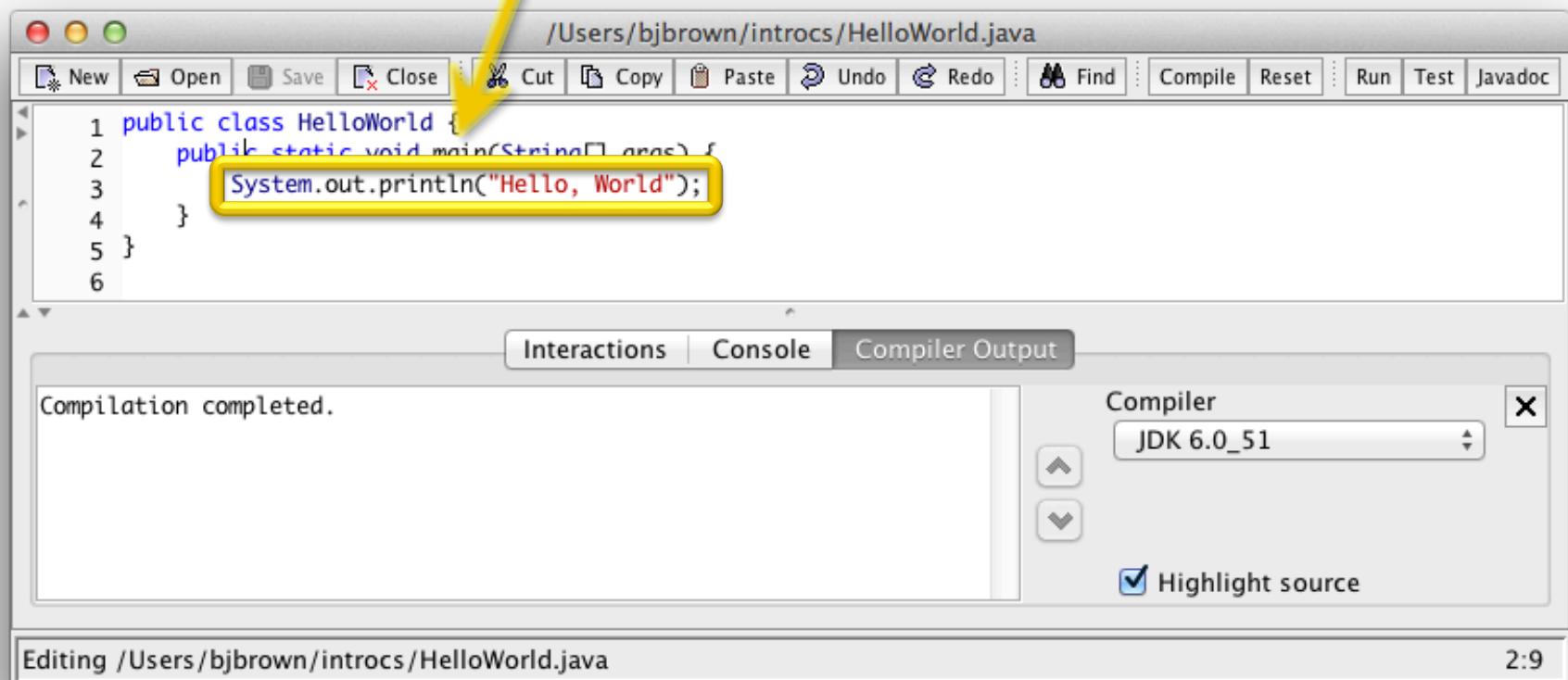
The first two lines of the code are highlighted with a yellow box and a yellow arrow points from the word "Scaffolding" to these lines. Below the editor, there are tabs for "Interactions", "Console", and "Compiler Output". The "Compiler Output" tab shows the message "Compilation completed.". To the right of the editor, there is a "Compiler" dropdown set to "JDK 6.0_51" and a checked checkbox for "Highlight source". At the bottom of the window, it says "Editing /Users/bjbrown/introcs/HelloWorld.java" and has a timestamp "2:9".



Section 1.1

Your First Program

Print the text "Hello, World".



A screenshot of a Java IDE interface. The title bar shows the file path: /Users/bjbrown/introcs/HelloWorld.java. The menu bar includes New, Open, Save, Close, Cut, Copy, Paste, Undo, Redo, Find, Compile, Reset, Run, Test, and Javadoc. The main editor window contains the following Java code:

```
1 public class HelloWorld {  
2     public static void main(String[] args) {  
3         System.out.println("Hello, World");  
4     }  
5 }  
6
```

