

# Before we start

If you or someone you know is suffering from **food and/or housing insecurities** the Triton Food Pantry (in the old Student Center),

<https://www.facebook.com/tritonfoodpantry/>

is free and anonymous, and includes produce.

If you find yourself in an uncomfortable situation, ask for help. We are committed to upholding University policies regarding nondiscrimination, sexual violence and sexual harassment.

**OPHD** at (858) 534-8298, [ophd@ucsd.edu](mailto:ophd@ucsd.edu), <http://ophd.ucsd.edu>.

**CARE** at Sexual Assault Resource Center at 858 5345793 [sarc@ucsd.edu](mailto:sarc@ucsd.edu) <http://care.ucsd.edu>

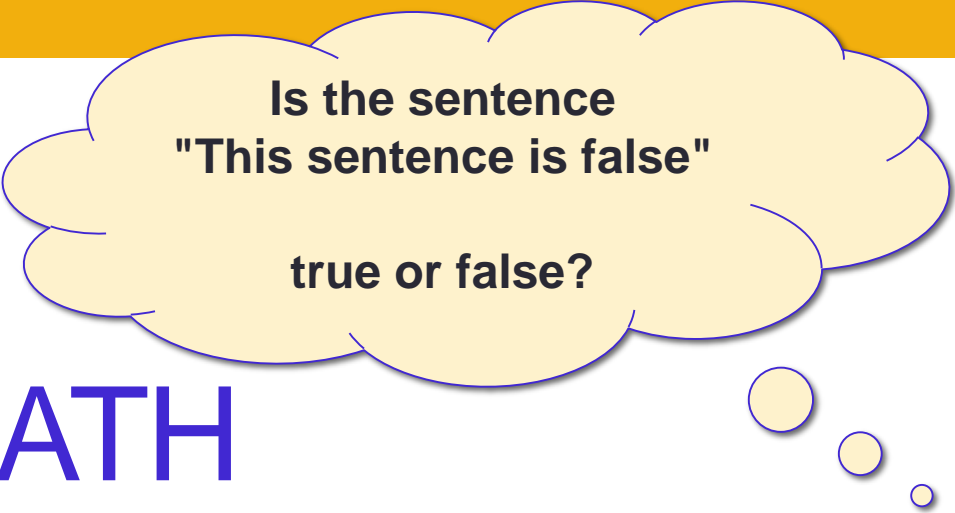
Counseling and Psychological Services (**CAPS**) at 858 5343755 or <http://caps.ucsd.edu>

Financial aid resources, the possibility of emergency grant funding, and off-campus housing referral resources are available. See CAPS and your college dean.

# CSE 20

# DISCRETE MATH

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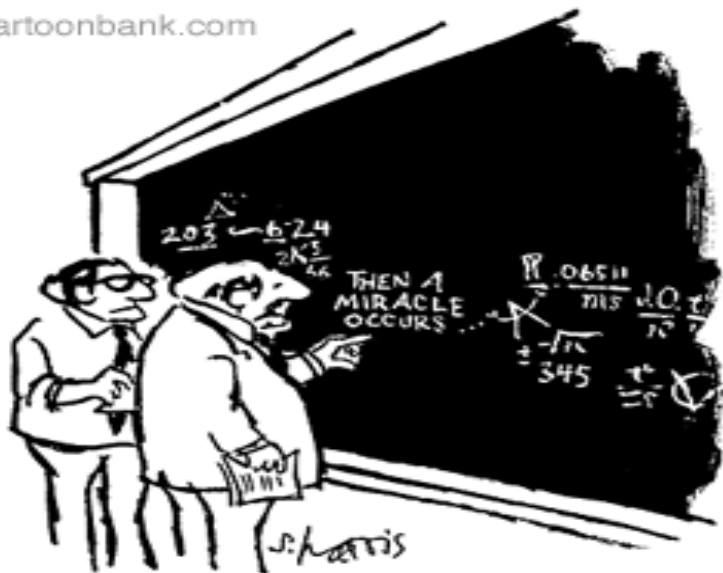
Is the sentence  
"This sentence is false"  
true or false?

