What is Computing? Informatics?

- What is computer science, what is its potential?
  - What can we do with computers in our lives?
  - What can we do with computing for society?
  - Will networks transform thinking/knowing/doing?
  - Society affecting and affected by computing?
  - Changes in science: biology, physics, chemistry, …
  - Changes in humanity: access, revolution (?), …
- Privileges and opportunities available if you know code
  - Writing and reading code, understanding algorithms
  - Majestic, magical, mathematical, mysterious, …

Theory and Practice

- http://xkcd.com/664/
- http://en.wikiquote.org/wiki/Yogi_Berra
- Einstein on simplicity: http://en.wikiquote.org/wiki/Albert_Einstein
  - Occam's Razor
- How do you write Jotto to run in a browser?
  - Does Python programming help here?
  - http://www.cs.duke.edu/courses/cps006/spring11/jotto/
- How can we make a database-backed website using Ajax for online course evaluations?

What can be programmed?

- What class of problems can be *solved*?
  - Hadoop, Intel i7, Mac, Windows7, Android,…
  - Alan Turing contributions
    - Halting problem, Church-Turing thesis
- What class of problems can be *solved efficiently*?
  - Problems with no practical solution
    - What does practical mean?
  - We can't find a practical solution
    - Solving one solves them all
    - Would you rather be rich or famous?

Schedule students, minimize conflicts

- Given student requests, available teachers
  - write a program that schedules classes
  - Minimize conflicts
- Add a GUI too
  - Web interface
  - …
  - …

One better scenario, is this better?

Summary of Problem Categories

- Some problems can be solved 'efficiently'
  - Run large versions fast on modern computers
  - What is 'efficient'? It depends
- Some problems cannot be solved by computer.
  - Provable! We can't wait for smarter algorithms
- Some problems have no efficient solution
  - Provably exponential 2^n so for "small" n …
- Some have no known efficient solution, but …
  - If one does they all do!

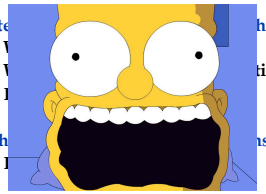
Entscheidungsproblem

- What can we program?
  - What kind of computer?
- What can't we program?
  - Can't we try harder?
- Can we write a program that will determine if any program *P* will halt when run on input *S*?
  - Input to halt: P and S
  - Output: yes/no halts

Good sites: http://del.icio.us/

- What is social bookmarking?
  - Why is del.icio.us interesting?
  - Who posts, who visits?
- What about a website of interesting websites?
  - What would you expect to find there?
  - Would the site list itself?
- What about sites that list/link to themselves?
  - What about a site with all sites that list themselves?

Bad sites: http://haz.ardo.us



- Site
  - V
  - V
  - I
- Wh
  - I
- Website of all the sites that don't list themselves?
  - Is `notlisted.com` listed on `notlisted.com`?

halting module/problem: writing `doesHalt`

```
"""
    function doesHalt returns True if progname
    halts when run on input, and False if progname
    doesn't halt (infinite loop)
"""
    def doesHalt(progname,input):
        #code here

    name = "SpreadingNews.py"
    data = "input.txt"
    if doesHalt(name,data): print "program ended!"
```

- We're assuming `doesHalt` exists – how to use it?
  - It works for any program and any data! Not just one, that's important in this context

How to tell if X stops/halts on Y

```
import halting
def runHalt():
    prog = "SpreadingNews.py";
    input = "["abc", "def", "hij"]"
    if halting.doesHalt(prog,input):
        print prog,"stops"
    else:
        print prog,"loops 4ever"
```

- Can user enter name of program, X? Input, Y?
  - What's the problem with this program?

Consider this module *`Confuse.py`*

```
import halting
print "enter name of program",
prog = raw_input()
if halting.doesHalt(prog,prog):
    while True:
        pass
print "finished"
```

- We want to show writing `doesHalt` is impossible
  - Proof by contradiction:
  - Assume possible, show impossible situation results
- Can a program read a program? Itself?

Are hard problems easy? Clay Prize

Theory and Practice

- Number theory: pure mathematics
  - How many prime numbers are there?
  - How do we factor?
  - How do we determine primeness?
- Computer Science
  - Primality is "easy"
  - Factoring is "hard"
  - Encryption is possible

public-key cryptography

randomized primality testing

Wikileaks, PGP, PKI, verification

- http://cryptome.org/0001/wikileaks-keys/wikileaks-keys.htm
- Where are wikileaks servers and how to find them?
  - What if they're taken down
  - Where is information
  - What about imposters or verification?
- File x distributed
  - Download
  - Verify integrity and source!

How is Python like all other programming languages, how is it different?

A Rose by any other name…C or Java?

- Why do we use [Python | Java] in courses ?
  - [is | is not] Object oriented
  - Large collection of libraries
  - Safe for advanced programming and beginners
  - Harder to shoot ourselves in the foot
- Why don't we use C++ (or C)?
  - Standard libraries weak or non-existant (comparatively)
  - Easy to make mistakes when beginning
  - No GUIs, complicated compilation model
  - What about other languages?

