Simple Equations, Deep Understanding How Topics in Algebra and Calculus relate to Technology and Artificial Intelligence

Qiyam Tung and Alison Cornell

G-TEAMS
Department of Computer Science (Univeristy of Arizona)
Desert View High School

January 21, 2012

Who are we?

- Qiyam Tung – Computer Science-Computer Vision (U. of Arizona)
- Alison Cornell – Desert View Teacher
- Working together because of G-TEAMS (NSF funded collaboration between grad students and teachers in GK-12).
- Determining what to add to lessons/units
- Purpose of our lessons
- Management of class (one teaches, the other helps out)

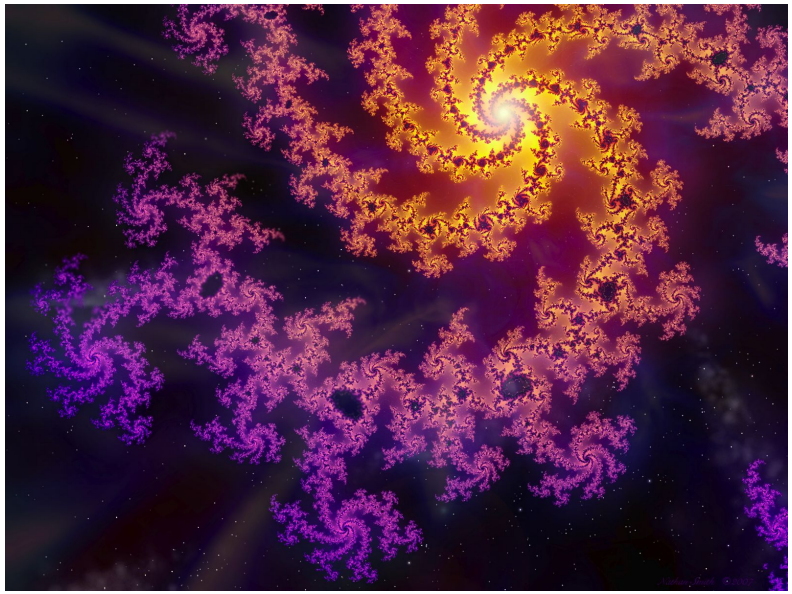
Why Mathematics?

"Why do we study mathematics?"

What can lines tell us?

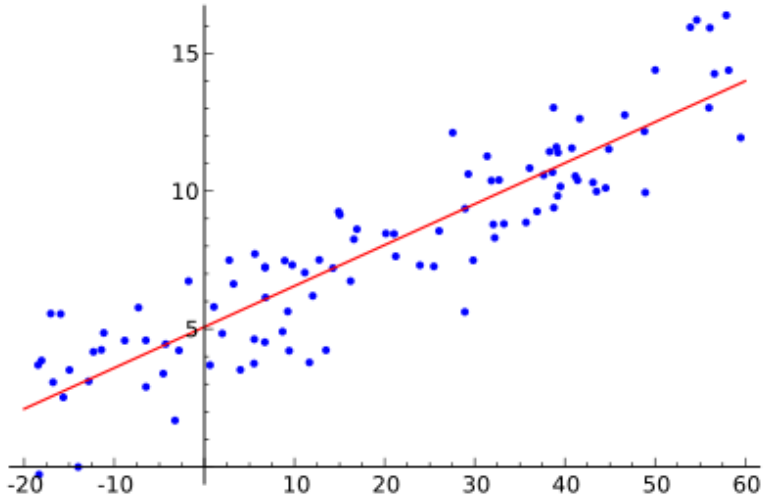
One equation can have multiple *interpretations*

- Shape (Geometry)
- Tangent line (Calculus)
- Prediction/Classification (machine learning/AI)



