Programming as a Creative Outlet

VCTM 2019

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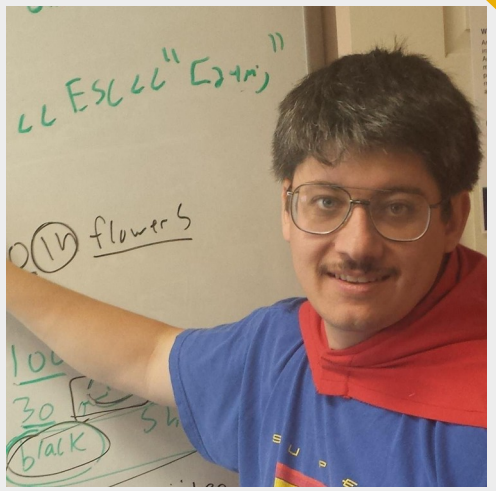
Robert Marmorstein



– PhD and MS in Computer Science from the College of William and Mary

– BA in Computer Science and Mathematics from Washington and Lee

– Research Interests in Cyber Security, Systems Programming, Sensor Networks, and Education

– Member of the Teachers and Technologists for Tomorrow Pipeline Initiative

Toni Sorrell

–PhD in Systems Modeling and Analysis from VCU

– MS in Interdisciplinary Studies from VCU

– National Board Certified Teacher AYA Mathematics from 2005-2015

– Taught 5th – 12th grade mathematics and science

– Nine years teaching pre-service elementary teachers at VCU and Longwood

– Research in Parameter Tuning Problems for Optimization Software

Overview

1) Design and document algorithms using children's literature

2) Teach and learn principles of Cyber Security and password generation

3) Jokes and messages teach ASCII encoding

4) Color by number illustrates image representation

5) Explore algorithm design using a random board puzzle-piece game

Why Unplugged Activities?

Pencil and Paper Activities

- Interactive and creative
- Inexpensive
- Provide “increased concentration levels and a more sensorial experience”[1]
- Gives students time to think
- Does not require access to a computer lab or laptops
- Fun!

[1]Vincent, Jane (2016) Students’ use of paper and pen versus digital media in university environments for writing and reading – a cross-cultural exploration. Journal of Print Media and Media Technology Research, 5 (2). pp. 97-106. ISSN 2223-8905

Algorithm Design Using Children's Literature

Computer Science Standard

[3.4/4.4/5.4] The student will **create a plan** as part of the **iterative design process**, both independently and collaboratively using strategies such as pair programming (e.g., **storyboard**, **flowchart**, **pseudo-code**, **story map**).

[Related: English 3.8c 4.7d,f 5.7c,d,e]

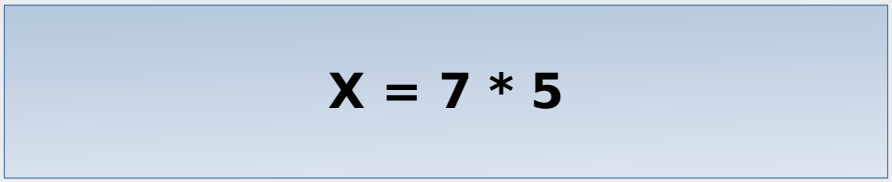
[7.2] The student will document programs to make them easier to follow, test, and debug.

[8.4] The student will use flowcharts and/or pseudo code to address complex problems as algorithms.

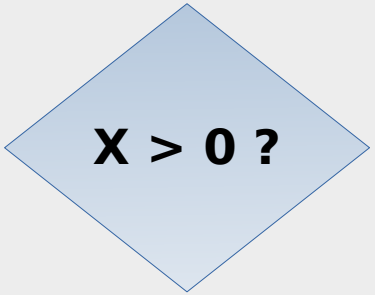
Algorithm Design Using Children's Literature

What is a flowchart?