Why do we learn other languages?

- Perl, Python, PHP, Ruby, C, C++, Java, Scheme, ML,
  - Can we do something different in one language?
    - In theory: no; in practice: yes
  - What languages do you know? All of them.
  - In what languages are you fluent? None of them
- In later courses why do we use C or C++?
  - Closer to the machine, understand abstractions at many levels
  - Some problems are better suited to one language

Find all unique/different words in a file

Across different languages: do these languages have the same power?

Guido van Rossum

- BDFL for Python development
  - Benevolent Dictator For Life
  - Late 80's began development
- Python is multi-paradigm
  - OO, Functional, Structured, ...
- We're looking forward to a future where every computer user will be able to "open the hood" of their computer and make improvements to the applications inside. We believe that this will eventually change the nature of software and software development tools fundamentally.

Guido van Rossum, 1999!

Unique Words in Python

```
#! /usr/bin/env python

def main():
    f = open('/data/melville.txt', 'r')
    words = f.read().strip().split()
    allWords = set()
    for w in words:
        allWords.add(w)
    for word in sorted(allWords):
        print word

if __name__ == "__main__":
    main()
```


Unique words in Java

```
import java.util.*;
import java.io.*;
public class Unique {
  public static void main(String[] args)
                        throws IOException{
    Scanner scan =
          new Scanner(new File("/data/melville.txt"));
    TreeSet<String> set = new TreeSet<String>();
    while (scan.hasNext()){
        String str = scan.next();
        set.add(str);
    }
    for(String s : set){
        System.out.println(s);
    }
  }
}
```


Unique words in C++

```
#include <iostream>
#include <fstream>
#include <set>
using namespace std;

int main(){
  ifstream input("/data/melville.txt");
  set<string> unique;
  string word;
  while (input >> word){
    unique.insert(word);
  }
  set<string>::iterator it = unique.begin();
  for(; it != unique.end(); it++){
    cout << *it << endl;
  }
  return 0;
}
```


PHP, Rasmus Lerdorf and Others

- Rasmus Lerdorf
  - Qeqertarsuaq, Greenland
  - 1995 started PHP, now part of it
  - http://en.wikipedia.org/wiki/PHP
- Personal Home Page
  - No longer an acronym
- "When the world becomes standard, I will start caring about standards."

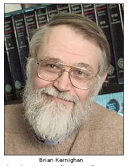
Rasmus Lerdorf

Unique words in PHP

```
<?php

$wholething = file_get_contents("file:///data/melville.txt");
$wholething = trim($wholething);

$array = preg_split("/\s+/",$wholething);
$uni = array_unique($array);
sort($uni);
foreach ($uni as $word){
   echo $word."<br>";
}

?>
```


Kernighan and Ritchie

- First C book, 1978
- First 'hello world'
- Ritchie: Unix too!
  - Turing award 1983
- Kernighan: tools
  - Strunk and White


Brian Kernighan


Dennis Ritchie

- Everyone knows that debugging is twice as hard as writing a program in the first place. So if you are as clever as you can be when you write it, how will you ever debug it?

Brian Kernighan

How do we read a file in C?

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int strcompare(const void * a, const void * b){
  char ** stra = (char **) a;
  char ** strb = (char **) b;
  return strcmp(*stra, *strb);
}

int main(){
  FILE * file = fopen("/data/melville.txt","r");
  char buf[1024];
  char ** words = (char **) malloc(5000*sizeof(char **));
  int count = 0;
  int k;
```


Storing words read when reading in C

```
while (fscanf(file,"%s",buf) != EOF){
  int found = 0;   // look for word just read
  for(k=0; k < count; k++){
    if (strcmp(buf,words[k]) == 0){
      found = 1;
      break;
    }
  }
  if (!found){     // not found, add to list
    words[count] = (char *) malloc(strlen(buf)+1);
    strcpy(words[count],buf);
    count++;
  }
}
```

- Complexity of reading/storing? Allocation of memory?

Sorting, Printing, Freeing in C

```
qsort(words,count,sizeof(char *), strcompare);
for(k=0; k < count; k++) {
  printf("%s\n",words[k]);
}

for(k=0; k < count; k++){
  free(words[k]);
}
free(words);

}
```

- Sorting, printing, and freeing
  - How to sort? Changing sorting mechanism?
  - Why do we call free? Where required?

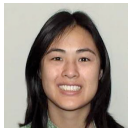
def is_this_the_end_of_learning_of():
[x for x in …]

Maria Cimino

- Math/Italian (min)

Tamara Louie

- BME

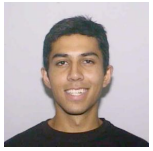


Alexandra Levitt

- Program II

Qasim Khan

- Economics



Herng Lee

- Economics

Bryan Gomez-Wong

- Political Science/ Economics(min)/ MMS

Amy Oh

- Statistics/ Asian&Mideast Studies (min)

Gordon Motsinger

- Psychology/ Asian&Mideast Studies (min)/ Religion

Cory Nanni

- Biology/ Psychology(min)