Calculus: Regression/Classification

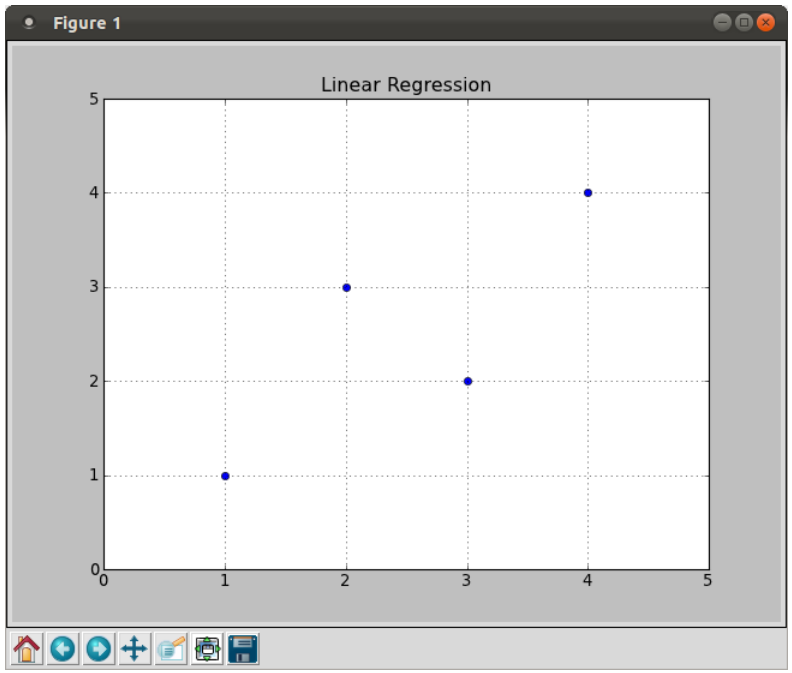
Regression: you can use lines to predict data (e.g. future housing pricing).
One natural extension is classification (face or no face in a picture)



Teaching Regression

How do we estimate a line's parameters (e.g. slope)?

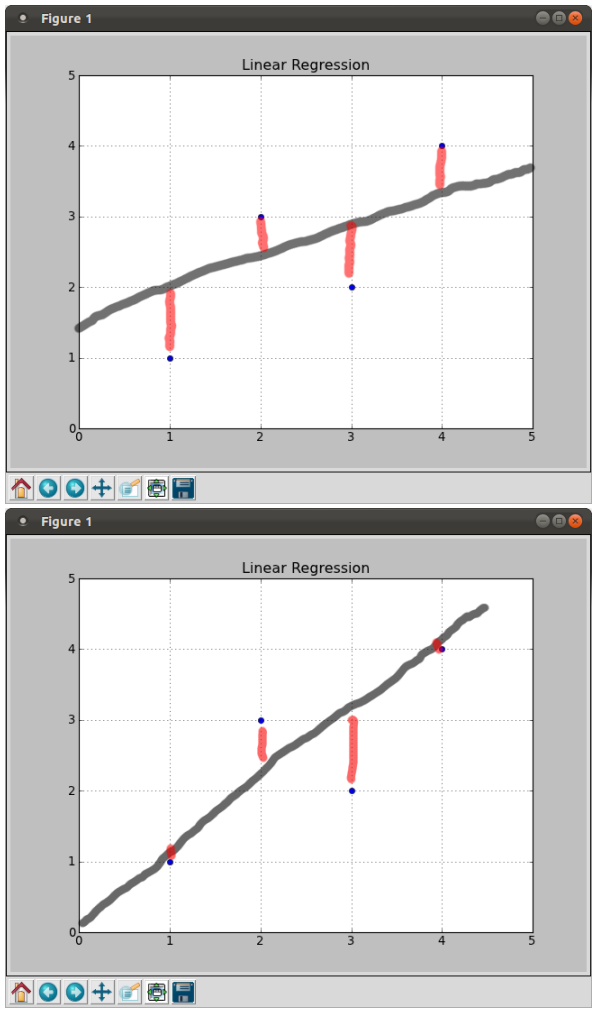
- Guesstimate
- Calculate!



