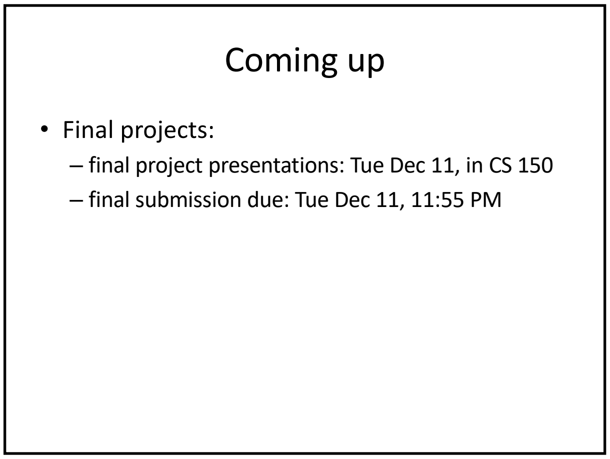
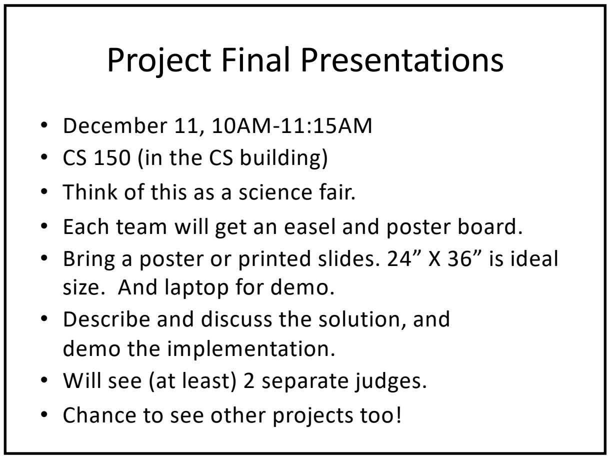


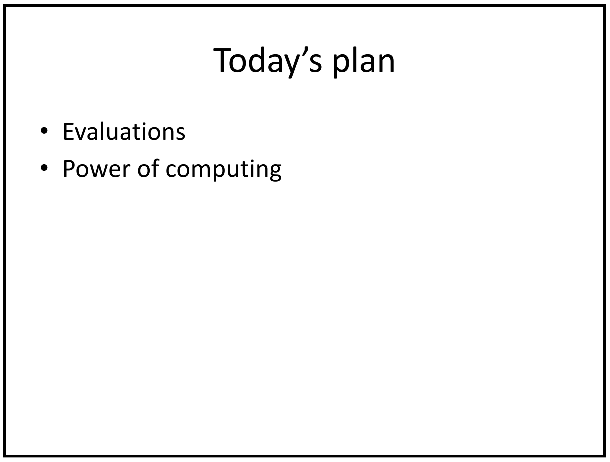
Coming up

- Final projects:
  - final project presentations: Tue Dec 11, in CS 150
  - final submission due: Tue Dec 11, 11:55 PM



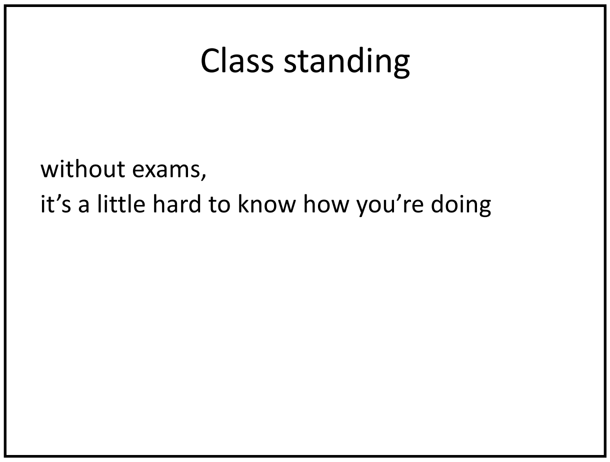
Project Final Presentations

- December 11, 10AM-11:15AM
- CS 150 (in the CS building)
- Think of this as a science fair.
- Each team will get an easel and poster board.
- Bring a poster or printed slides. 24” X 36” is ideal size. And laptop for demo.
- Describe and discuss the solution, and demo the implementation.
- Will see (at least) 2 separate judges.
- Chance to see other projects too!



