THERE IS ROOM IN THE BALCONY!

Romeo, Romeo, where art thou!

Up in the balcony, where it's cheaper!

CS/ENGRD 2110 SPRING 2017

Lecture 1: Overview and intro to types

http://courses.cs.cornell.edu/cs2110/2017sp

Welcome to CS2110!

OO Programming and Data Structures

382 Freshmen

138 Sophomores

049 Juniors

045 Seniors

036 Meng/Masters

023 Graduate PhD

003 Continuing Education

676 Total

As of Wed morn, 25 Jan

Instructors:
David Gries, Scott Wehrwein

Recitation leaders (Tas): 23

Consultants: 19

Letter grade: 674

S/U grade: 12

Welcome to CS2110!

Learning about:

- OO, abstract data types, generics, Java Collections, …
- Reasoning about complex problems, analyzing algorithms we create to solve them, and implementing algorithms with elegant, easy-to-understand, correct code
- Testing; Reasoning about correctness
- Data structures: linked lists, trees, hash tables, graphs, etc.
- Recursion
- Algorithmic complexity
- Parallelism —threads of execution

Usefulness of 2110

This summer I'm working in particle physics, making simulations of some of the background signal we'd expect to see in our detector for an experiment run in the particle accelerator. What I'm working on a clustering algorithm to put together energy depositions from several quantized points in the detector to learn what the initial particle's energy and position was. After some thought, I decided the best first sweep over this data would be to do a depth first search starting about a high energy deposition in the calorimeter. It works great, and my PI was very excited about the results!

Usefulness of 2110

I am working at a startup in Silicon Valley this summer … that does subscription-based financial management and billing among other things. It has been pretty incredible the amount I've learned from your class that relates to this internship and I have definitely decided to pursue computer science (I was initially engineering physics).

Is CS2110 right for you?

- Knowledge of Java not required
  - Only ~30% of you know Java –others know Matlab, Python …
  - Requirement: comfort with some programming language, on the level of CS1110 (Python based) and CS1112 (Matlab based).

    Prior knowledge of OO not required.
  - We assume you do not know Java!
  - If you know Java, the first 3 weeks will be easier for you but you STILL have to learn things, probably unlearn what you learned

Homework!

Homework 1. Read article Why Software is So Bad.
Link: Course website -> Lectures notes (Lecture 1)
Homework 2. Get Java, Eclipse, DrJava on your computer.
Homework 3. Spend some time perusing the course website.
Look at course information, resources, links, etc.

Homework 4. BEFORE EACH LECTURE/RECITATION:
download pdf form of the slides, bring to class and look at them during lecture. We project not only PPT but also Eclipse and other things. Having PPT slides in paper form or on your laptop/tablet can help you during the lecture.

Lectures

- TR 10:10-11am, Statler auditorium
  - Attendance mandatory

- ENGRD 2110 or CS 2110?
  - **Same course!** We call it CS 2110 in online materials
  - Non-engineers sign up for CS 2110
  - Engineers should sign up for ENGRD 2110

Sections (Recitations)

T 12:20	4 sections:
T 1:25	3 sections:
T 2:30	2 sections:
T 3:35	2 section:
W 12:20	3 sections:
W 01:25	3 sections:
W 02:30	2 sections:
W 07:30	1 section:

Some time EARLY, visit StudentCenter and change your section to even out the numbers

- Attendance mandatory
- Sometimes flipped: you watch videos beforehand, come to recitation and do something
- Sometimes review, help on homework, new material
- No permission needed to switch sections, but do register for whichever one you attend

CS2111

- An “enrichment” course
- Help students who might feel overwhelmed by CS2110
- Gives more explanation of core ideas behind Java, programming, data structures, assignments, etc.
- Taught by Gries and Wehrwein, 1 credit S/U
- Only for students who also take CS2110
- Only requirement: Attend weekly lecture

I would just like to thank you for taking the time to hold CS2111 this year. You have no idea how the class helped and impacted a lot of us. I would never had "survived" CS2110 without your generous share of your knowledge. I appreciated your time.

Academic Excellence Workshops

- Two-hour labs: students work together in cooperative setting
- *One credit S/U course based on attendance*
- Time and location TBA
- Visit Olin 167 and ask about AEWs
- See website for more info:

www.engineering.cornell.edu/academics/undergraduate/curriculum/courses/workshops/index.cfm

Piazza

- Click link on our “links” web page to register
- Incredible resource for 24 x 7 help with anything
- We keep an eye on it and answer questions. YOU can (and will) too. Visit the Piazza often.