Teaching Regression

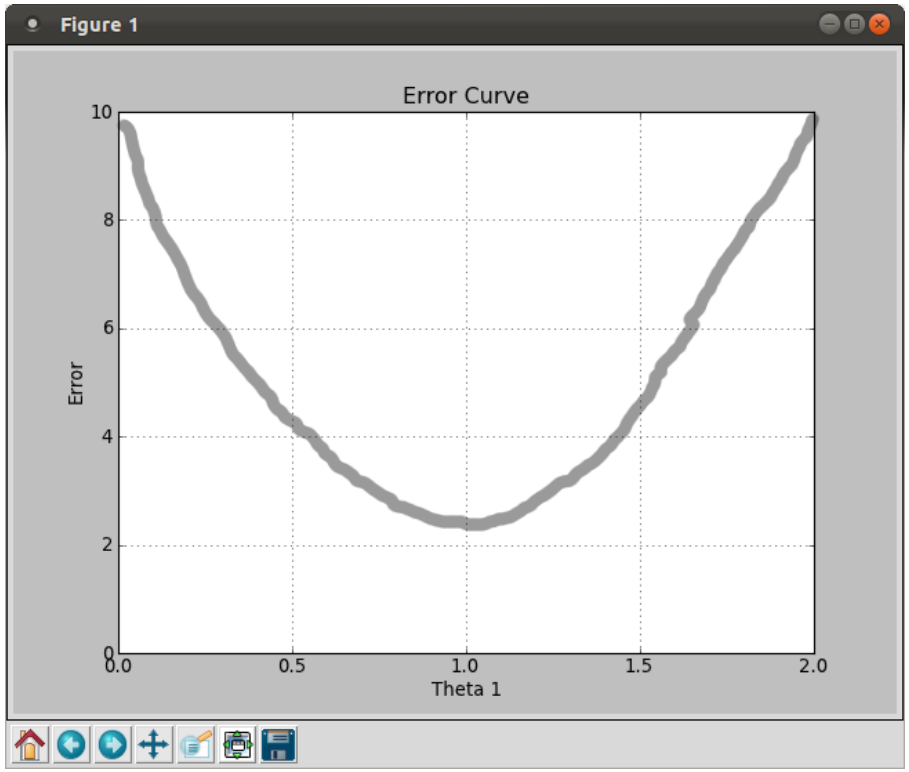
How do we estimate a line's parameters (e.g. slope)?

- Given the slope of a line, we can measure how "bad" a fit it is.
- Call this measure the "error."
- What we want to do is get a fit so that the error is *minimal*



Teaching Regression

- How does the error change as we change the slope?
- Set derivative (of error function) to zero to find minimum.



Working Together

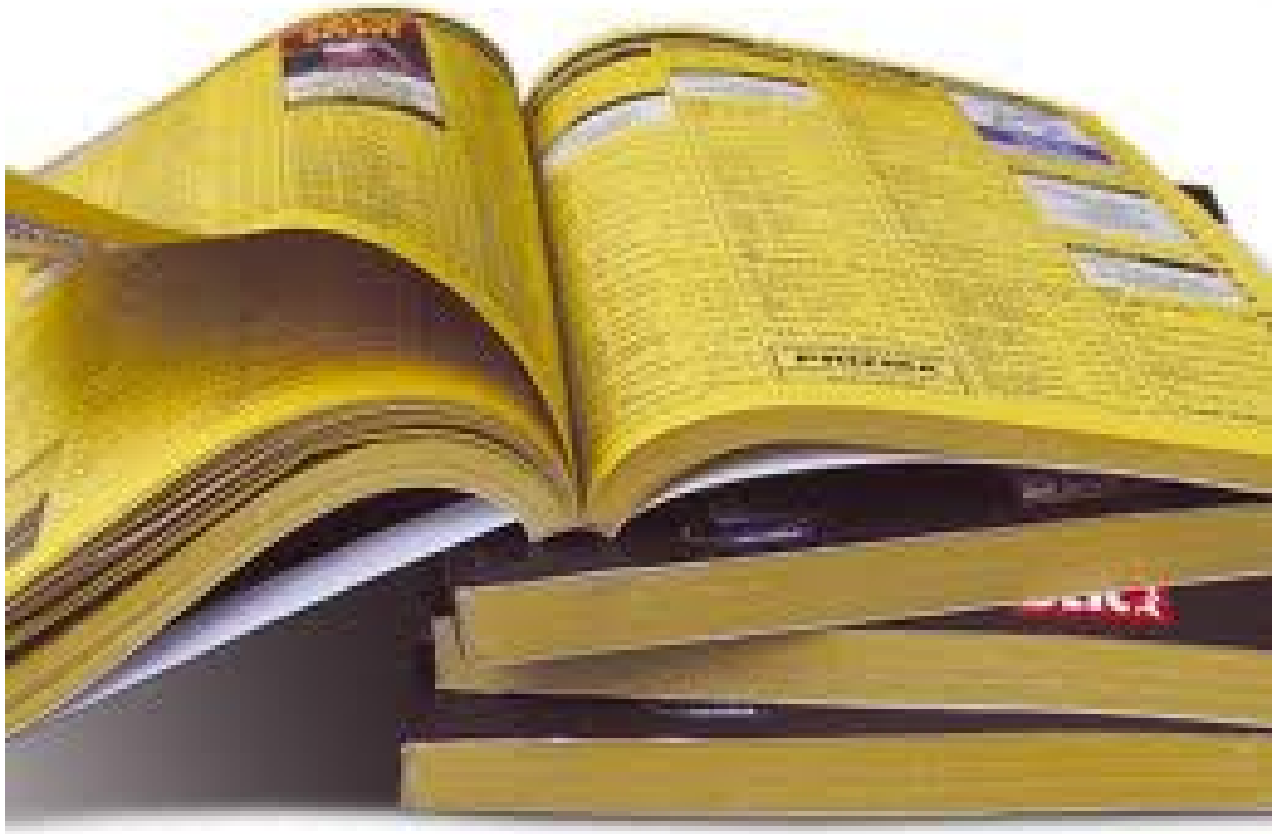
- Students struggled with Error formula. Good idea to review summation formula and other algebra basics.
- Students should work in groups to complete practice problems. Some will need extra description to understand the problem.
- Helpful to have covered maximum/minimum in calculus before this activity.
- Phonebook activity good for group work.