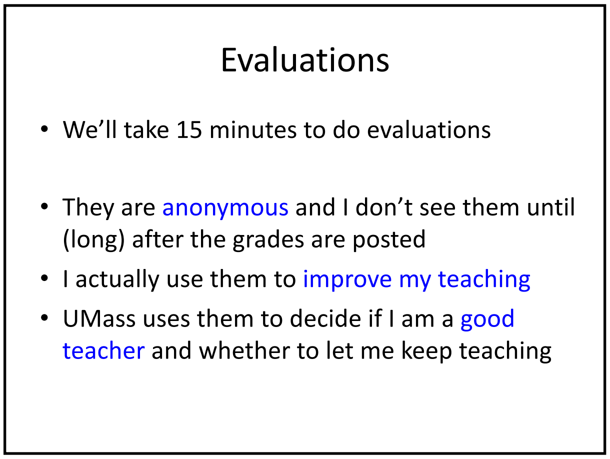
Today’s plan

- Evaluations
- Power of computing



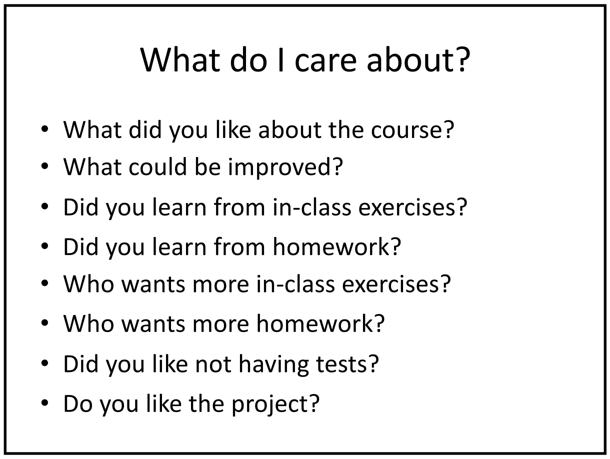
Class standing

without exams,
it’s a little hard to know how you’re doing



Evaluations

- We’ll take 15 minutes to do evaluations
- They are anonymous and I don’t see them until (long) after the grades are posted
- I actually use them to improve my teaching
- UMass uses them to decide if I am a good teacher and whether to let me keep teaching



What do I care about?

- What did you like about the course?
- What could be improved?
- Did you learn from in-class exercises?
- Did you learn from homework?
- Who wants more in-class exercises?
- Who wants more homework?
- Did you like not having tests?
- Do you like the project?

Evaluations

http://owl.oit.umass.edu/partners/courseEvalSurvey/uma/

- If we get 80% participation by tomorrow:
  - Everyone gets 0.5 points of extra credit.
  - Everyone gets a chance to submit an optional extra credit assignment.

Power of Software

Can you write any program I describe to you?

Can you write:

A program HALTS?
INPUT: the source code of a method
OUTPUT: false if the method enters an infinite loop,
true if it does not.

What’s HALTS?(method)?

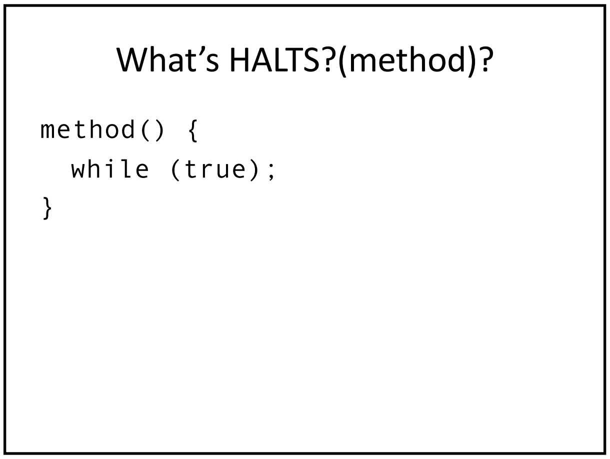
```
method() {
  print “hello world”;
}
```

What’s HALTS?(method)?

```
method() {
  for (int x=0; x<5; x++)
    print “hello world”;
}
```

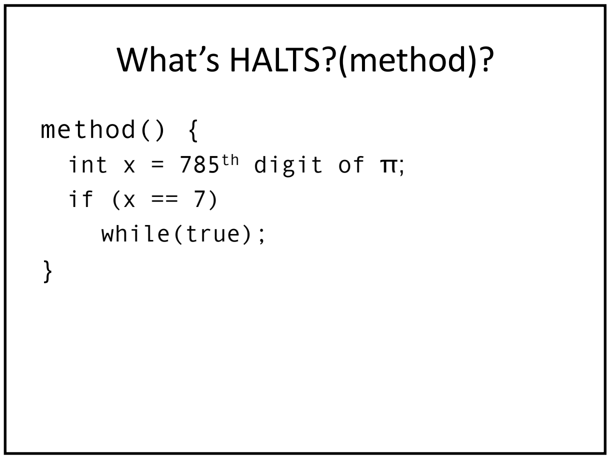
What’s HALTS?(method)?

```
method() {
  for (int x=0; x<-1; x++)
    print “hello world”;
}
```