Fall 2017

<http://cseweb.ucsd.edu/classes/fa17/cse20-ab/>

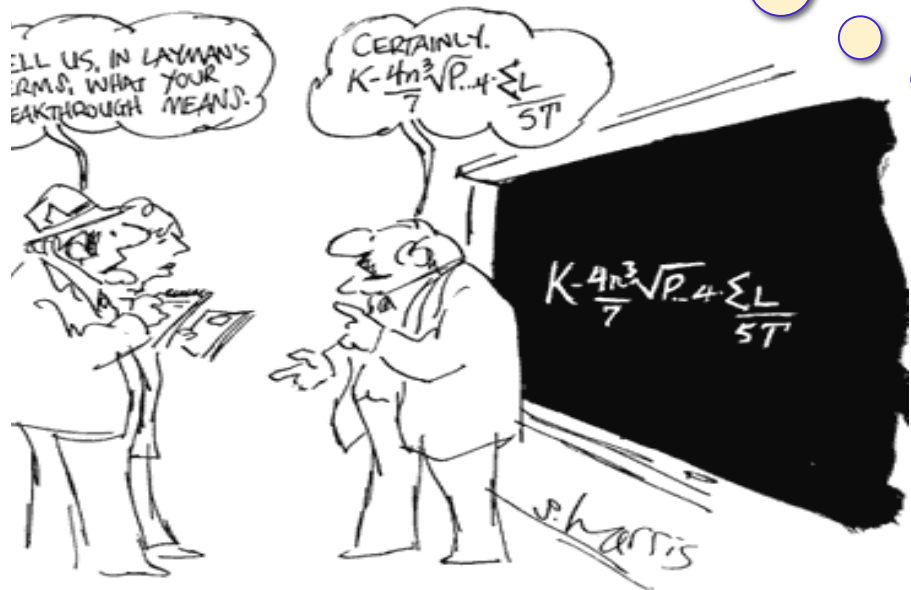
# Learning goals

© Cartoonbank.com



"I think you should be more explicit here in step two."

Is the sentence  
"This sentence is false"  
true or false?



## In this class, we will answer ...

- How do we decide (and prove) what's true?  
About algorithms and games and strategies / databases / cryptographic systems / compilers / operating systems / circuits ...
- How do we exploit these properties to solve problems?  
Use integer representations to build ALU, use strings to build error-correcting codes, use logic to optimize database queries ...
- What's impossible? And what can we say about it?  
Logical paradoxes, different sizes of infinity

# Introductions



# About you

**Are you taking  
or do you plan  
to take Math  
109?**

Have you used iClickers before?

- A. Yes
- B. No

CENTR 105: AB

CENTR 115: BA

To change your remote frequency

1. Press and hold power button until flashing
2. Enter two-letter code
3. Checkmark / green light indicates success

**Why use  
clickers?**

# About the team

"Minnes" *rhymes with* Guinness

CSE 4206: office hours + come by anytime I'm in.

Best way to get in touch is via Piazza

- Public post: question about class policy, notes, etc.
- Private post: question about your HW submission, grading, special circumstances.

Website: [cseweb.ucsd.edu/~minnes](http://cseweb.ucsd.edu/~minnes)

Email: [minnes@eng.ucsd.edu](mailto:minnes@eng.ucsd.edu)

Ongoing theory + education research: read more on class website



TAs + Tutors

# Logistics

More details on  
Review Quiz 1

## Weekly activities:

Pre-class reading/videos + Class + Discussion section + Review Quiz + HW

**Textbook:** Rosen 7<sup>th</sup> Edition other editions ok; on reserve

**Exams:** Midterm: **Tuesday** Oct 31  
Final: **Saturday** Dec 16



**Website:** <http://cseweb.ucsd.edu/classes/fa17/cse20-ab/>

**Gradescope:** Homework submission and exam return.

**Piazza:** announcements and Q&A. [Contact instructors here!](#) [HW solutions here!](#)

**Office hours:** instructors and tutors. [Discuss HW questions here!](#)

**Class podcast:** [podcast.ucsd.edu](http://podcast.ucsd.edu) [Live + Supplementary videos](#)



# About this class: Academic integrity

It's an integrity violation to...