Logarithms and Search

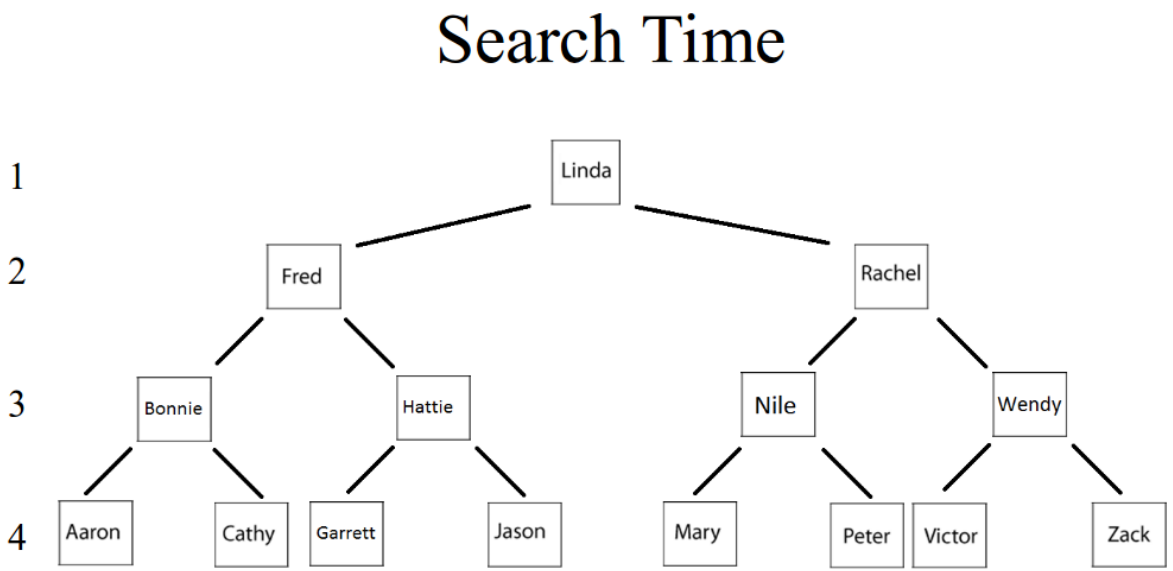
How do you search through a giant database efficiently?
What does efficient mean?