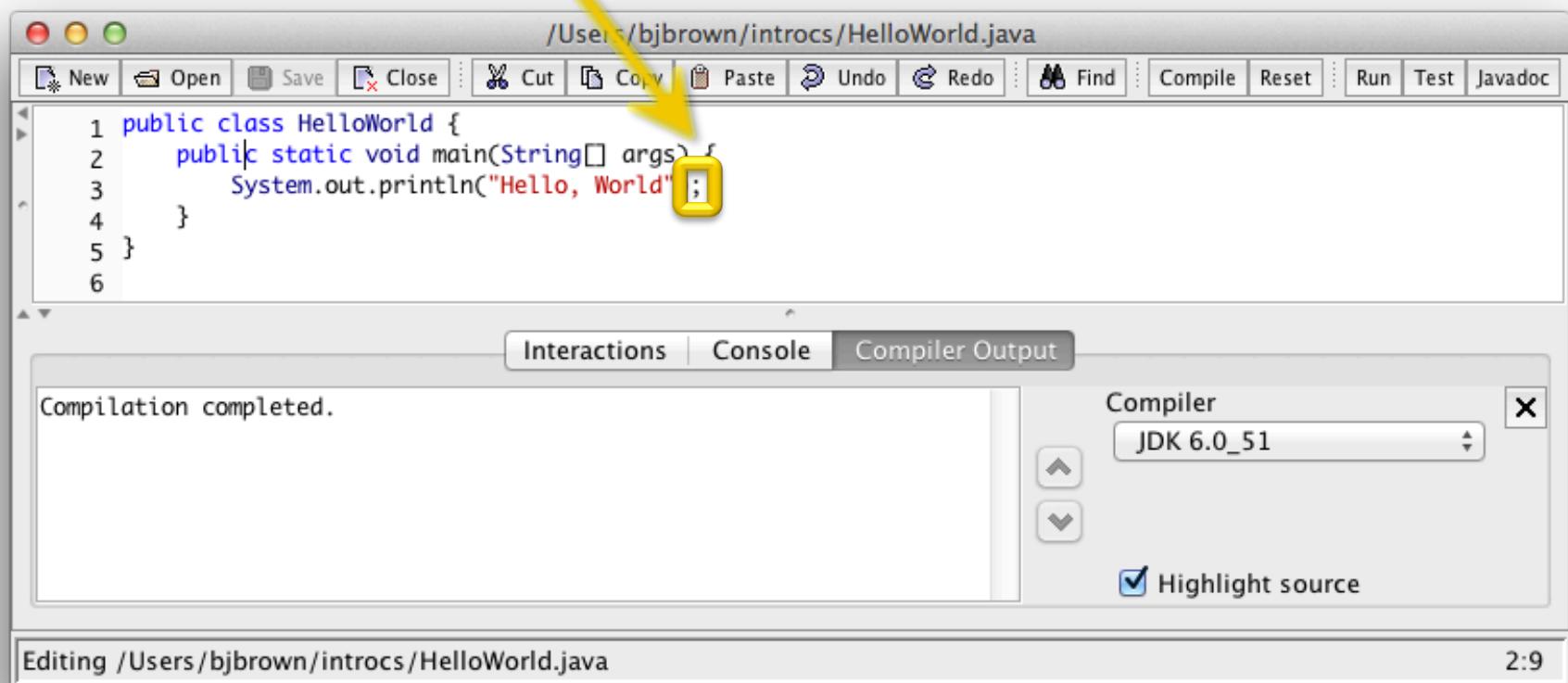
A yellow arrow points to the line `System.out.println("Hello, World");`. Below the editor, there are tabs for Interactions, Console, and Compiler Output. The Compiler tab is selected, showing "JDK 6.0_51" and a checked checkbox for "Highlight source". The status bar at the bottom indicates "Editing /Users/bjbrown/introcs/HelloWorld.java" and the time "2:9".



Section 1.1

Your First Program

Statements end with a ;



A screenshot of an IDE interface showing the Java code for a "HelloWorld" program. The code is as follows:

```
1 public class HelloWorld {  
2     public static void main(String[] args) {  
3         System.out.println("Hello, World");  
4     }  
5 }  
6
```

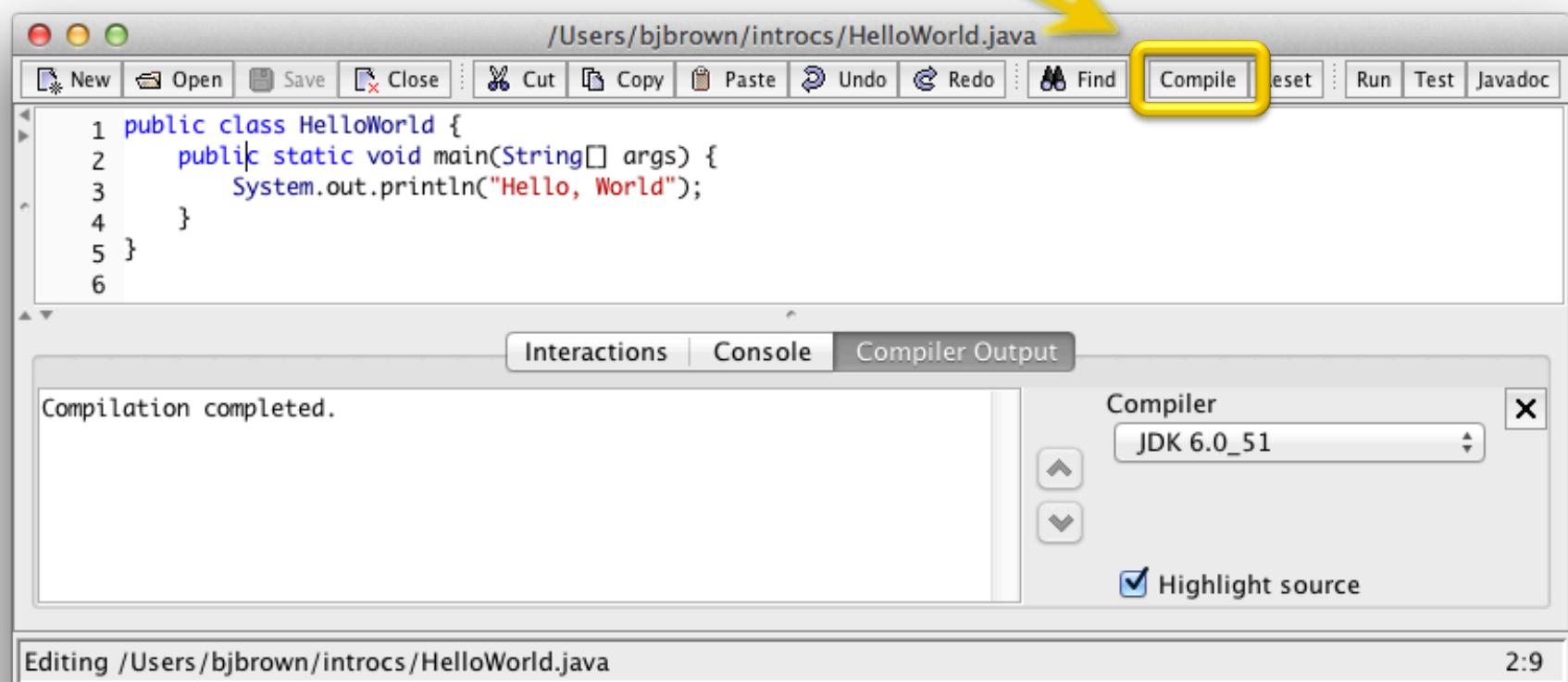
A yellow arrow points to the closing brace of the main method, which is highlighted with a yellow box. Below the code editor, there are tabs for "Interactions", "Console", and "Compiler Output". The "Compiler Output" tab shows the message "Compilation completed.". To the right of the code editor, there is a panel titled "Compiler" with a dropdown menu set to "JDK 6.0_51" and a checked checkbox for "Highlight source". At the bottom of the IDE window, it says "Editing /Users/bjbrown/introcs/HelloWorld.java" and the time "2:9".



