The UCSD Freshman Seminar on *The Slide Rule*

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Background

- Started seminar in 2003
- For UCSD freshman
- 10 weeks, 1 hour per week, 1 unit of credit
- Classes limited to 10-20 students
- Students come from all areas
  - Engineering
  - Physical sciences
  - Some humanities

Why teach about slide rules?

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- Engineering heritage

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- Power of slide rules vs. computers

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- Engineering heritage
- Power of slide rules vs. computers
- Interesting mathematics

Why do students take this seminar?

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"I have no idea what a slide rule is, but I know engineers used them to build great things"

Why do students take this seminar?

"I thought it would be cool to learn how to use a slide rule and show my friends"

Why do students take this seminar?

"My dad used a slide rule, and I want to learn about it (and show him)"

Topics

- How the slide rule works
  - all the scales

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- The math behind the slide rule

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  - all the scales
- The math behind the slide rule
- Advanced topics

First few weeks

- The basics
  - learning to read the scales
  - multiplication, division, powers, roots
  - folded scales, inverted scales, …
- Trig scales
- LL scales

Significant Digits

- What is 2.1 x 3.1?

Significant Digits

- 2.1 x 3.1 = 6.51 “by calculator”

Significant Digits

- 2.1 x 3.1 = [6.3 .. 6.8]
  - 2.05 x 3.05 ≈ 6.25
  - 2.15 x 3.15 ≈ 6.77

Significant Digits

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  - 2.05 x 3.05 ≈ 6.25
  - 2.15 x 3.15 ≈ 6.77
- 2.1 x 3.1 ≈ 6.5 2 significant digits

Significant Digits

- What is 2.8 x 4.1?

Significant Digits

- 2.8 x 4.1 = 11.48 “by calculator”

Significant Digits

- 2.8 x 4.1 = [11.1 .. 11.8]
  - 2.75 x 4.05 ≈ 11.14
  - 2.85 x 4.15 ≈ 11.83

Significant Digits

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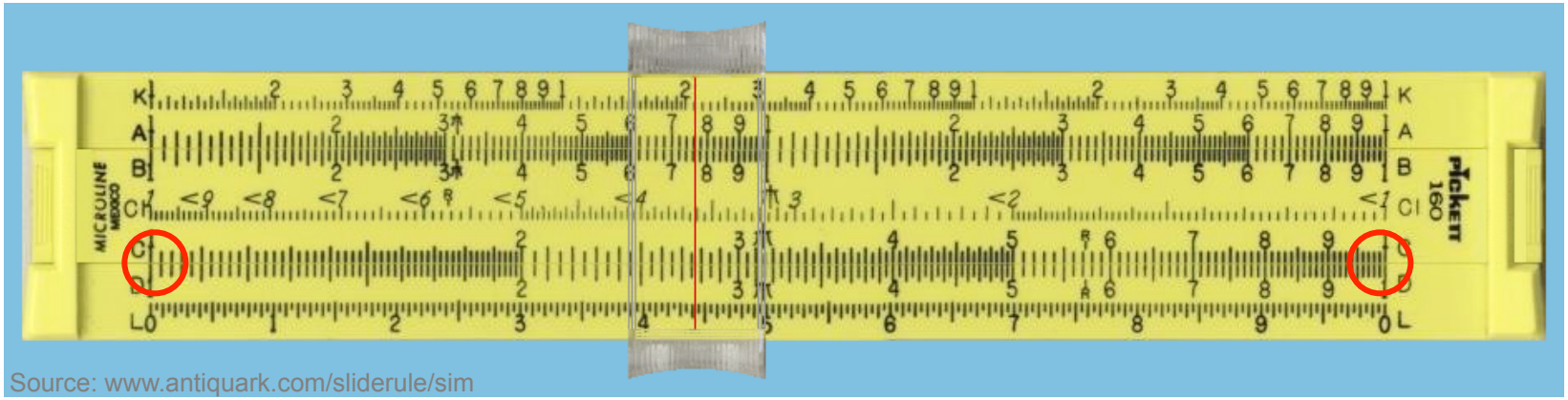
- 2.8 x 4.1 ≈ 11.5 3 significant digits

Precision

- Depends on physical length
- 10 inch rule: 3-4 digits
- Ways to increase precision
  - Increase physical length
  - Wrap scale around rule to increase length
  - Magnify the area of focus

Precision — Relative Error



Source: www.antiquark.com/sliderule/sim

- Compare physical distances at extremes
  - Distance (1.00, 1.01) ≈ Distance (9.9, 10)
  - (1.01-1.00)/1.00 = 1%, (10-9.9)/10 = 1%
- Relative error uniform across log scale

Precision vs. Accuracy

- $2 \times 3 = 6$
  - accurate, not precise
- $2.00 \times 3.00 = 6.01$
  - more precise, less accurate
- Are 2 and 2.00 located at same place?
  - Does it matter? Why?