- Click in for someone who is absent
- Sign discussion attendance sheet for someone who is absent
- Ask others to give you specific HW or quiz or test answers
- Share your answers on HW or quiz or test
- Work on HW with anyone else than your HW partner
- Search the internet or other resources not provided for this quarter's class for HW solutions or hints
- Share answers or notes while taking an exam

**This not a complete list ... you are responsible for knowing and following the guidelines** *Academic integrity violations will be taken seriously and reported to the UCSD Academic Integrity Office.*

# About this class: Academic integrity

You are working on a homework question with your partner and are stuck on a question. You run into a friend who solved the problem already and shows you her solution. You look at it, but put it away before continuing the group conversation. Is this acceptable?

- A. Yes
- B. No

# Today's learning goals

- How can we determine if an **algorithm** does what it's supposed to?
  - Trace pseudocode given input.
  - Explain the higher-level function of an algorithm expressed with pseudocode.
  - Identify and explain (informally) whether and why given pseudocode satisfies properties of being an algorithm.
  - Give counterexamples to show how an algorithm fails to be correct.
  - Define the greedy approach for an optimization problem.
  - Analyze whether the greedy approach solves an optimization problem.

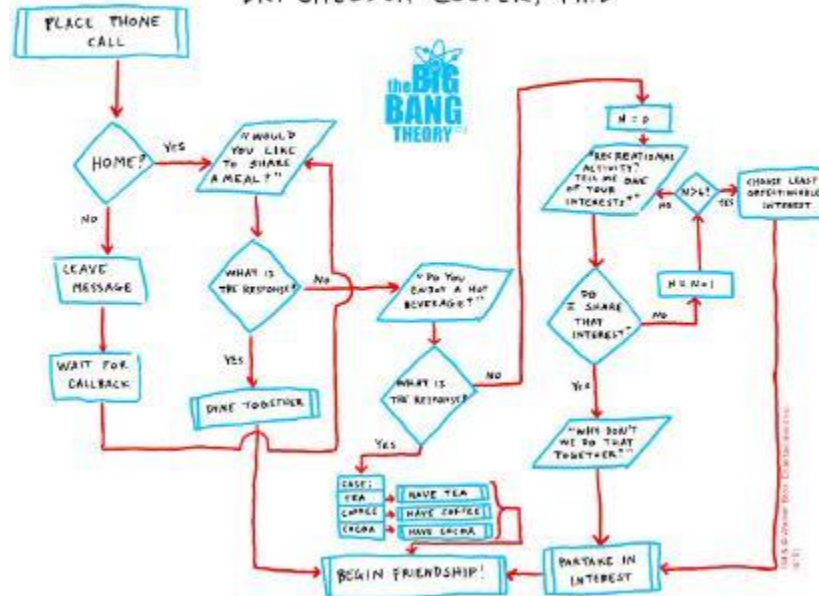
# Algorithm?

Rosen 3.1 p. 191

Finite sequence of precise instructions for solving problem.