Section 1.1

Your First Program

**Compile to translate
to machine code**



A screenshot of an IDE interface. The title bar shows the file path: /Users/bjbrown/introcs/HelloWorld.java. The menu bar includes New, Open, Save, Close, Cut, Copy, Paste, Undo, Redo, Find, Compile, Reset, Run, Test, and Javadoc. A yellow arrow points to the 'Compile' button in the menu bar. The code editor displays the following Java code:

```
1 public class HelloWorld {  
2     public static void main(String[] args) {  
3         System.out.println("Hello, World");  
4     }  
5 }  
6
```

The bottom left of the interface shows the message "Compilation completed." The bottom right contains a "Compiler" dropdown set to "JDK 6.0_51" and a checked checkbox for "Highlight source". The status bar at the bottom indicates "Editing /Users/bjbrown/introcs/HelloWorld.java" and the time "2:9".



Section 1.1

Your First Program

Run the compiled program

The screenshot shows the DrJava IDE interface. At the top, the title bar displays the file path: /Users/bjbrown/introcs/HelloWorld.java. Below the title bar is a menu bar with standard options: New, Open, Save, Close, Cut, Copy, Paste, Undo, Redo, Find, Compile, Reset, Run, Test, and Javadoc. The 'Run' button is highlighted with a yellow box and an arrow pointing to it from the text above. The main workspace contains the Java code for 'HelloWorld':

```
1 public class HelloWorld {  
2     public static void main(String[] args) {  
3         System.out.println("Hello, World");  
4     }  
5 }  
6
```

Below the code, there is a tab bar with three tabs: 'Interactions' (which is highlighted with a yellow box), 'Console', and 'Compiler Output'. The 'Interactions' tab displays the following session:

```
Welcome to DrJava. Working directory is /Users/bjbrown/introcs  
> run HelloWorld  
Hello, World  
>
```

At the bottom of the window, a status bar shows the message "Running main Method of Current Document" and the time "2:9".



Section 1.1

Why Java?



Java

```
public class Hello_World {  
    public static void main(String[] args) {  
        System.out.println("Hello, World.");  
    }  
}
```



C/C++

```
#include <stdio.h>  
  
int main(int argc, char** argv) {  
    printf("Hello, World.\n");  
    return 0;  
}
```



Matlab

```
disp('Hello, World.)
```



JavaScript

```
document.write("Hello, World.");
```



Fortran

```
PROGRAM HELLO  
PRINT *, 'Hello, World.'  
END
```



OCaml

```
print_endline "Hello, World."
```



Lisp

```
(princ "Hello, World.")
```



sh

```
echo Hello, World.
```



Logo

```
print [Hello, World.]
```

"There are only two kinds of [programming] languages: the ones people complain about and the ones nobody uses." - Bjarne Stroustrup

Java is:

- Widely used
- Practical for many problems
- Includes most modern language abstractions



x86 Assembly

```
.model tiny  
.code  
.org 100h  
  
main proc  
    mov    ah,9  
    mov    dx,offset hello_message  
    int    21h  
    retn  
  
hello_message db 'Hello, world.$'  
main endp  
end main
```