Calculating Power

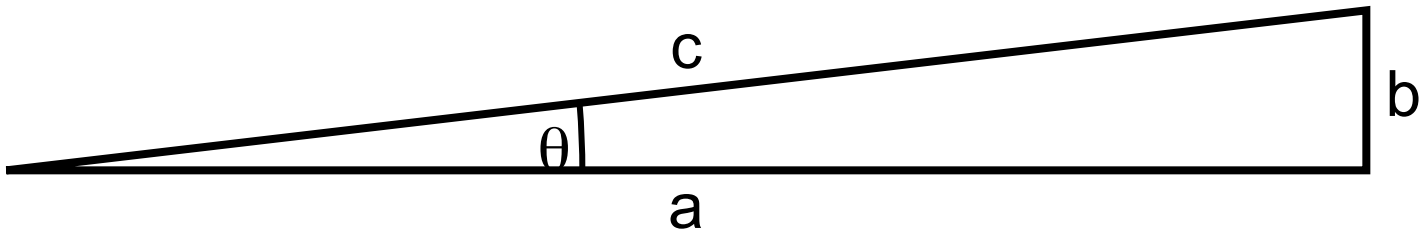
- Any operation expressible in the form

  A + B = C or **A - B = C**

  can be implemented with a slide rule

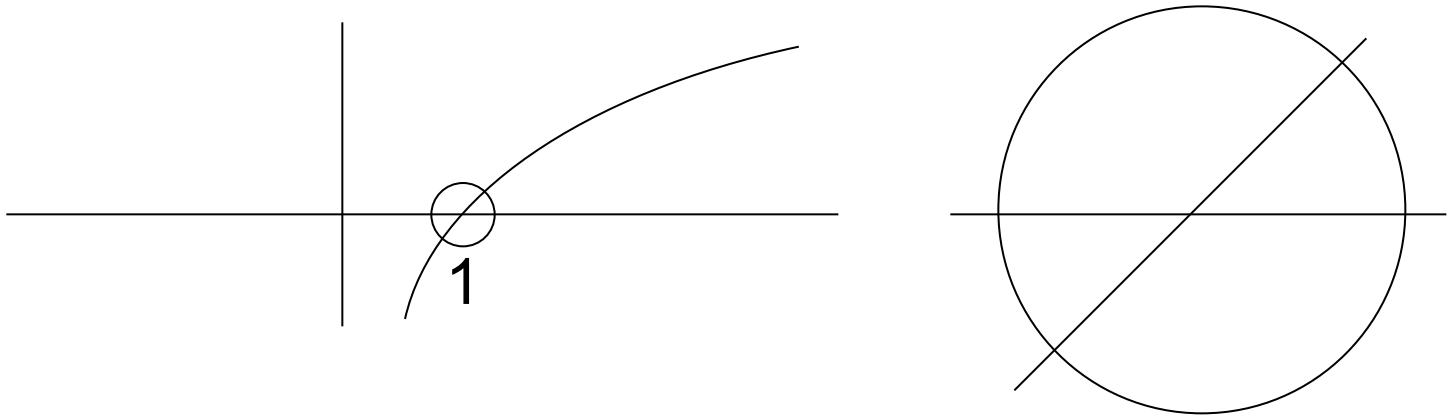
- $x \times y = z \rightarrow \log x + \log y = \log z$
- $x \div y = z \rightarrow \log x - \log y = \log z$
- $x^y = z \rightarrow \log \log x + \log y = \log \log z$

sin θ ≈ tan θ, for small θ



- sin θ = b/c, tan θ = b/a
- For small θ
  - a ≈ c, therefore sin θ ≈ tan θ
  - Use ST scale for θ < 5.74

ln 1+x ≈ x for small x



- Near x = 1, ln 1+x ≈ x (linear)
- log 1 = 0

The Gilligan's Island Problem

- You are stranded on an island
- You are "the professor"
- You must save the crew
- You decide to build a slide rule

How to build scales?

- How do you determine graduations for …
  - log scale
  - log log scale
  - sin scale
  - tan scale
- Arithmetic + geometry, *no calculators*

Larger Lessons

- Economy of calculating
  - slide rules
  - calculators
  - computers
- Estimation, approximation
- Social value
  - parents, grandparents

Quotes

My skills of estimation are getting better … I like being engrossed in the calculations, instead of just punching them into my calculator. I make less mistakes, and find I know what I am talking about …

- Brian Robbins

Quotes

I like being able to see mathematical operations in the visual way that a slide rule allows … This seminar has given me a better understanding of precision, relationship between logs and multiplication, and Benford's Law.

- Amy Cunningham

Quotes

What amazes me the most about the slide rule is that it works … I can't help but marvel at its design and that someone actually was able to create such a device ... Its complexity is just mind boggling.

- Kendra Kadas

Quotes

I was in physics class, and the professor explained how tan and sin are close for really small angles. The class didn't show much reaction, but my first thought was "hey, I learned that from my slide rule seminar."

- John Beckfield

Quotes

This slide rule seminar is the only thing saving me from a quarter full of literature writing, and other humanitarian monotony. After hours of "theory of literature," I realized I still had slide rule homework. Hurray!

- Lydia McNabb

Quotes

The slide rule rules. The slide rule is truly an extension of a person, not something completely separate such as the calculator. I actually had to think before, during, and after getting the answer on the slide rule.

- Lynn Greiner

Quotes

I'm actually quite amazed with the design of the slide rule. I find the folded scales especially ingenious … I definitely feel I understand what I'm doing - not quite the "black box" that calculators are.

- Ryan Lue

Quotes

The more I use the slide rule, the greater the insight I have into how ingeniously the scales were put together. I hope I can re-teach my parents how to use it.

- Chris Brumbaugh

Questions?

FOR MORE INFO

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