**University of California, Berkeley – College of Engineering, EECS Dept**

Spring 2011 Instructor: Dan Garcia 2011-05-11

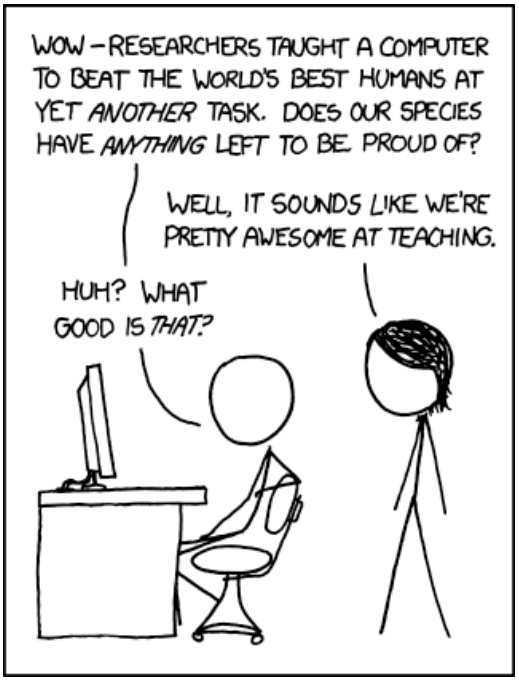
# CS10 Paper Final Exam

| | |
|---|---|
| *Last Name* | |
| *First Name* | |
| *Student ID Number* | |
| `cs10-` *Login First Letter* | **a b c d e f g h i j k l m** |
| `cs10-` *Login Last Letter* | **a b c d e f g h i j k l m**<br>**n o p q r s t u v w x y z** |
| *The name of your LAB TA (please circle)* | **Glenn Luke Navin** |
| *Name of the person to your Left* | |
| *Name of the person to your Right* | |
| *All my work is my own. I had no prior knowledge of the exam contents nor will I share the contents with others in CS10 who have not taken it yet.* ***(please sign)*** | |

## Instructions

- This booklet contains 4 double-sided pages including this cover page. Put all answers on these pages; don't hand in any stray pieces of paper.
- Please turn off all pagers, cell phones and beepers. Remove all hats and headphones.
- You have 180 minutes to complete this exam. This final is closed book, no computers, no PDAs, no cell phones, no calculators, but you are allowed three double-sided pages of notes. There may be partial credit for incomplete answers; write as much of the solution as you can. When we provide a blank, please fit your answer within the space provided.

| Q | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Online | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pts | 4 | 4 | 8 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 10 | 10 | 15 | 80 |
| # | | | | | | | | | | | | | | |



# Short-answer Questions (this page only)

**Question 1** : HCI researchers stress the need to *understand* users. How is this usually done?

**Question 2:** What is the cloud computing *cost associativity* idea that is so exciting? Feel free to answer this by finishing the sentence: "In the old days, you could rent 1 core for N hours for D dollars. Today..."

**Question 3:** You wish to perform a compute-intensive *mapping* task on N elements of a list, and then *reduce* all the mapper's output to a single number. It's a perfect world, and there are N cores available to help.

**a)** The _____ *programming paradigm* makes authoring this parallel code the easiest.
**b)** Given that you get ideal performance speedup, what does *Amdahl's law* tell us about the "mix" of code in your program? _____
**c)** If the order of growth of your *mapper* were LINEAR (on the size of the input list) for 1 core, then for N cores in parallel (in a perfect world) it'd be: _____
**d)** If the order of growth of your *reducer* were LINEAR (on the size of the input list) for 1 core, then for N cores in parallel (in a perfect world, where the reducer is *associative* and *commutative*, and many reducers can run at once) it'd be: _____

**Question 4:** What CS10 "big idea" was used by the BART map artists who recently redesigned the BART map to show the stops (mostly) equally spaced and in a straight line?

**Question 5:** Your final project passes the *Turing Test*, congratulations! What does that mean it can do?

**Question 6:** If a board game is *strongly solved* and found to be a *win*, what exactly does that mean?

**Question 7:** Recall that the *Subset Sum* problem (determining if a handful of numbers from a given set added to 0) was NP-complete (NP-hard and in NP). If a fellow CS10 student proves they've found a polynomial-time solution for it, what would that mean for a random problem in NP (say, the *Traveling Salesman* problem of a salesman who needs to find the most efficient route that goes through all cities and returns home)?