Phonebook Search

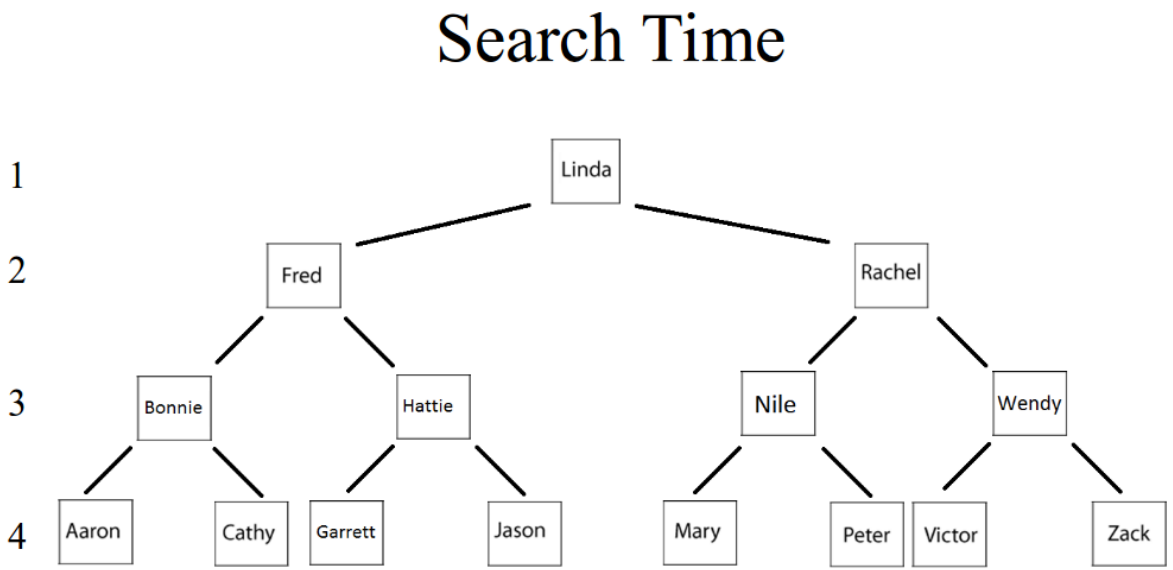
Phonebook activity



Phonebook Search



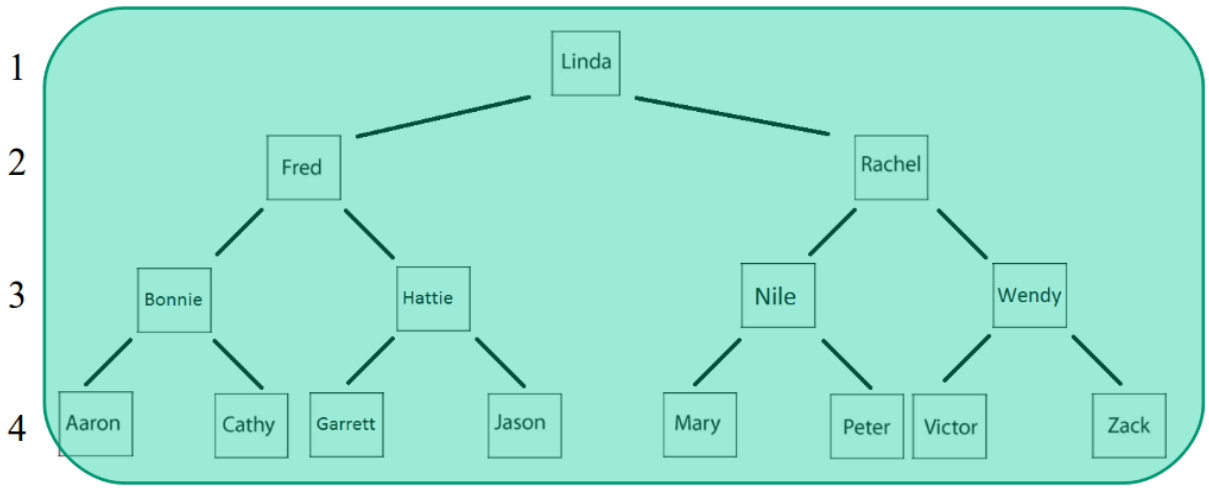
Phonebook Search



15 (n)ames
4 (c)hecks
How is (c)hecks (search time) related to number of (n)ames?

