Engaging Programming Assignments to Recruit/Retain CS0 Students

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CS0 Overview

The Rise of CS0

Because only 25% of high schools offer CS courses [1], often college students enroll in CS courses with little or no programming experience. Consequently, the need for a CS0 course taught at a slower pace using a more beginner-friendly programming language is growing. Studies have found higher retention and success rates for CS1 students when they take CS0.

Who Enrolls in CS0?

Students in CS0 vary significantly in terms of their:
- Programming experience levels
- Majors
- Math experience levels

CS0 (CptS 111) at WSU

CptS 111 is the CS0 course at Washington State University (WSU). To more successfully recruit students to CS0 and retain students to CS1, we aim to:
- Engage students in the course materials early and frequently
- Focus on programming assignments that incorporate engagement practices put forth by the National Center for Women in Information Technology (NCWIT)
- Cover foundational topics such as functions, literals, operators, arithmetic, lists, loops, conditionals, and graphics.

Programming Tools Used

The CptS 111 course uses:
- Python programming language
- APIs such as Google Maps [2]
- Hardware from AdaFruit Industries [3].

NCWIT EngageCSEdu

NCWIT sponsors a program called EngageCSEdu [4], a collection of peer-reviewed introductory CS materials that are contributed by faculty.

All materials in the collection have demonstrated evidence of NCWIT's research-based engagement practices:
- Make it matter
- Build student confidence and professional identity
- Grow inclusive student community

References
[1] Information Technology and Innovation Foundation, 2016
[2] https://developers.google.com/maps/documentation/distance-matrix/
[3] https://www.adafruit.com/
[4] https://www.engage-csedu.org/

## Example CS0 Assignments

Lightboard Lab (Lists, Loops)

ENGAGEMENT EXCELLENCE

- Hands on with Adafruit hardware
    - Fadecandy microcontroller (~$25 each)
    - 8x8 RGB LED matrix (~$35 each)
- Design "frames", 1D (or 2D) lists of RGB tuples
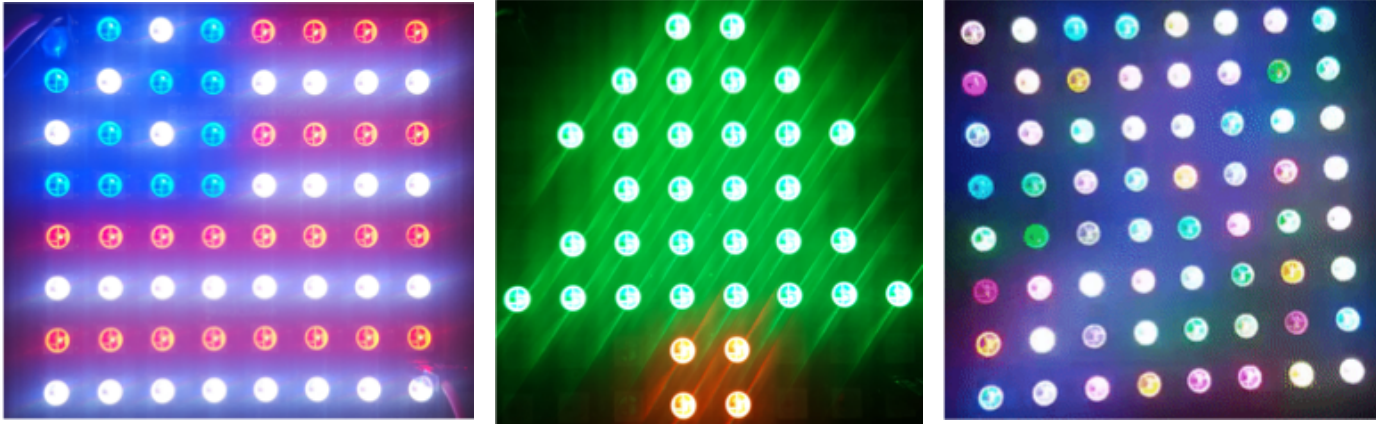
```
while True:
    for letter in python:
        client.put_pixels(letter)
        time.sleep(delay)
        client.put_pixels(black)
        time.sleep(delay_black)
```