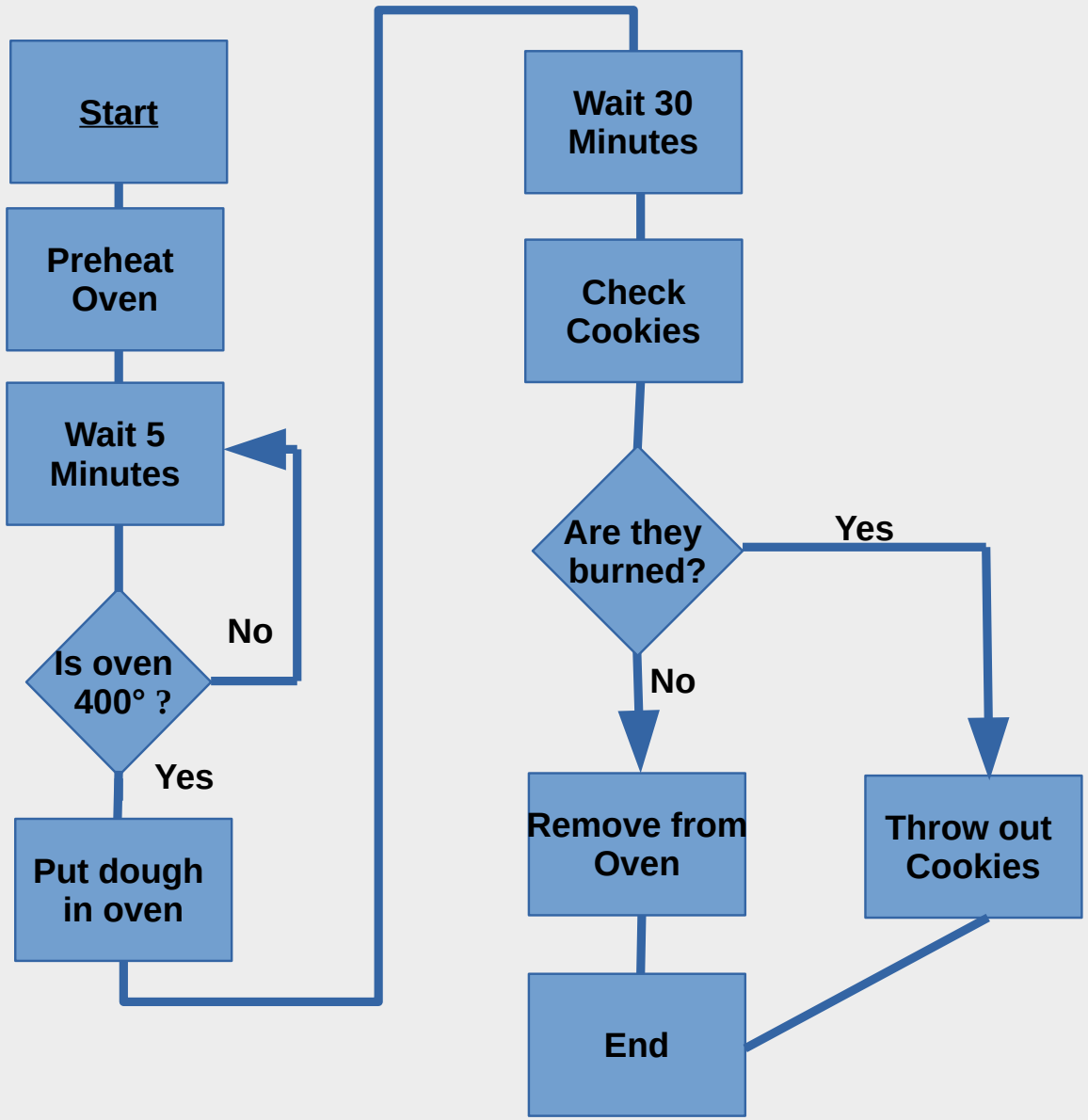
- A diagram that illustrates the **control flow** of a computer program.
- Uses two symbols:
  - Rectangles indicate **sequential steps**



  - Diamonds represent **decisions**



Flowcharts


Start
Preheat Oven
Wait 5 Minutes
Is oven 400° ?
No
Yes
Put dough in oven
Wait 30 Minutes
Check Cookies
Are they burned?
Yes
No
Remove from Oven
Throw out Cookies
End

Flowcharts

- Provide a high-level understanding of a program that abstracts away details
- No longer widely taught in Computer Science
- Primarily used to communicate technical ideas to non-technical stakeholders

Flowcharts Unplugged

- Use “Choose Your Own Adventure” as an algorithm
- Have students draw flow charts for the adventure
- Illustrates concept of a loop and a decision statement

Exploring Password Strength with a Guessing Game

Computer Science Standards

[4.11/5.10] The student will determine whether passwords are strong, explain why strong passwords should be used, and demonstrate proper use and protection of personal passwords.

What makes a password weak?

- **Length:** Short passwords are easy to guess
- **Variety:** Passwords with fewer kinds of characters are weaker
- **Commonly used passwords:** password, admin, 12345678, iloveyou
- **Use of personal information:** names, birthdays, phone numbers, school mascots are easy to find online
- **Insecure storage or use:** writing down a password, storing it on your phone, sharing it with a friend, reusing it on many sites.

https://haveibeenpwned.com/

Passwords

Which is better?

- Scenario 1: Double the length of the password
- Scenario 2: Use mixed case password

Let m be the number of glyphs in the character set.

Let n be the length of the password.