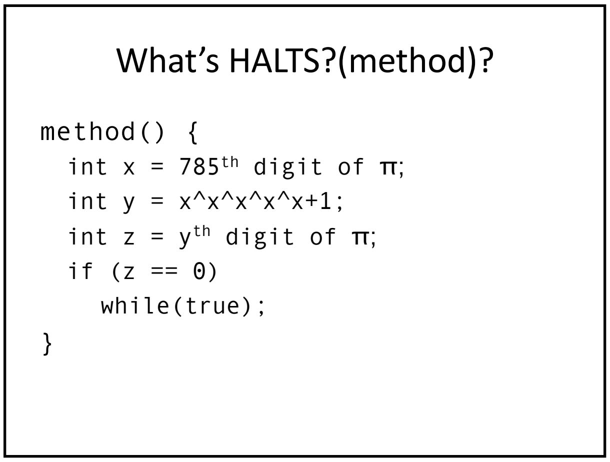
What's HALTS?(method)?

```
method() {
  while (true);
}
```



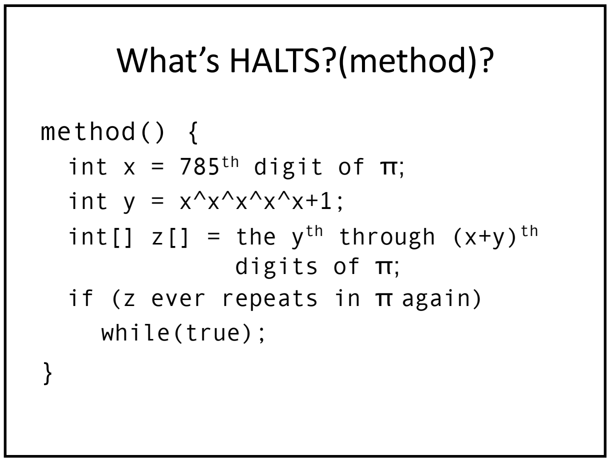
What's HALTS?(method)?

```
method() {
  int x = 785th digit of π;
  if (x == 7)
    while(true);
}
```



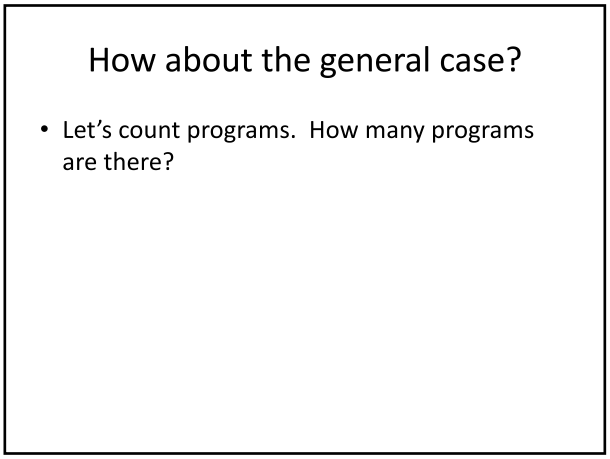
What's HALTS?(method)?

```
method() {
  int x = 785th digit of π;
  int y = x^x^x^x^x+1;
  int z = yth digit of π;
  if (z == 0)
    while(true);
}
```



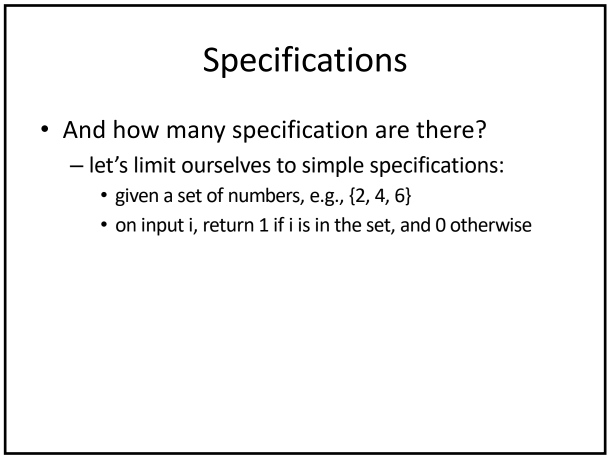
What's HALTS?(method)?

```
method() {
  int x = 785th digit of π;
  int y = x^x^x^x^x+1;
  int[] z[] = the yth through (x+y)th
                digits of π;
  if (z ever repeats in π again)
    while(true);
}
```



How about the general case?