Phonebook Search

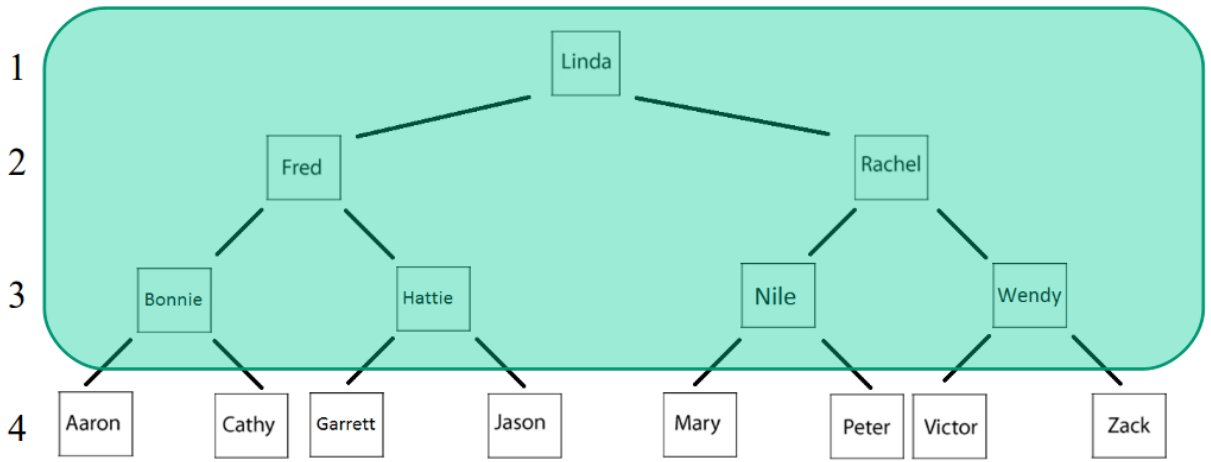
Binary Trees



$2^4 - 1 = 15$

Phonebook Search

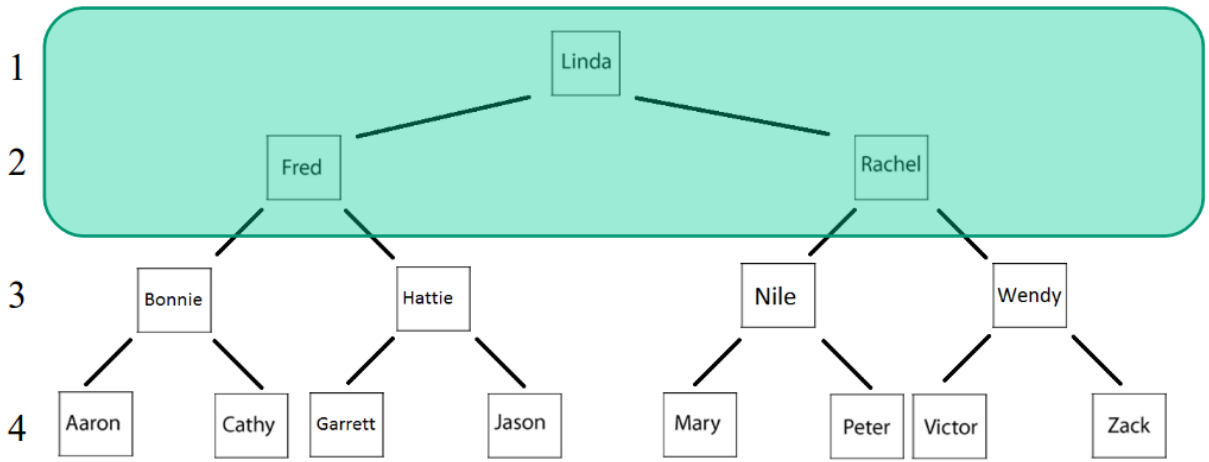
Binary Trees



$2^3 - 1 = 7$

Phonebook Search

Binary Trees



$2^2 - 1 = 3$

Phonebook Search

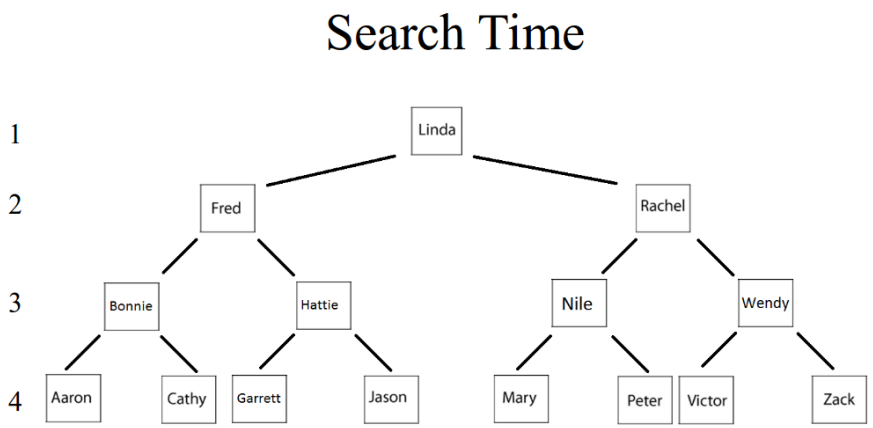
There exists a relationship between the number of (c)hecks and number of (n)ames. Essentially,