**Question 8**: Jaron Lanier ends his "First Church of Robotics" Op-Ed piece with: *"We serve people best when we keep our religious ideas out of our work"*. Given that stance, what would he say to the IBM folks who put *Watson* on Jeopardy?

**Question 9**: What was the remarkable achievement displayed at the "Great Robot Race" grand challenge?

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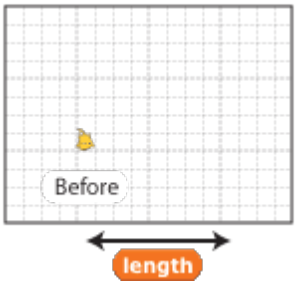
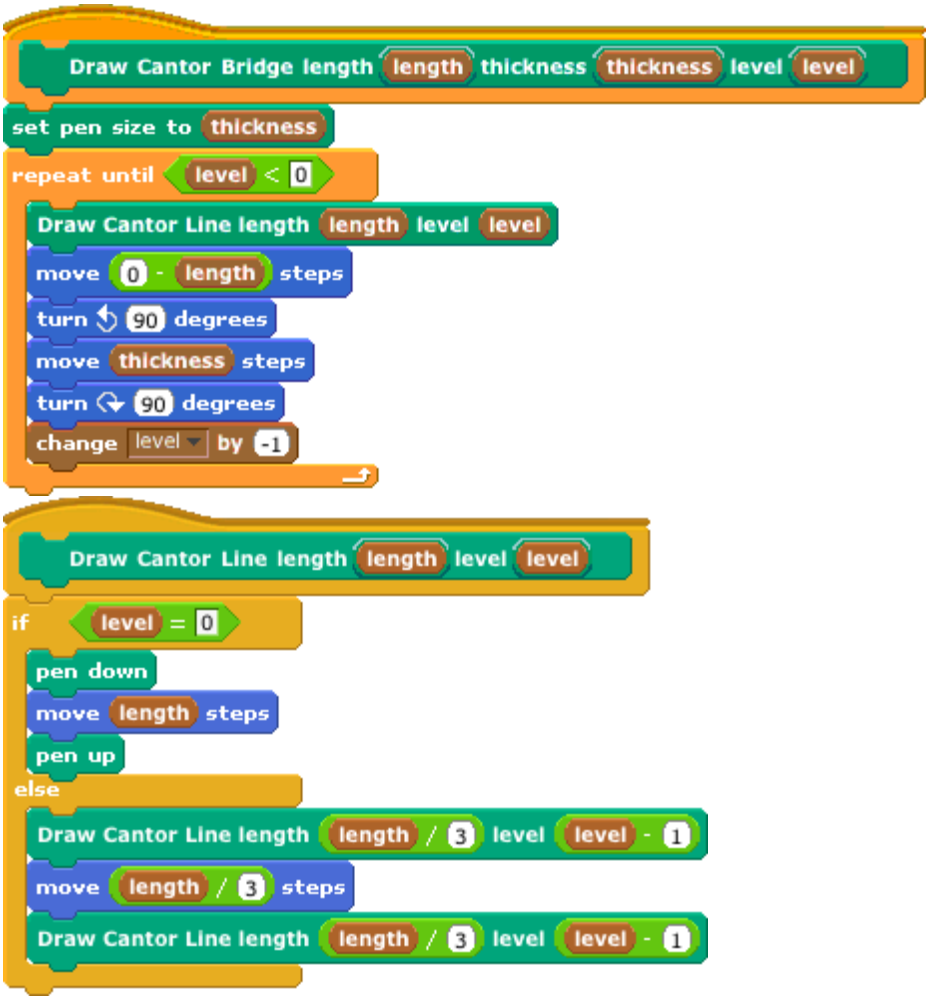
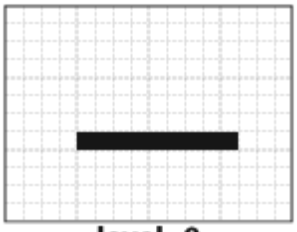
## Question 10: *Cantor Bridge over the river Kwai*

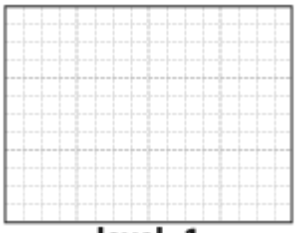
We've authored a fractal that implements the *Cantor Bridge* fractal and showed below the result of a call to