Your computer
speaks this

Computational Art

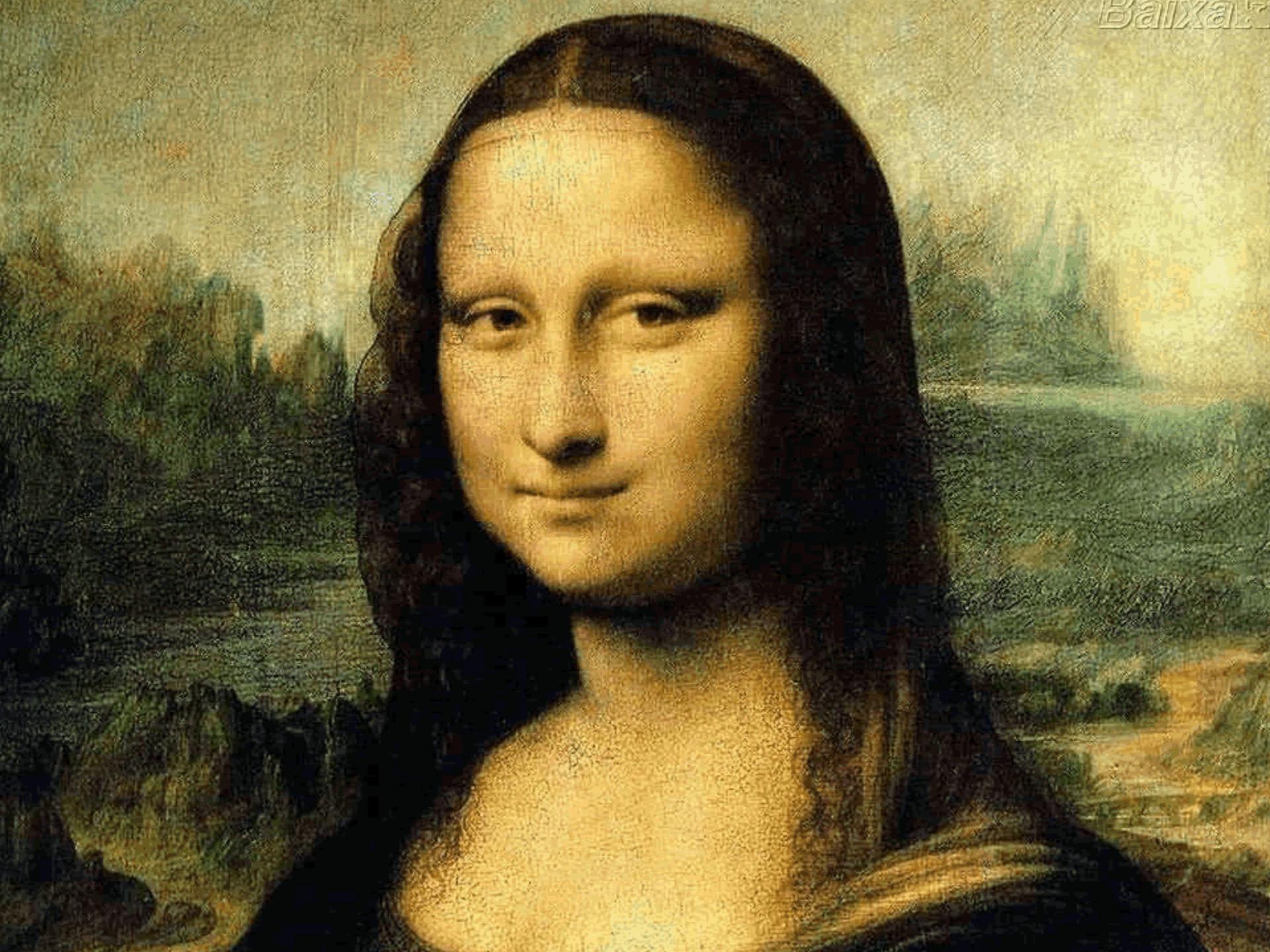
Examples

Protopypes by Ira Greenberg



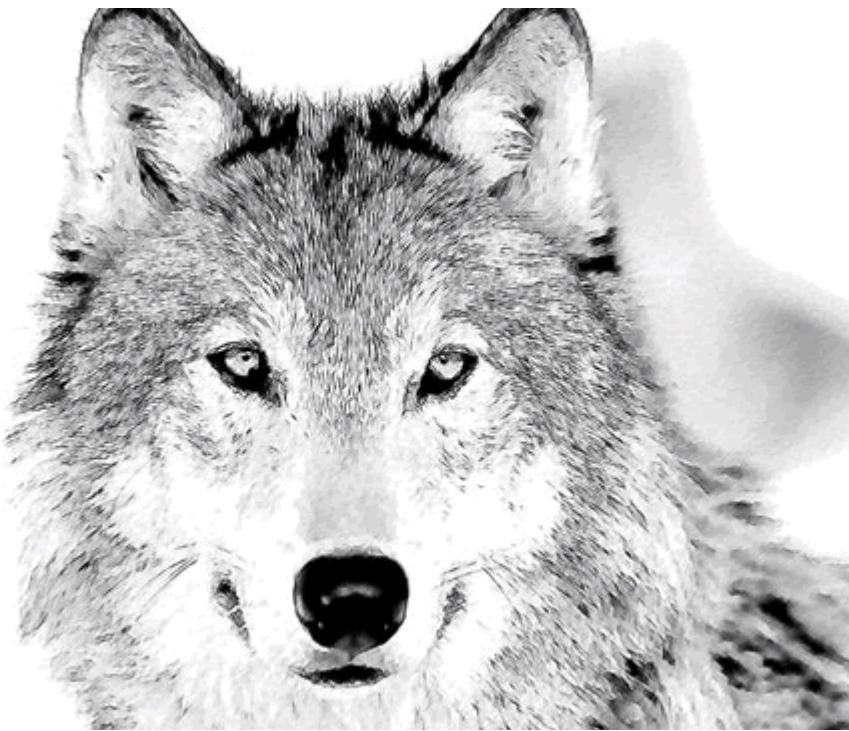
Shepard Fairey



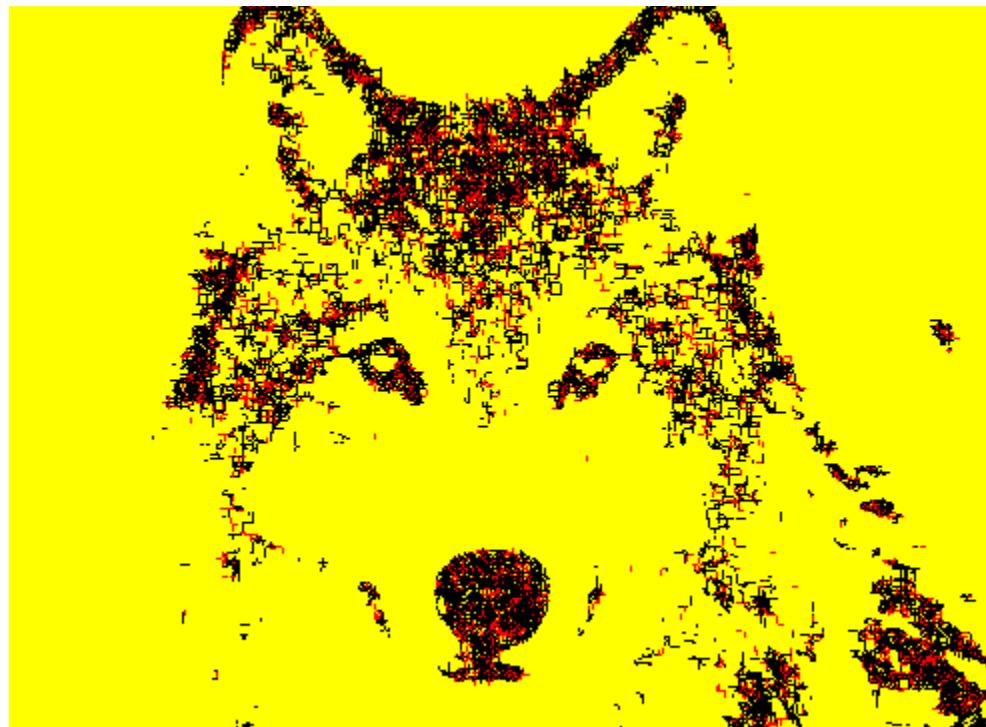


Balkan





Abstract Art



Procedural Art



More Procedural Art

 **MATHEMATICA**
& Wolfram Language

Home Questions Tags Users Unanswered

How do I draw a pair of buttocks?

Asked 5 years, 6 months ago Active 3 years, 11 months ago Viewed 146k times

