BITS AND REPRESENTATIONS

MSiA 413
Week 2 Discussion

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Announcements

- Homework Groups are out
  - HW1 will be posted by the end of the day
  - Due next week!
- Office Hours
  - Nikos – Thursday 1:30 – 2:30 Mudd 3517
  - Vyas – Friday 4-5 Mudd 3532

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Introduction

- Biography
- Philosophy/Purpose
  - Nikos's lectures are about learning new material, my sections are going to be about reinforcement and supplemental material.
  - Ask me questions here or on Piazza
- Quick informal survey
  - What is your background?
  - What are you looking to get out of the course?

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Integer Representations

- What is the smallest number of bits necessary to represent 2018 as an unsigned number?
  - As a signed number?
- Convert 2018 to binary
- Convert 2018 to hex
- Write -2018 in binary using two's-complement signed representation as a two-byte number
- Calculate 20+18 using 5-bit unsigned integers
- Calculate 20+18 using 6-bit signed integers

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Arithmetical Properties

- If x, y, and z are unsigned integers, which statements are true?
  - x + y == y + x
  - x + (y + z) == (x + y) + z
  - x == -(-x)
  - x + x >= x
- Which of the above answers change with signed integers?
- Which of the above answers change with floating point representation?
- If x and y are signed integers with x > y, is (float) x > (float) y?

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Primitive Data Types in Databases

Assume every entry in your database has the following format:

`(char[16] double double int)`

- How many bits would an entry in this table be?
- If you have 4GB of RAM, how large can your table be if you want to store the entire table in memory?
- If the string were removed, how many times larger could your table be and still fit in memory?
- What else do you think might limit the size of the table?

Data Type	Bytes
char	1
short	2
int	4
float	4
long	4
double	8
long long	8

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Real Data Types

- True or False: In 32-bit floating point arithmetic, 0.2 + 0.2 == 0.4
- True or False: In 32-bit floating point arithmetic, 0.25 + .25 == .5
- Convert the number 0.8 into base-2, with a 4-bit mantissa
- What is this number really equal to?
- What is the relative error of this approximation?

$$\varepsilon_{rel} = \frac{|f(x) - x|}{|x|}$$

- What would the relative error of this approximation be if a 5-bit mantissa were used instead?
- What would the relative error be using full 32-bit floating point?
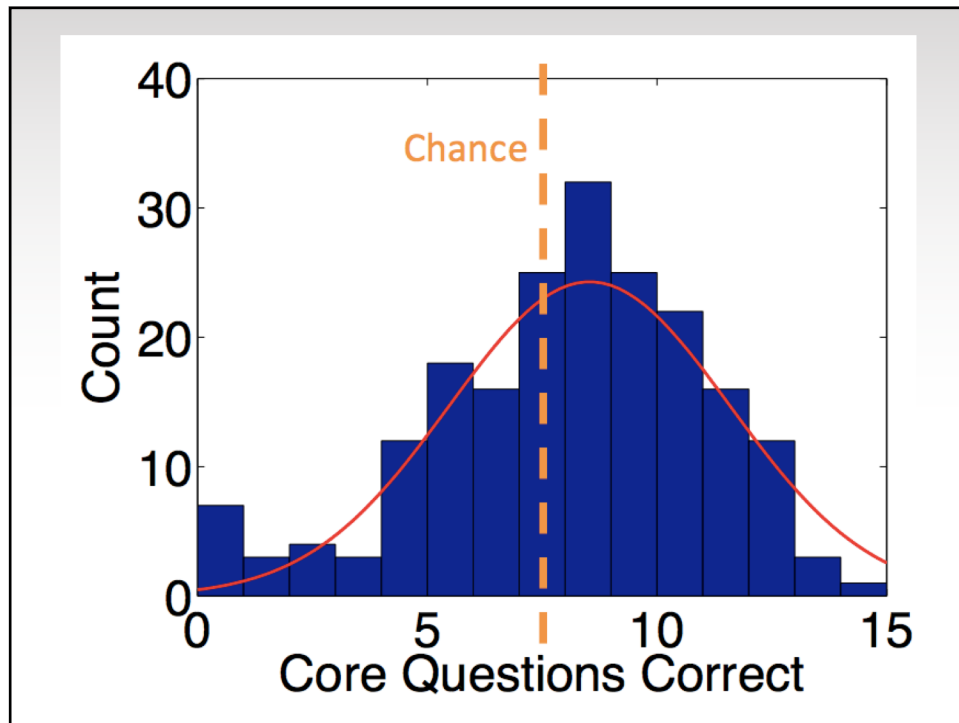- http://www.binaryconvert.com/result_float.html

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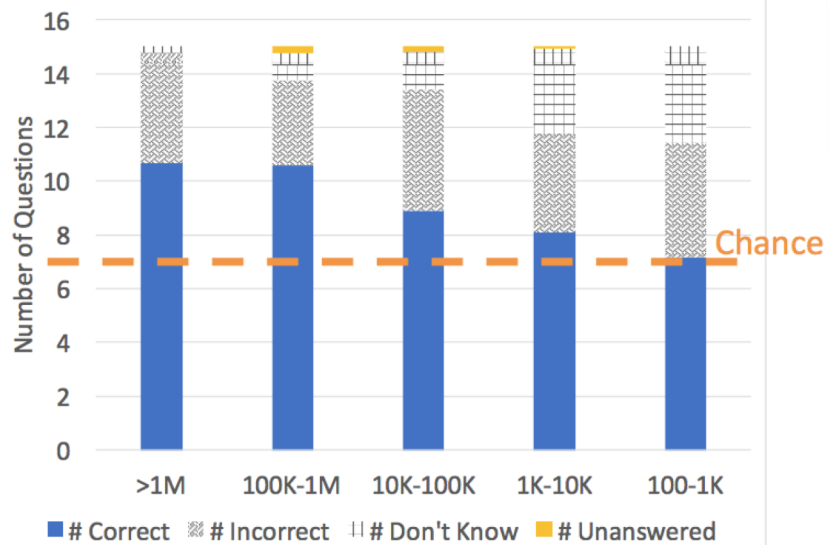## Do People Really Understand Floating Point?

- One of our faculty members surveyed academics and researchers at top universities to ask them a series of basic questions about floating point arithmetic.
  - Tracked Position, Area of Expertise, Training with FP, Experience with Largest Codebase, etc.
  - Not a random sample of the public!
- Can anyone guess what happened?

Dinda, P., & Hetland, C. (2018, May). Do Developers Understand IEEE Floating Point?. In 2018 IEEE International Parallel and Distributed Processing Symposium (IPDPS) (pp. 589-598). IEEE.

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Largest Contributed Codebase