The size of the search space is given by:

$$|S| = m^n$$

Scenario 1: $|S_1| = m^{2n}$

Scenario 2: $|S_2| = (2m)^n$

Passwords

Example:

Passwords of different length with 3 different characters (for instance: a, b, c)

$$y = 3^x.$$

Double the size of the character set (a, b, c, d, e, f):

$$y = 6^x.$$

Double the length of the password:

$$y = 3^{2x}.$$

Let’s explore this in Desmos:
https://www.desmos.com/calculator/6v4viry00i

Password Activity

- Help students understand password strength by playing Hangman with weak passwords
- Count number of guesses so that students can compare difficulty of guessing each one
- Some weak passwords: House, Dynamite, F1do, JaneSmith, C@rrot, abcd12345
- A strong password: a!h47B9g

Image Representation Using Color-By-Number

Computer Science Standards

[4.14/5.13] The student will use numeric values to represent non-numeric ideas in the computer (e.g., binary, ASCII, **pixel attributes such as RGB**).

[Related SOL: Math 5.19a]

[6.7] The student will explain how binary sequences are used to represent digital data.

Exclusion: Conversions between binary and base-ten numbers are beyond the scope of these standards.

Representing Images

0 0 **1 1** 0 0 0 0 0 0 0 0 **1 1** 0 0
0 0 **1 1** 0 0 0 0 0 0 0 0 **1 1** 0 0
0 0 **1 1** 0 0 0 0 0 0 0 0 **1 1** 0 0
0 0 **1 1 1 1 1 1 1 1 1 1** 0 0
0 0 **1 1 1 1 1 1 1 1 1 1** 0 0
0 0 **1 1** 0 0 0 0 0 0 0 0 **1 1** 0 0
0 0 **1 1** 0 0 0 0 0 0 0 0 **1 1** 0 0
0 0 **1 1** 0 0 0 0 0 0 0 0 **1 1** 0 0

Representing Images

Colors: RGB (Red-Green-Blue) Format

Red: 255 0 0

Green: 0 255 0

Blue: 0 0 255

Yellow: 255 255 0

Magenta: 255 0 255

Cyan: 0 255 255

White: 255 255 255

Black: 0 0 0

What color is 128 0 128?

Representing Images

255	255	0	255	255	0	255	255	0	255	255	0
255	255	**0**	**0**	**0**	**0**	**0**	**0**	**0**	255	255	0
255	255	**0**	**0**	**0**	**0**	**0**	**0**	**0**	255	255	0
255	255	0	255	255	0	255	255	0	255	255	0

Representing Images

Color Palette:

0	White	5	Green
1	Black	6	Blue
2	Red	7	Purple
3	Orange	8	Brown
4	Yellow	9	Turquoise

Representing Images

Activity: Color by Numbers

- Give students an RGB color chart, markers, and coloring page
- Have them color images based on a palette

Data Representation using Jokes and Quotes

Computer Science Standards

[4.14/5.13] The student will use numeric values to represent non-numeric ideas in the computer (e.g., binary, **ASCII**, pixel attributes such as RGB).

[Related SOL: Math 5.19a]

[6.7] The student will explain how binary sequences are used to represent digital data.

Exclusion: Conversions between binary and base-ten numbers are beyond the scope of these standards.

Representing Text

- Text is represented on a computer using encodings
- Encodings assign a number to each letter, number, or symbol
- Common encodings: UTF-8 (Unicode) and ASCII

Representing Text

- ASCII (American Standard Code for Information Interchange)

•	**A**	65	**a**	97	**0**	48	**[Space]** 32
•	**B**	66	**b**	98	**1**	49	**!** 33
•	**C**	67	**c**	99	**2**	50	**“** 34
	…						
•	**Z**	90	**z**	122	**9**	57	**$** 36

Representing Text

Activity:

- Decode punch lines of jokes from ASCII

- Encode messages into ASCII codes

  What do you call a crab that plays Baseball?

  65 32 112 105 110 99 104 32 104 105 116 116 101 114

Constructing Algorithms using Board Games

Computer Science Standards

[2.1/3.1/4.1/5.1] The student will construct sets of step-by-step instructions (**algorithms**) both independently and collaboratively, a) **using sequencing**; b) **using loops**; c) **using variables to store and process data**; d) **performing number calculations on variables (addition, subtraction, multiplication and division)**; and e) **using conditionals** (if-statements).

[Related SOL: Math 5.18]
[Related SOL: Math 5.19]
[Related SOL: Math 5.5, 5.7]
[Related SOL: Math 5.2, 5.3]

Computer Science Standards

[6.1/7.1/8.1] The student will construct programs to accomplish a task **as a means of creative expression** or **scientific exploration** using a **block based** or text based programming language, both independently and collaboratively,

a) combining control structures such as if-statements and loops; and

b) creating **clearly named variables** that represent different data types, including numeric and non-numeric data, and perform operations on their values.

[Related SOL: Math 6.3, 6.6]

Algorithm Construction

Activity:

- Have students create a board game from cut-outs
- Cut-outs represent sequential steps and decision statements
- Students track variables on a “score” sheet

Thank you!

http://marmorstein.org/~robert/VCTM/

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Virginia Computer Science Standards taken from:

http://www.doe.virginia.gov/testing/sol/standards_docs/computer-science/index.shtml