287 I'm trying to develop a function which 3D plot would have a buttocks like shape.

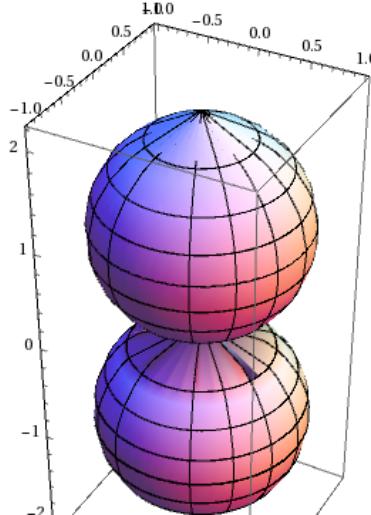
Several days of searching the web and a dozen my of own attempts to solve the issue have brought nothing but two pitiful formulas below.

They have some resemblance to the shape I want, though not quite.

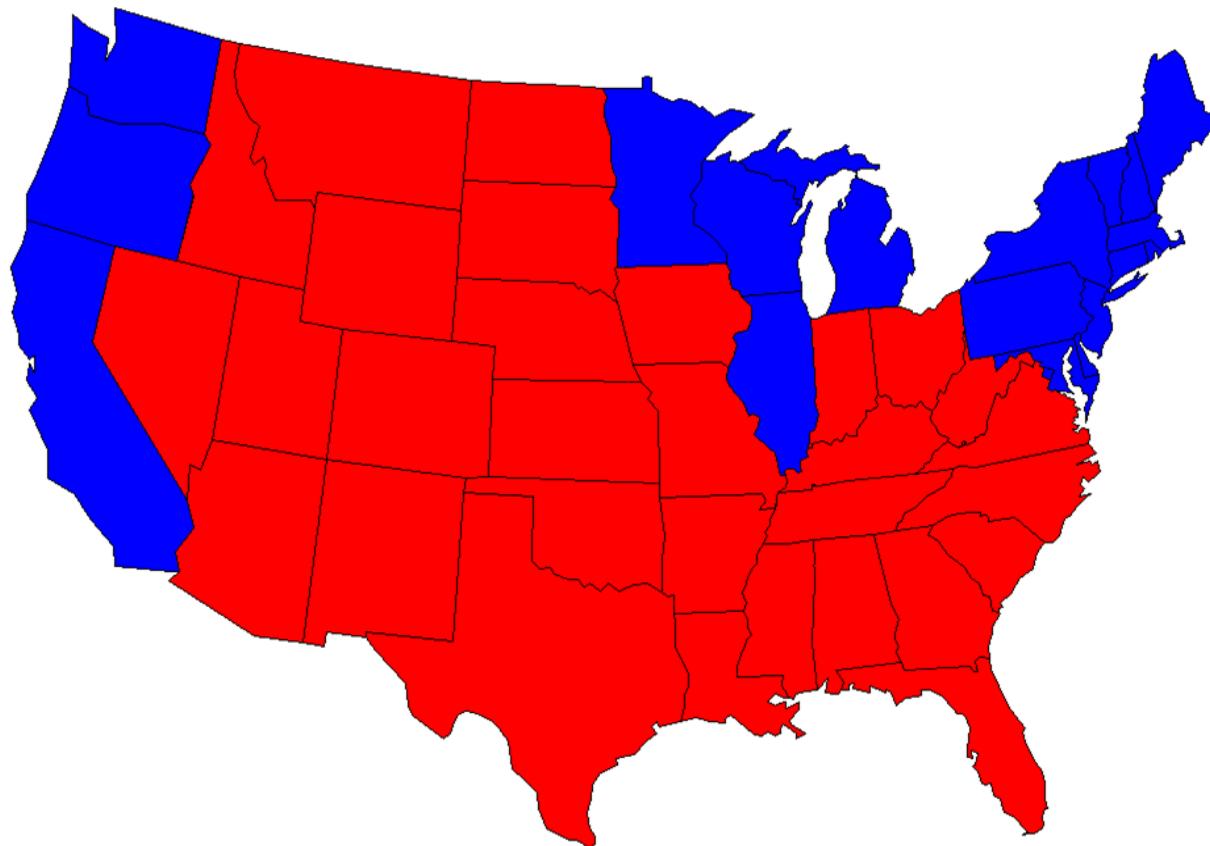
157 Could you help me to obtain a proper formula?