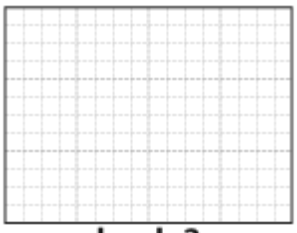

Draw the result of calls to the same block with *level* = 1 and 2. For each complete picture, we always start a drawing by lifting the pen (if it was down), clearing the screen, and moving the sprite to the "Before" point facing to the right. (We've made a subtle change to BYOB for this problem -- instead of a circular pen, it's a square pen. So instead of drawing lines with round endpoints, it draws lines with square endpoints.) The line segment drawn in the "*level* = 0" picture below is thickness pixels high.





level=0

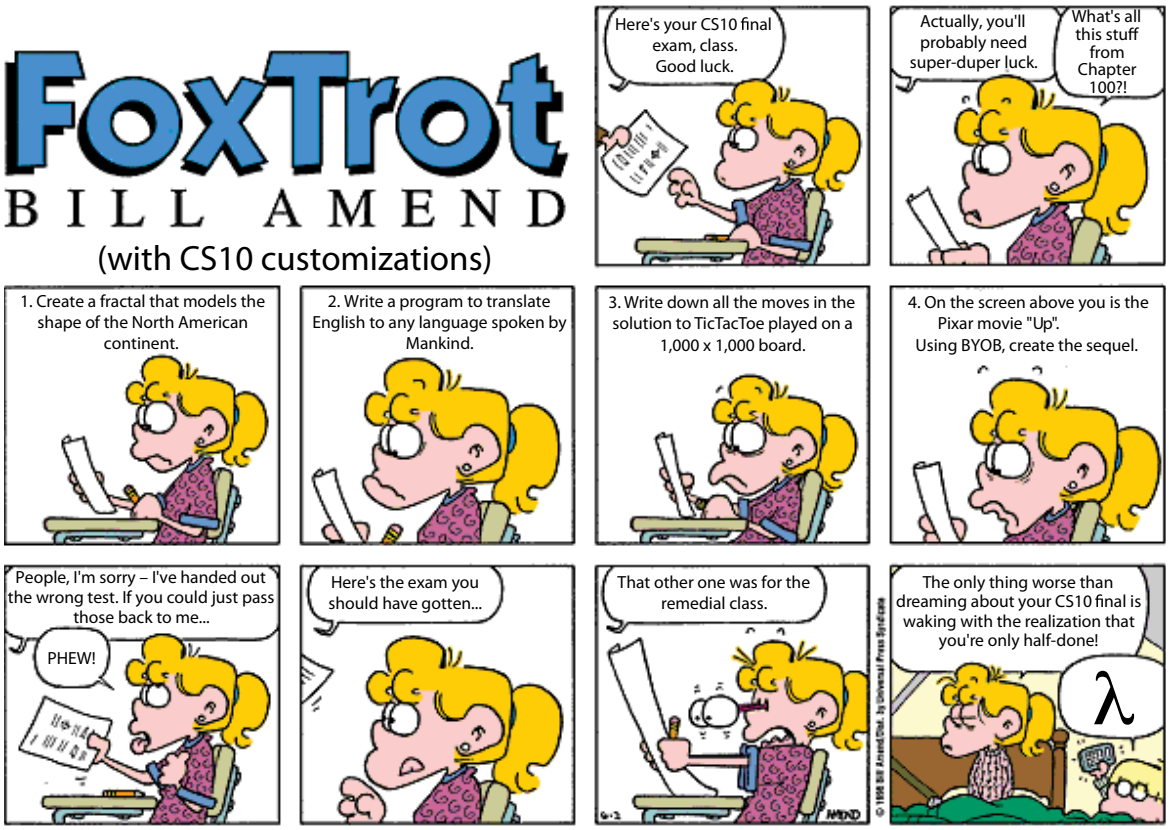

level=1


level=2

# FoxTrot

BILL AMEND

(with CS10 customizations)