Resources

- Book: Frank M. Carrano, *Data Structures and Abstractions with Java, 3rd ed., Prentice Hall. It is OPTIONAL!*
  - *2nd edition is okay. E-book not required*
  - Share textbook. Need access to it from time to time
  - Copies on reserve in Engr Library
- PPT slides (on course website and Piazza) outline all of OO in Java. Has index at beginning
- Great Java resource: online materials at Oracle JDK web site.
- VideoNote: videos of lectures from Fall 2015. http://www.videonote.com/cornell. Log in with netid

Obtaining Java and Eclipse

- Follow instructions on our Resources web page
  - Make sure you have Java JDK 1.8, if not download and install. We explain how on the web page.
  - Then download and install the Eclipse IDE
- Test it out: launch Eclipse and click "new>Java Project"
  - This is one of a few ways Java can be used
  - When program runs, output is visible in a little console window

DrJava IDE

- IDE: Integrated Development Environment
- DrJava is a much simpler IDE, few features
- We use it **only** to demo Java features and programming concepts. Has an "interactions pane", which allows trying things without requiring a complete Java program. Great tool!
- DON'T use it for course assignments –use Eclipse
- Free at www.drjava.org. Download the jar file, *not* the app!!!

Coursework

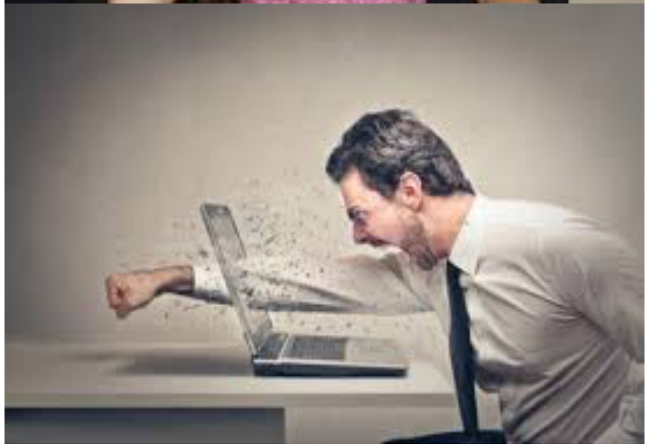
- 7–8 programming assignments (37%)
- Two prelims (14% – 16%)
- Final exam (30%)
- Course evaluation (1%)
- Work in recitations (1-3%)

Formula will change as course progresses and we make changes in assignments, give quizzes, etc.

Exams are most important aspect in determining final grade

Assignments: a real learning experience

- Teams of one or two
  - A0 and then A1 will be posted soon on the CMS
  - Finding a partner: choose your own or contact your TA. Piazza can be helpfu'



One way to do
an assignment:
Wait until the day
before it is due.
Result: Frustration, anger,
impatience, long lines in
consulting room. No fun.
Not a good educational experience

Assignments: a real learning experience

One way to do an assignment:
Read the handout immediately.
Work on it every (other) day.
Ponder. Look things up. Get help in consulting room, with no lines, or office hours. Fun, hard work, a great learning experience

Piano lessons:
Practice Daily?
Or put off practicing until an hour before weekly lesson?

Academic Integrity… Trust but verify!

- 98% of you are honest and don’t try to cheat
- We use artificial intelligence tools to check each homework assignment, so catch the other 2%
  - The software is accurate!
  - It tests your code and notices similarities between code written by different people
- Sure, you can fool this software
  - … but it’s easier to just do the assignments
  - … and if you try to fool it and screw up, you might fail the assignment or even the whole course.

Types in Java

References in text and in JavaSummary

type: A.14 slide 4

variable: A.13 slide 7

variable declaration: A.15 slide 7

Primitive types, A.16, back inside cover slide 5

Constants, A.17 slide 20

Assignment, A.18-A.20 slide 8

Casting, A.21 slide 6

Expressions: A.22-A.23

Precedences: A.24, back inside cover

Unicode character codes, back inside cover

Type: Set of values
together with operations on them.

Type integer:

values: …, –3, –2, –1, 0, 1, 2, 3, …

operations: +, –, *, /, unary –

God's integers!
Can represent them in many ways — decimal, binary, octal, maybe as strokes | | | | (that's 4)

Do you know how your computer represents them?

The integers as the basis

Leopold Kronecker (1823-1891), Prussian mathematician,

Argued that arithmetic and analysis should be founded on the whole numbers (integers):

Die ganzen Zahlen hat der liebe Gott gemacht, alles andere ist Menschenwerk.

The beloved God made the whole numbers, everything else is the work of man.

He insisted on the constructibility of math objects. Real numbers –do they really exist?