Here are those bad solutions I've got myself:

```
ParametricPlot3D[{Sin[y] Sqrt[1 - (Abs[x] - 1)^2],  
Cos[y] Sqrt[1 - (Abs[x] - 1)^2], x}, {x, -10, 10}, {y, -3 Pi, 3 Pi},  
AspectRatio -> Automatic]
```



Red & Blue States



Summertime

Summertime,
And the livin' is easy
Fish are jumpin'
And the cotton is high

Your daddy's rich
And your mamma's good lookin'
So hush little baby
Don't you cry

One of these mornings
You're going to rise up singing
Then you'll spread your wings
And you'll take to the sky

But till that morning
There's a'nothing can harm you
With daddy and mamma standing by

Summertime,
And the livin' is easy
Fish are jumpin'
And the cotton is high

Your daddy's rich
And your mamma's good lookin'
So hush little baby
Don't you cry

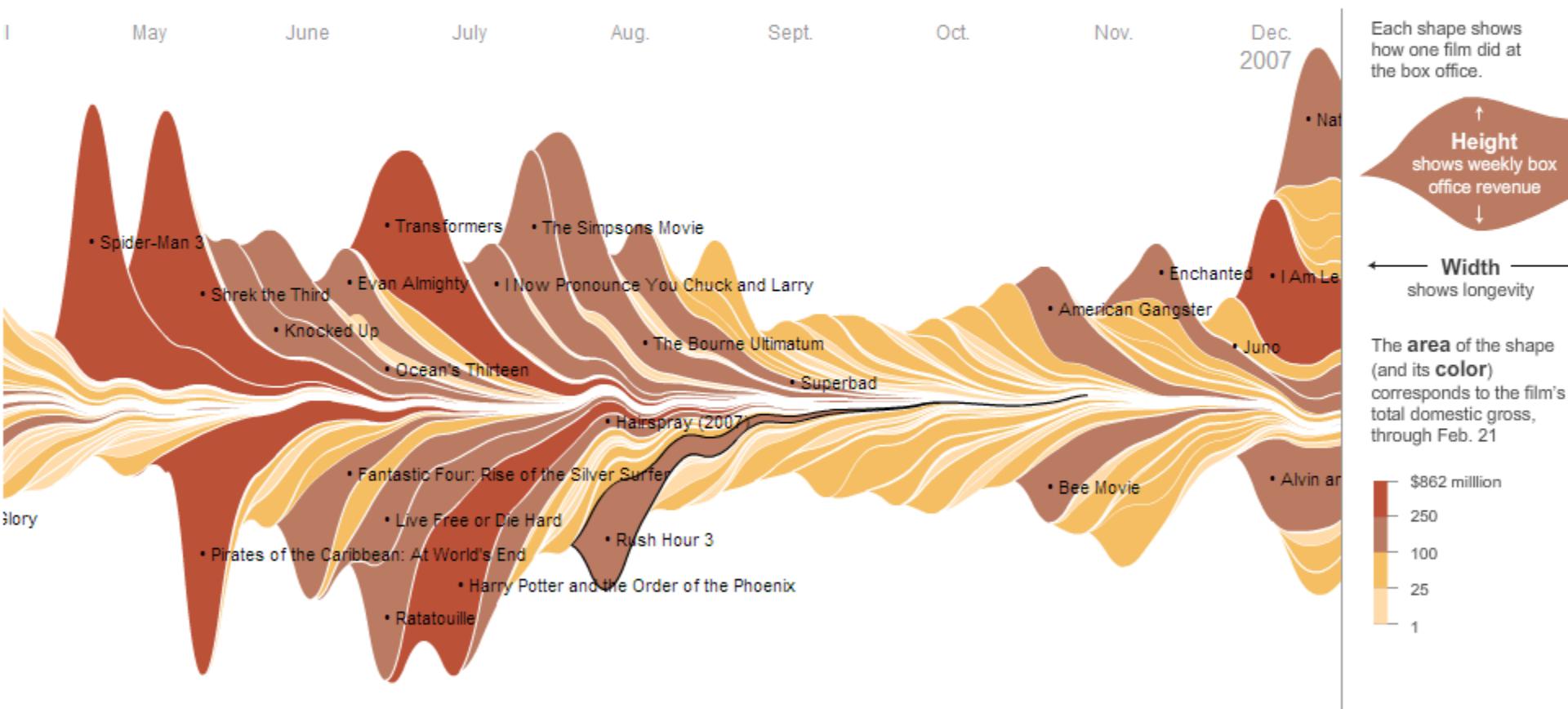
Word Cloud



Created using: wordle.net



Box Office Earnings



From: The Ebb and Flow of Movies: Box Office Receipts 1986 — 2008
nytimes.com
February 23, 2008