## Question 11: *Keep the dog away from the family tree...*

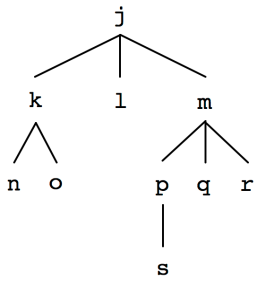
We're sure you fondly remember the ancestors person problem from the midterm. We've included it (with the answer) on the last page of this exam in case you've forgotten about it.

a. We were always bothered by the fact that we had to count *ourselves* in our ancestors. Modify the answer reprinted below so you *don't* count yourself in your ancestors. (I.e., all the ancestors person example calls should now report a number one smaller: ancestors a would report **8**, ancestors b would report **4**, etc.). You are not allowed to add any new lines, only make subtle *changes* to the code below.

```
1 ancestors(PERSON)

2   if parents-found?(PERSON)

3      report ( 1 + ancestors(father(PERSON)) + ancestors(mother(PERSON)) )

4   else

5      report ( 1 )
```

b. We would now like a list of us and all our *descendants* in no particular order (i.e., our children, their children, etc) by writing the block me and my descendants person. This problem is harder than ancestors person because we can have *many* children, but it's simpler because we only need a single helper children person which reports a list of all our children (empty if we have no kids!). Examples:

```
children j ==> (k l m)    ;; great-grandma j has 3 kids
children p ==> (s)        ;; p only has one kid, s
children l ==> ()         ;; same for n, o, q, r and s

me and my descendants j ==> (j k l m n o p q r s)
me and my descendants k ==> (k n o) ;; all these in any order
me and my descendants l ==> (l)
```




```
me-and-my-descendants(PERSON)

    if ( ____________________________________ )

        report ( ____________________________________________________ )
    else
        report ( ____________________________________________________

                 ____________________________________________________ )
```

Login: **cs10-____**

## Question 12: *Driving Miss Calculate...*

You'd like to do some natural language processing, so you decide to write a reporter called **calculator** that takes an *expression* (a list) of the form **(number operation number operation … number)**, where **plus** and **times** are the only operations, and calculates the result. Examples:

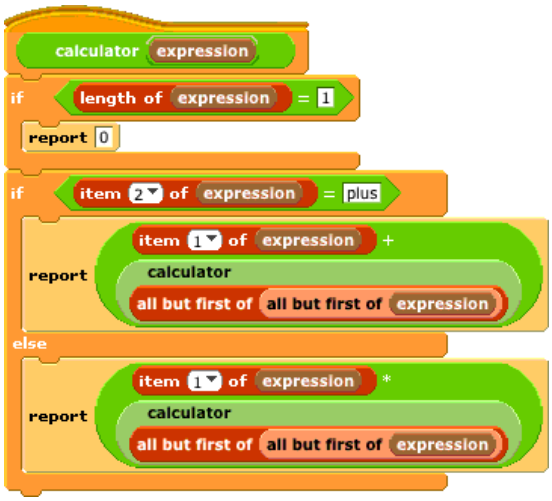

```
==> 5                    ;; 5
```


```
==> 4                    ;; 2 + 2
```


```
==> 25                   ;; 2 * 3 * 4 + 1 = (2 * 3 * 4) + 1
```


```
==> 11                   ;; 1 + 2 * 3 + 4 = 1 + (2 * 3) + 4
```

Notice that **times** is always more important than **plus**. I.e., **(1 plus 2 times 3)** should behttp://61a-fa11.appspot.com/ evaluated as **1 + (2 * 3)**, and **not (1 + 2) * 3**. You may assume that **calculator** is always called on valid expressions (and is never called on an empty list). Unfortunately, your code has two bugs that you need to fix:




```
calculator(EXPRESSION)

1     if ( length-of(EXPRESSION) = 1 )
2         report ( 0 )
3     if ( item(2)of(EXPRESSION) = plus )
4         report ( item(1)of(EXPRESSION) +
5                  calculator(all-but-first-of(all-but-first-of(EXPRESSION))) )
6     else
7         report ( item(1)of(EXPRESSION) *
8                  calculator(all-but-first-of(all-but-first-of(EXPRESSION))) )
```

a. Let's first fix the most obvious bug. Replacing line # _____ with _____ would cause 

to correctly return **6** instead of **3**. The code should then work for all expressions that only use **plus**. Go ahead and make this change to the code above.

b. After you apply the fix in part (a), there's still one remaining bug. Complete the sentence:

The shortest expression that should return ___ but instead returns ___ is _____.

c. The final bug has been found in the "else" case in lines 7 and 8. Write the case correctly below. After this change, the block should work as specified on all valid expressions.