You can't compute most of them because they have an infinite number of digits.

God's integers!

Type: Set of values together with operations on them.

Matlab and Python are **weakly typed**:

One variable can contain at different times a number, a string, an array, etc.

One isn't so concerned with types.

Java **strongly typed**:

A variable must be declared before it is used and can contain only values of the type with which it is declared

Valid Python sequence:

```
x= 100;
x= 'Hello World';
x= (1, 2, 3, 4, 5 );
```

Corresponding Java

```
int x;
x= 100;

x= "Hello";
```

Declaration of x: x can contain only values of type **int**

Illegal assignment: "Hello" is not an **int**

Weakly typed versus strongly typed

Weakly typed:

Shorter programs, generally.

Programmer has more freedom, language is more liberal in applying operations to values.

Strongly typed:

Programmer has to be more disciplined. Declarations provide a place for comments about variables.

More errors caught at compile-time (e.g. it's a syntax error to assign a string to an **int** variable).

Note: weak and strong typing not well defined; literature has several definitions

Type: Set of values
together with operations on them.

Java Type int:

values: -2^{31} .. $2^{31}-1$

operations: +, −, *, /, %, unary −

b % c : *remainder*
when b is divided by c.
67 % 60 = 7

Integer.MAX_VALUE

Java designers decided on this Principle: primitive operations on type **int** should yield an **int.**

what if 2^31 +1: it would return the -2147483648 which
is equal to the Integer.MIN_VALUE

Most-used ‘primitive’ types

Inside back cover, A-6..7

int: values: -2^{31} .. $2^{31}-1$
operations: +, –, *, /, %, unary –

b % c : *remainder*
when b is divided by c.
67 % 60 = 7

double: values like : –22.51E6, 24.9
operations: +, –, *, /, %, unary –

Write values in
“scientific notation”

char: values like : 'V' '$' '\n'
operations: none

Use single quotes for
type char.
'\n' is new-line char

boolean: values: true false
operations: ! (not), && (and), || (or)

Can’t use integers
as booleans!

About ‘primitive’ type int

Inside back cover, A-6..7

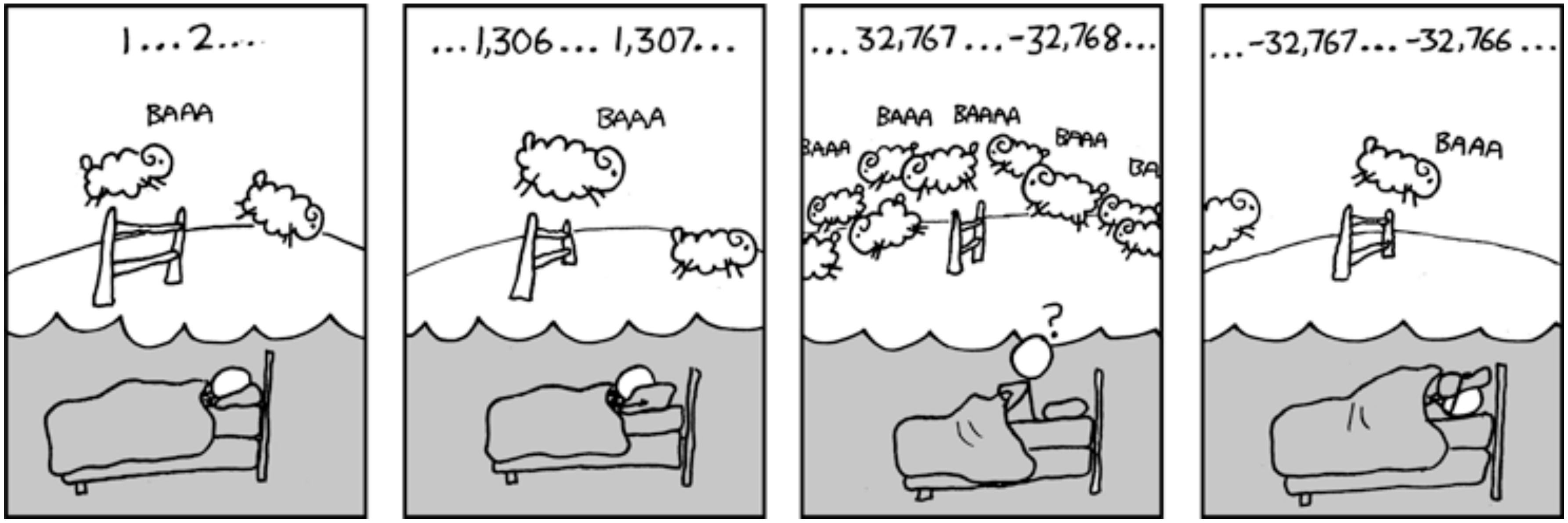
Java Principle: A basic operation of type **int** must produce an **int**

int: values: -2^{31} .. $2^{31}-1$, i.e.