## THE FRIENDSHIP ALGORITHM

DR. SHELDON COOPER, Ph.D

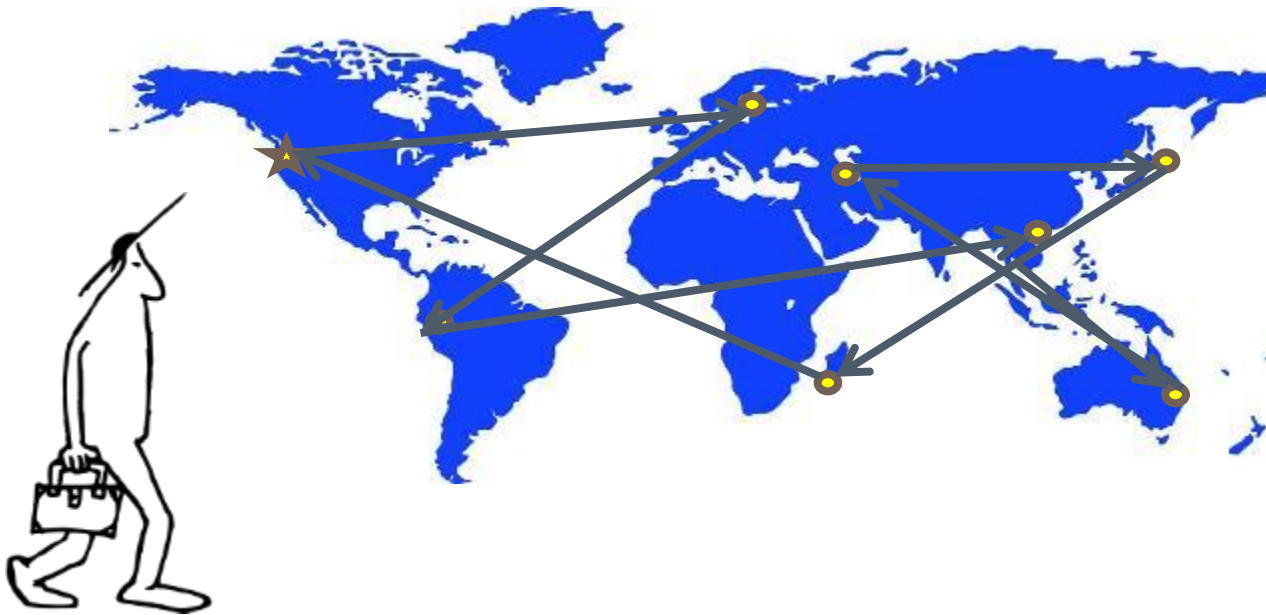


Properties

- finite (terminating)

- correct

# Optimization



# Cookies!

*Rosen p. 198*

1	7	2
8	9	6
3	5	4

Select 3 cookies

Optimize chocolate  
*aka maximize total number  
of chocolate chips*

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*Greedy approach:* pick cookie with most chocolate chips first, then pick one with 2<sup>nd</sup> most second, etc.

# Cookies!

*Rosen p. 198*

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Select 3 cookies

Optimize chocolate  
*aka maximize total number  
of chocolate chips*

*Greedy approach:* pick cookie with most chocolate chips first, then pick one with 2<sup>nd</sup> most second, etc.

*Correct? i.e. Will it always find the optimal solution?*



# Cookies!

*Rosen p. 198*

1	7	2
8	9	6
3	5	4

Select 3 cookies **at most one per row/ column**  
Optimize: maximize total number of chocolate chips

*Greedy approach:* pick cookie with most chocolate chips first, then pick one with 2<sup>nd</sup> most second (**of allowed remaining cookies**), etc.

# Cookies!

Rosen p. 198

1	7	2
8	9	6
3	5	4

What cookie is picked first?

- A. 1
- B. 9 *dumb choice*
- C. 8
- D. Not well defined

**Greedy approach:** pick cookie with most chocolate chips first, then pick one with 2<sup>nd</sup> most second (**of allowed remaining cookies**), etc.

# Cookies!

Rosen p. 198

1	<del>7</del>	2
<del>8</del>	9	<del>6</del>
3	<del>5</del>	4

What cookie is picked next?

- A. 8
- B. 1
- C. 4
- D. None of the above

*Greedy approach:* pick cookie with most chocolate chips first, then pick one with 2<sup>nd</sup> most second (**of allowed remaining cookies**), etc.

# Cookies!

Rosen p. 198

1	7	2
8	9	6
3	5	4

14

19

Is this the best we can do?

- A. Yes
- B. No, but there's no algorithm to find this best.
- C. No, and there's an algorithm to find this best. cf JS

**Greedy approach:** pick cookie with most chocolate chips first, then pick one with 2<sup>nd</sup> most second (**of allowed remaining cookies**), etc.

# Cookies!

*Rosen p. 198*

- Selecting **any 3 cookies** to maximize chocolate:
  - Greedy algorithm is definite, finite, correct.
- Selecting one cookie from **each row / each column**, to maximize chocolate:
  - Greedy algorithm is definite, finite, NOT correct.