$$2^c - 1 = n \tag{1}$$

Or, to make it simpler

$$2^c = n \tag{2}$$

If we know how many names there are, how do we compute the number of checks needed?



$$2^c = n \tag{3}$$

$$log_2(2^c) = log_2(n) \tag{4}$$

$$c = log_2(n) \tag{5}$$

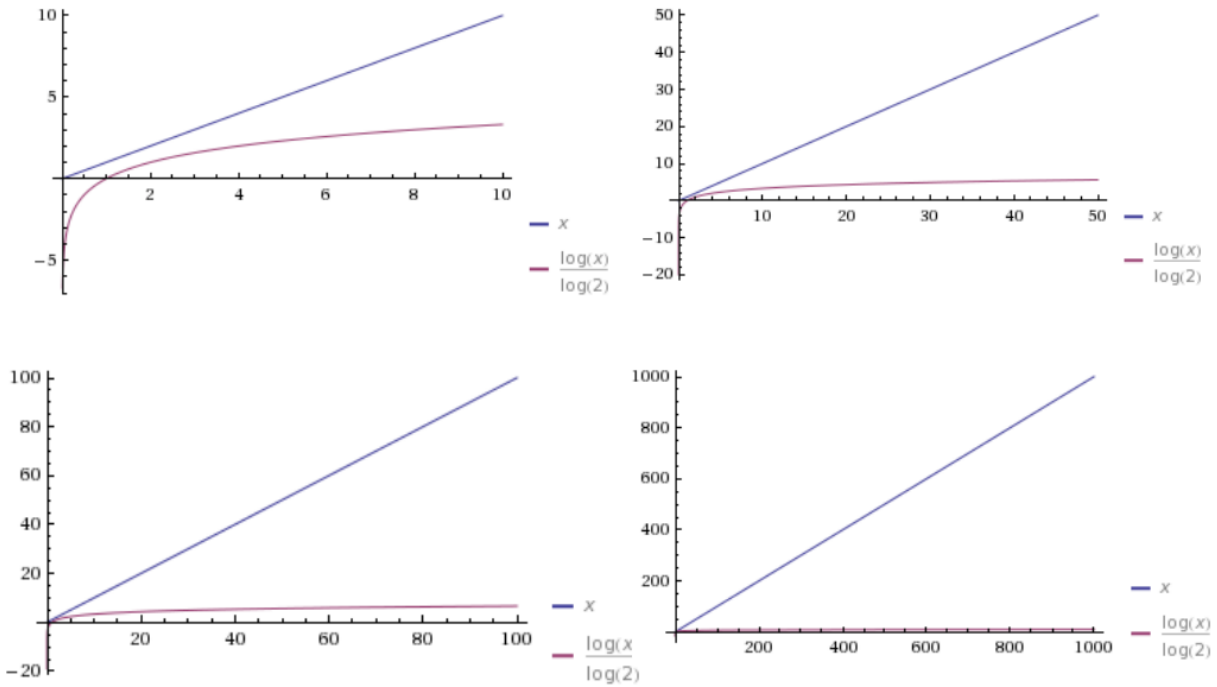
Phonebook Search

What does this mean?