operations: +, –, *, /, %, unary –

Integer.MAX_VALUE: name for max **int** value: $2^{31}-1$: 2147483647

Integer.MAX_VALUE + 1 is -2^{31}: -2147483648 WRAP-AROUND



Primitive number types

Inside back cover, A-6..7

Integer types:	**byte** 1 byte	**short** 2 bytes	**int** 4 bytes	**long** 8 bytes	usual operators
Real types:	**float** 4 bytes	**double** 8 bytes		–22.51E6 24.9	usual operators

Use these to save space.

Have an array of 1,000,000 integers in range 0..7?
Use a **byte** array rather than an **int** array

Don't worry about this in next 7-8 weeks. Use **int** and **double.**

Casting among types

Page A-9, inside back cover

(**int**) 3.2 casts **double** value 3.2 to an **int**

any number type

any number expression

narrow $\xrightarrow{\text{may be automatic cast}}$ wider

byte short int long float double

$\xleftarrow[\text{must be explicit cast, may truncate}]{}$

(**int**) is a unary prefix operator, just like –

– – 3 evaluates to 3

– (**int**) 3.2 evaluates to –3

Char is a number type!

Page A-9, inside back cover

char is a number type: (**int**) 'V' (**char**) 86

$\uparrow$ Unicode repr. in decimal: 86

$\uparrow$ **'V'**

Unicode: 16-bit char repr. Encodes chars in just about all languages. In java, use hexadecimal (base 16) char literals:

'\u0041' is 'A'
'\u0042' is 'B'

'\u0056' is 'V'

'\u0024' is '$'

'\u0950' is 'ॐ' —Om, the sound of the universe
'\u5927' is '大' —大衛 is (I think) a transliteration
'\u885b' is '衛' of David into Chinese (Da Wei)

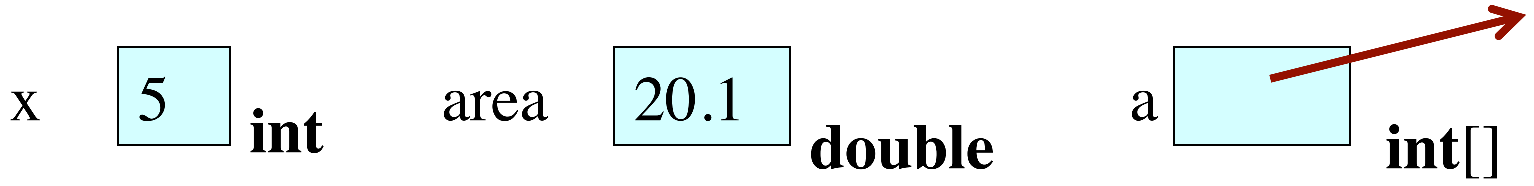
See www.unicode.org

Basic variable declaration

Page A-6

Declaration: gives name of variable, type of value it can contain

int x;	Declaration of x, can contain an **int** value
double area;	Declaration of area, can contain a **double** value
int[] a;	Declaration of a, can contain a pointer to an **int** array. We explain arrays much later



Assignment statement

Much like in other languages —need ‘;’ at end**:**

<variable>= <expression> ;

```
int x;
x= 10;
… other code
x= x+1;
```

Have to declare x before assigning to it.

```
int x= 10;
… other code
x= x+1;
```

Can combine declaration with an initializing assignment. Shorthand for a declaration followed by an assignment.

Assignment statement type restriction

Every expression has a type, which depends on its operators and the types of its operands in a natural way.

Rule: In x= e; type of e has to be same as or narrower than type of x. Reason: To avoid possibly losing info without the programmer realizing it.

double y= 5 + 1;

The value of 5+1 is automatically cast from type **int** to type **double**.

int x= ~~75.5~~ + 1;

Illegal: The exp value is of type **double**.

int x= (**int**) (75.5 + 1);

You can cast to **int** explicitly. 76 will be stored in x.

A function in Matlab, Python, and Java

Matlab

```
function s = sum(a, b)
   %  Return sum of a and b
s= a + b;
```

Python

```
def sum(a, b):
    """ return sum of a and b"""
    return a + b
```

```
/** return sum of a and b */
public static double sum(double a, double b) {
    return a + b;
}
```

Specification: in comment before function

return type

Declarations of parameters a and b