Drawing in Java Using the PennDraw Library: MyHouse.java

CIS 110

Explanatory Comment

```
10 public class MyMouse {  
11     public static void main(String[] args) {  
12         // set the size of the window to 500 pixels by 500 pixels  
13         PennDraw.setCanvasSize(500, 500);  
14  
15         PennDraw.clear(PennDraw.BLUE); // draw a blue sky
```

Your Textbook: Replace
StdDraw with **PennDraw**

PennDraw is “StdDraw 2.0”

Set Window Size

```
10 public class MyHouse {  
11     public static void main(String[] args) {  
12         // set the size of the window to 500 pixels by 500 pixels  
13         PennDraw.setCanvasSize(500, 500);  
14  
15         PennDraw.clear(PennDraw.BLUE); // draw a blue sky
```

Color the entire window blue

```
10 public class MyHouse {  
11     public static void main(String[] args) {  
12         // set the size of the window to 500 pixels by 500 pixels  
13         PennDraw.setCanvasSize(500, 500);  
14  
15         PennDraw.clear(PennDraw.BLUE); // draw a blue sky
```

Comment indicates *purpose*

Can replace BLUE with BLACK, CYAN, DARK_GRAY,
GRAY, GREEN, LIGHT_GRAY, MAGENTA, ORANGE,
PINK, RED, WHITE, or YELLOW

Color the entire window blue

```
10 public class MyHouse {  
11     public static void main(String[] args) {  
12         // set the size of the window to 500 pixels by 500 pixels  
13         PennDraw.setCanvasSize(500, 500);  
14  
15         PennDraw.clear(PennDraw.BLUE); // draw a blue sky
```

Comment indicates *purpose*

Set the color to grass green

17
18
19

```
// draw a green field
PennDraw.setPenColor(0, 170, 0);
PennDraw.filledRectangle(0.5, 0.25, 0.6, 0.3);
```

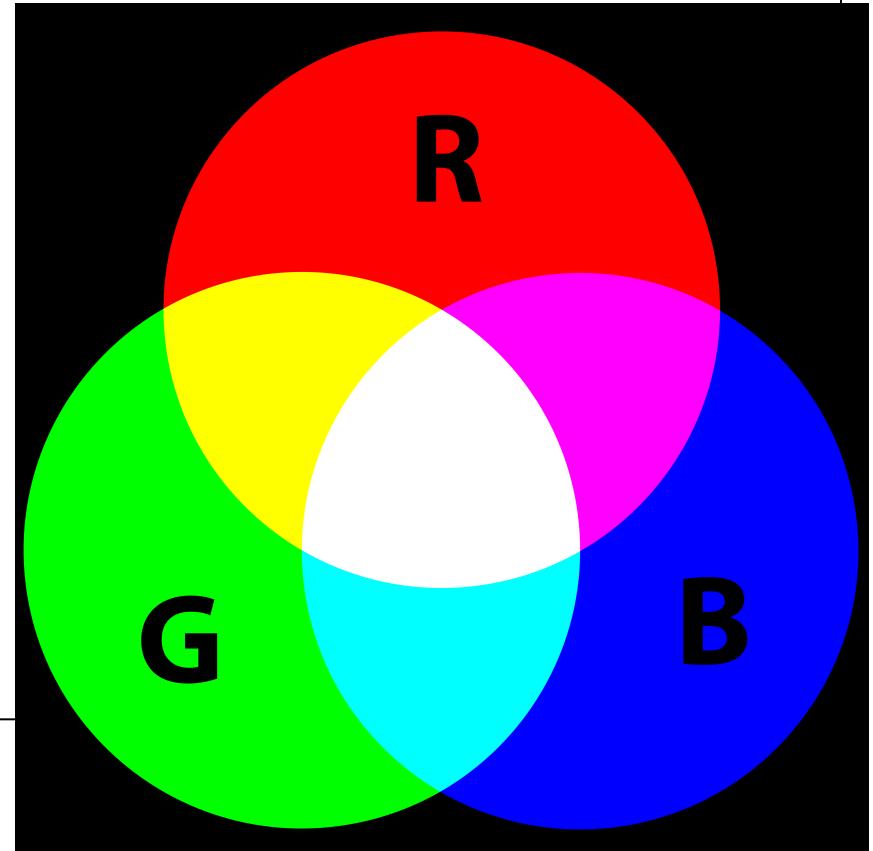


Colors

Composed of three elements:

1. Red
2. Green
3. Blue

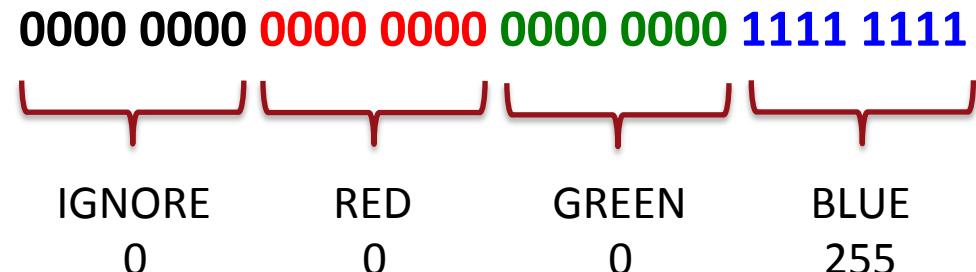
Values from 0 .. 255



Why 0 ... 255?