# Extra Credit Question

Learning computing concepts may have opened many doors for you in your future work. Although you may not ever use BYOB again, the concepts you have learned may become useful to you. Some examples include:

- Provide you with enough basic programming skills that you could easily pick up another language
- Appreciating that no new technology is black or white, and the societal / ethical / economic consequences are often unintended
- More conservatism w.r.t. social networks, your own privacy, e-voting, and the role of “big brother”, which is anyone with access to your information: from a government to a university to your local cloud provider.
- Provide you with basic analysis tools to estimate how an algorithm (or plan or idea, in the real world) would scale as you grow the size of the input, to determine when a problem is computationally tractable, and to recognize that some problems are not decidable.
- Empowering you to see a situation (say, how people are lining up to take a flight) and write a simulation that would model it (say, boarding from the outside in vs back-to-front vs random) to generate some data for your analysis.

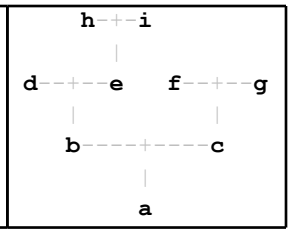
Aside from the examples given, or enhancing the examples given, please describe a situation in which you think the computing concepts you have learned will help you in the future.

# Midterm Question 12 with ANSWER: *Respect the family…*

You are interested in finding the *number of a person's ancestors*, that is, them, their parents, their parents' parents, etc. In their family, everyone has a unique name and couples are always recorded together -- if you find one parent, you've found the other. You are provided with three helper blocks (which access some global family tree): [parents found? person], [mother person] and [father person]. All three take as input a single argument, a [person] (however that is represented):

- [parents found? person] reports [true] or [false] depending on whether the system has found that person's parents (mother *and* father) or not.
- [mother person] reports that person's mother (a [person]), if she was found. (if she wasn't found, it's an error)
- [father person] reports that person's father (a [person]), if he was found. (if he wasn't, it's an error)

Example family: In the diagram, mothers (`b`,`d`,`f`,`h`) are listed to the left of the fathers (`c`,`e`,`g`,`i`)

| | |
|---|---|
| `a`'s parents were found, `b` and `c`. (`b` is the mother, `c` is thefather)<br>`b`'s parents were found, `d` and `e`.<br>`c`'s parents were found, `f` and `g`.<br>`e`'s parents were found, `h` and `i`.<br>`d`, `f`, `g`, `h` and `i`'s parents were not found in the family tree. |  |

Examples:

[parents found? e] reports [true] because we found `e`'s parents, who are `h` and `i`.

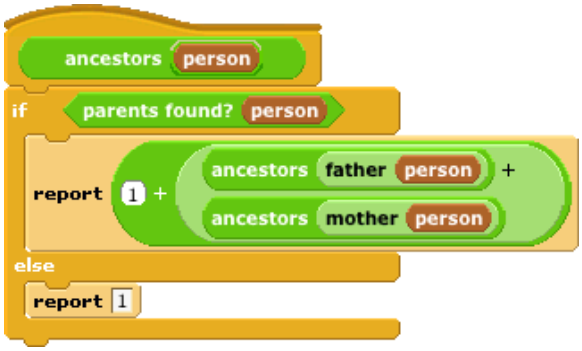
[parents found? d] reports [false] because we didn't find `d`'s parents.

[mother e] reports `h`, because `e`'s mother is `h`. (calling [mother ] on `d`, `f`, `g`, `h` or `i` is an error)

[father e] reports `i`, because `e`'s father is `i`. (calling [father ] on `d`, `f`, `g`, `h` or `i` is an error)

Fill in the blanks for the block [ancestors person] that reports that person's **total number** of their ancestors (counting themselves). Examples:

[ancestors a] reports 9 (for `a b c d e f g h i`)
[ancestors b] reports 5 (for `b d e h i`)
[ancestors c] reports 3 (for `c f g`)
[ancestors d] reports 1 (for `d`), etc...




```
ancestors(PERSON)
   if parents-found?(PERSON)
      report ( 1 + ancestors(father(PERSON)) + ancestors(mother(PERSON)) )
   else
      report ( 1 )
```