- Let's count programs. How many programs are there?



Specifications

- And how many specification are there?
  - let's limit ourselves to simple specifications:
    - given a set of numbers, e.g., {2, 4, 6}
    - on input i, return 1 if i is in the set, and 0 otherwise

First 64 programs

- How many of our specifications can I solve with 64 programs?
  (a) 64
  (b) 32
  (c) 8
  (d) 6
  (e) 2

set size -> number of specs

- Suppose I can only write 4 programs.
- I start with the smallest set specification:
  {}
- that's 1 program. (return false on all inputs)
- With 4 programs, I can do
  {}, {1}, {2}, {1, 2}

First 64 programs

- With 64 programs, how large can my specification sets get (if I am being compact)
  (a) 64
  (b) 32
  (c) 8
  (d) 6
  (e) 2

{}, {1}, {2}, {3}, {4}, {5}, {6},
{1, 2}, {1, 3}, {1, 4}, {1, 5}, {1, 6}, {2, 3}…
{1,2,3}, {1,3,4}, …, {1,2,3,4}, …, {1,2,3,4,5}

Scalability Problem

- To cover subsets of a set of n numbers, I need 2^n programs.
- But I only have as many programs are there are natural numbers.
- That's exponentially smaller than the number of specifications there are.

Can't do it for all subsets!

Can HALTS? exist?

- Imagine that you wrote HALTS?
- I will write a new program NALTS?:

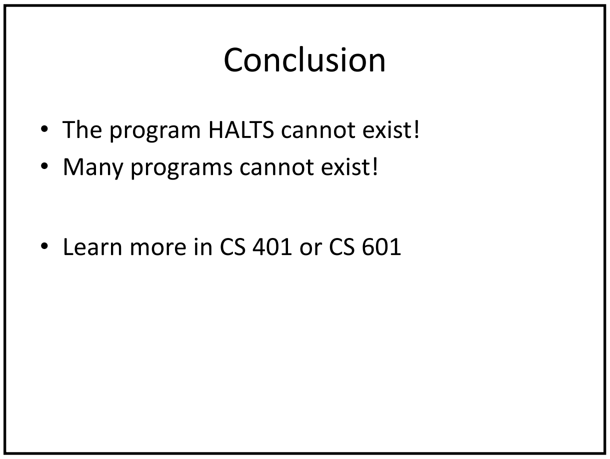
```
NALTS?(Method p) {
  if (HALTS?(p)==false) return 1;
  else while (true);
}
```

Key: run the program on itself
What is the value of
NALTS?(NALTS?)

What is the value of NALTS?(NALTS?)

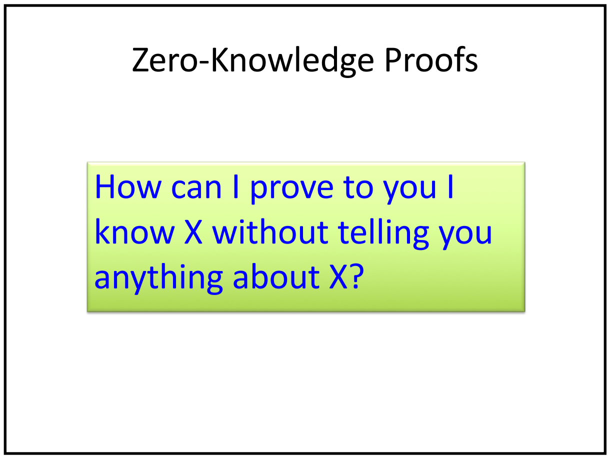
- Two cases:

1. If NALTS?(NALTS?) goes into an infinite loop, then
   HALTS?(NALTS?)==true, which means that NALTS? terminates.
   So case 1 is impossible.
2. If NALTS?(NALTS?) does not go into an infinite loop, then HALTS?(NALTS?)==false, which means that NALTS? does not terminate.
   So case 2 is impossible.



Conclusion

- The program HALTS cannot exist!
- Many programs cannot exist!
- Learn more in CS 401 or CS 601



Zero-Knowledge Proofs

How can I prove to you I know X without telling you anything about X?