Decimal	Binary
0	00000000
1	00000001
2	00000010
3	00000011
4	00000100
5	00000101
6	00000110
7	00000111
8	00001000
9	00001001
10	00001010
11	00001011
12	00001100
13	00001101
14	00001110
15	00001111
16	00010000
17	00010001
18	00010010
...	...
255	11111111

Each color is represented by 32 bits:



Notice there are 8 bits per color component.

The maximum value (all 1's) that can be represented in 8 bits is 255 in decimal.

Therefore, the range for each color component is 0 (off) ... 255 (full).

Set the color to grass green

17
18
19

```
// draw a green field
PennDraw.setPenColor(0, 170, 0);
PennDraw.filledRectangle(0.5, 0.25, 0.6, 0.3);
```



Solid rectangle

17
18
19

```
// draw a green field
PennDraw.setPenColor(0, 170, 0);
PennDraw.filledRectangle(0.5, 0.25, 0.6, 0.3);
```

17
18
19

```
// draw a green field
PennDraw.setPenColor(0, 170, 0);
PennDraw.filledRectangle(0.5, 0.25, 0.6, 0.3)
```

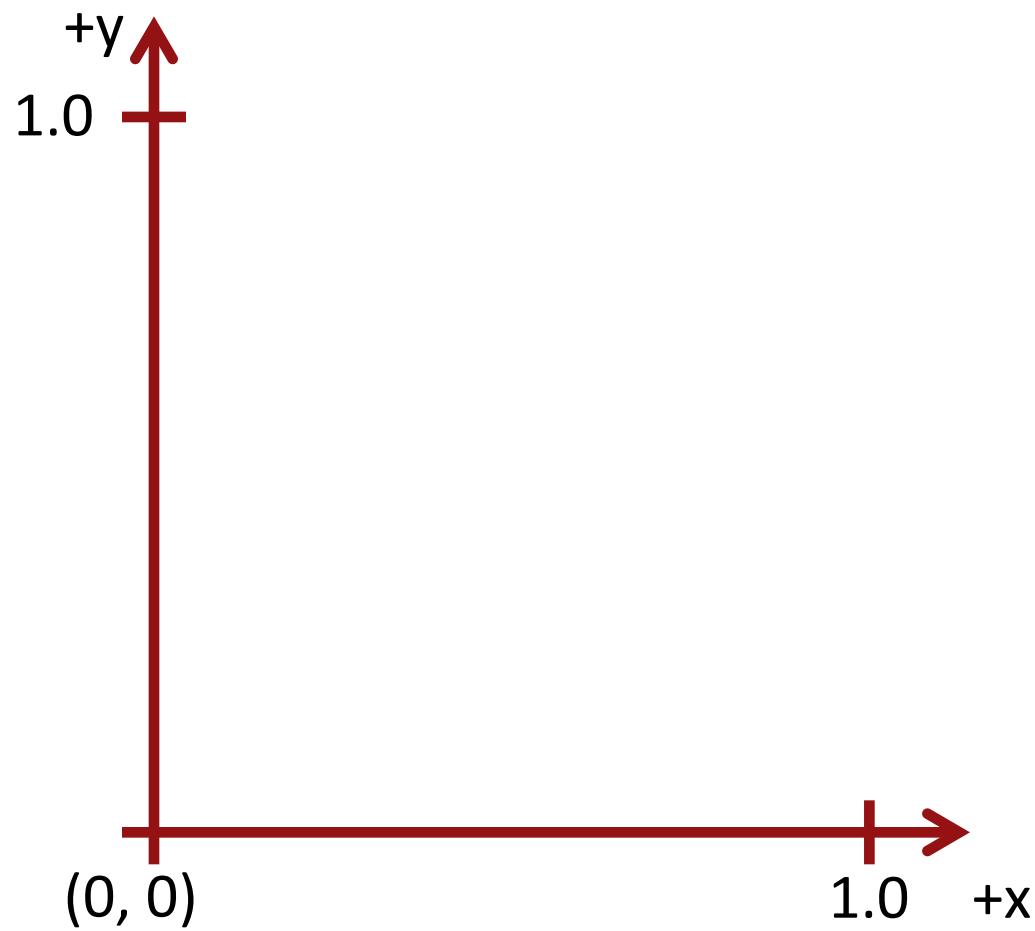
y center

half height

x center

half width

Coordinate System



Draw a solid triangle with corners
at (0.255, 0.7), (0.745, 0.7), (0.49, 0.9)



23

```
PennDraw.filledPolygon(0.255, 0.7, 0.745, 0.7, 0.49, 0.9);
```

Set line thickness (default is 0.002)



26

```
PennDraw.setPenRadius(0.005); // thicken the pen for outline drawing
```

Draw a rectangle outline



34

```
PennDraw.rectangle(250 / 500.0, 260 / 500.0, 120 / 500.0, 90 / 500.0);
```