# Algorithm?

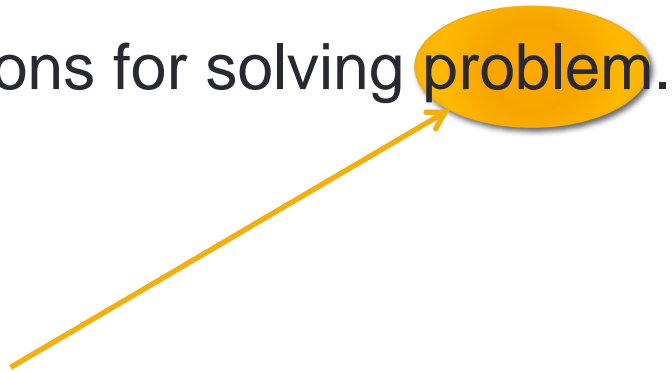
*Rosen 3.1 p. 191*

Finite sequence of precise instructions for solving **problem.**

**Optimization**

**Arithmetic**

...



# Algorithms!

Multiply  $142 \times 17$ .

$$\begin{array}{r} 142 \\ \times 17 \\ \hline \end{array}$$

$$\begin{aligned} & 142 \times 10 + 142 \times 7 \\ & = 142 \times 10 + 100 \times 7 + \dots \end{aligned}$$

$$(142 \times 10) + (142 \times 5) + (142 \times 2)$$

$$\begin{array}{r} 2 \overset{1}{1} 4 2 \\ \quad 1 7 \\ \hline \overset{1}{9} 9 4 \\ \quad 1 4 2 \\ \hline 2 4 1 4 \end{array}$$

What did we do?



# Russian Peasant Multiplication

**Input:** two factors, each a positive integer.

142, 17

Left	Right
142	17
284	8

71  
last?

Label two columns LEFT and RIGHT.

Write the value of first factor at the top of the LEFT column and the second factor at the top of the RIGHT column.

While last value in RIGHT column is greater than 1:

- On a new row in the LEFT column, write **double** the last value in this column.
- On the same row in the RIGHT column, write **half** the last value from this column.  
(Truncate fractions, i.e. ignore remainders)

Cross out the LEFT values in each row with even RIGHT value.

Add the remaining LEFT values together and output the result.

# Russian Peasant Multiplication

LEFT	RIGHT
142	17

While last value in RIGHT column is greater than 1:

- On a new row in the LEFT column, write double the last value in this column.
- On the same row in the RIGHT column, write half the last value from this column.

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Add the remaining LEFT values together and output the result.

# Russian Peasant Multiplication

LEFT	RIGHT
142	17
<del>284</del>	8 <i>even</i>
<del>568</del>	4 <i>even</i>
<del>1136</del>	2 <i>even</i>
2272	1

While last value in RIGHT column is greater than 1:

- On a new row in the LEFT column, write double the last value in this column.
- On the same row in the RIGHT column, write half the last value from this column.

Cross out the LEFT values in each row with even RIGHT value.

Add the remaining LEFT values together and output the result.

# Russian Peasant Multiplication

LEFT	RIGHT
142	17
284	8
568	4
1136	2
2272	1
2414	

While last value in RIGHT column is greater than 1:

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# Russian Peasant Multiplication

LEFT	RIGHT
142	17
284	
568	
1136	
2272	1
2414	

**Explore how this works in discussion + HW1!**

- If the value in the RIGHT column is greater than 1:
    - On the same row in the LEFT column, write double the last value from this column.
    - On the same row in the RIGHT column, write half the last value from this column.
- Cross out the LEFT values in each row with even RIGHT value.
- Add the remaining LEFT values together and output the result.

# To describe an algorithm

Rosen Appendix 3

- English description. RPM

- Pseudocode.  
(not specific  
syntax)

$x := 3$

assignment

$x = y$  ?

comparison

# For next time

- Read website carefully

<http://cseweb.ucsd.edu/classes/fa17/cse20-ab/>

- Complete **pre-class survey + pre-test**
  - Set up course tools: Piazza, gradescope, iclickers
- Start **Homework 1** Due Friday Oct 6, 11pm
  - Find a partner, if you wish (you can use Piazza to help)
  - Pseudocode and algorithms + number representations