Number of Names	Max Number of Checks
2	1
4	2
8	3
16	4
...	...
256	8

Phonebook Search

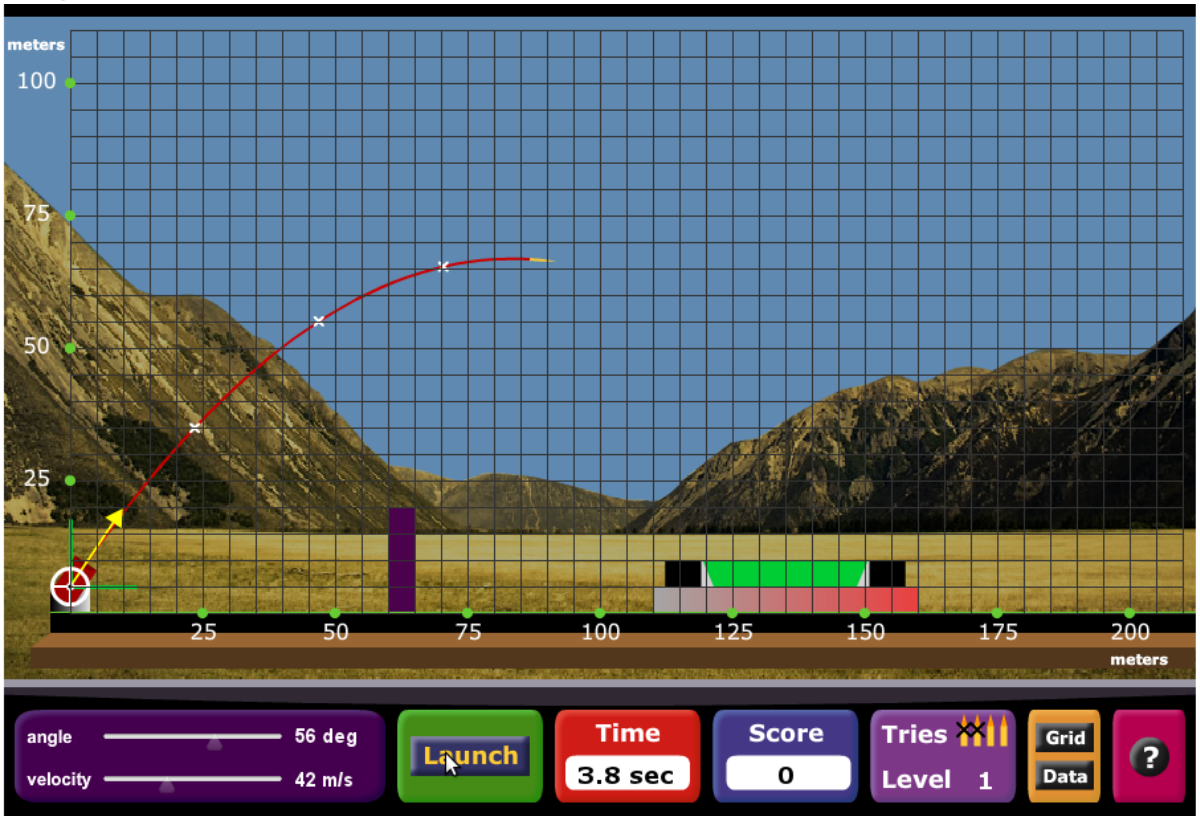
Comparing Linear and Binary Searches



y = time
x = number of names

Winning a game

Finding the parameters to a quadratic $ax^2 + bx + c = y$.



More Mathematics

More interpretations/activities

- Lines can be used to understand hit-detection (video games).
- Systems of equations (GPS)
- Functional notation and programming.

Thanks for coming!