- Insert time delays between frames
- Animate frames/delays with iteration
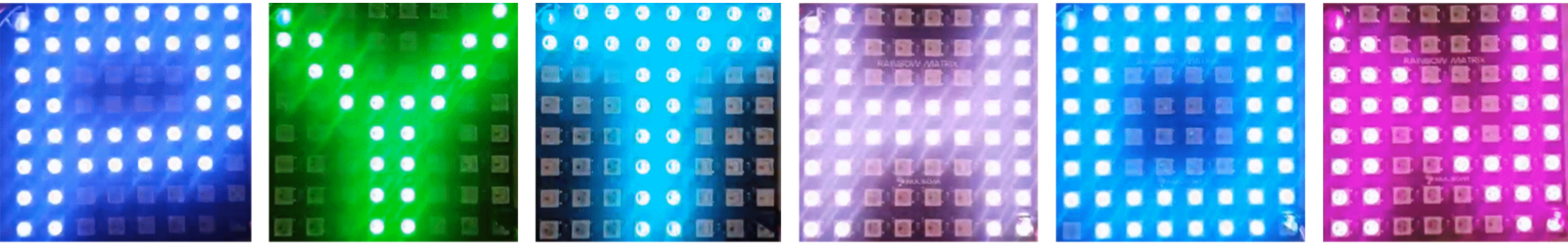
Best Road Trip Ever! (File I/O, Strings)

- Create a file that stores a road trip
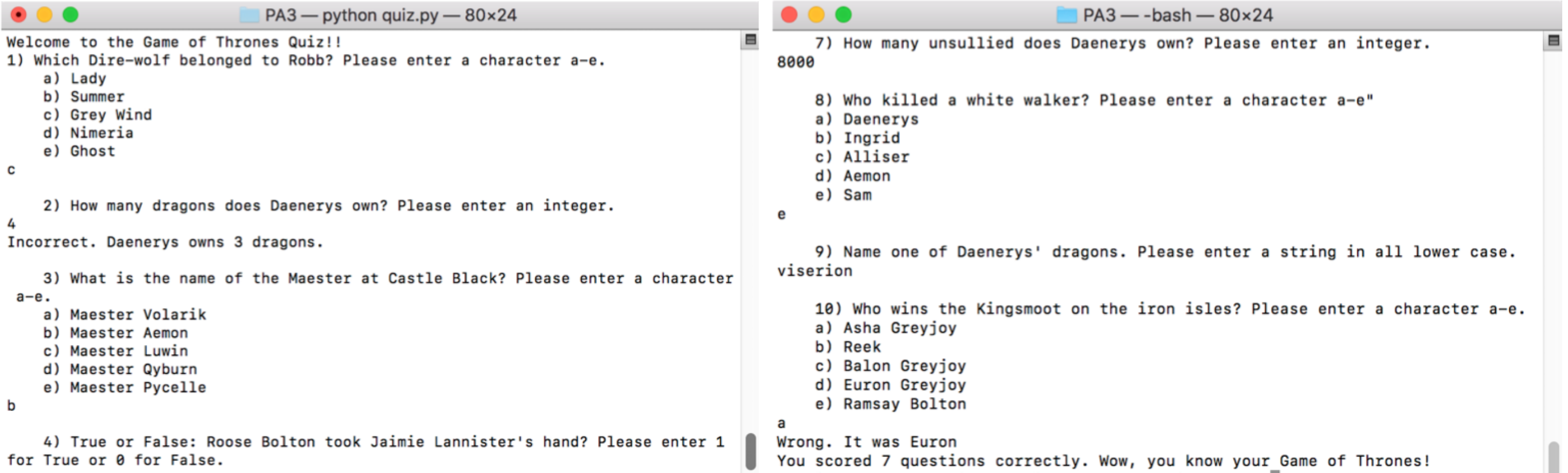- Use Google Maps Distance Matrix API to compute the distance/time between stops on the road trip

```
dist = get_distance("Seattle, WA", "Pullman, WA")
print("The distance between Seattle, WA and Pullman, WA is %d meters" %(dist))
```

The distance between Seattle, WA and Pullman, WA is 457989 meters

- Report road trip info and stats

"Are You a Fan?" Quiz (Conditionals)

ENGAGEMENT EXCELLENCE

- Example program output

```
Welcome to the Game of Thrones Quiz!!
1) Which Dire-wolf belonged to Robb? Please enter a character a-e.
    a) Lady
    b) Summer
    c) Grey Wind
    d) Nimeria
    e) Ghost
c
2) How many dragons does Daenerys own? Please enter an integer.
4
Incorrect. Daenerys owns 3 dragons.
3) What is the name of the Maester at Castle Black? Please enter a character a-e.
    a) Maester Volarik
    b) Maester Aemon
    c) Maester Luwin
    d) Maester Cyburn
    e) Maester Pycelle
b
4) True or False: Roose Bolton took Jaimie Lannister's hand? Please enter 1 for True or 0 for False.
```

```
7) How many unsullied does Daenerys own? Please enter an integer.
8000
8) Who killed a white walker? Please enter a character a-e.
    a) Daenerys
    b) Ingrid
    c) Alliser
    d) Aemon
    e) Sam
e
9) Name one of Daenerys' dragons. Please enter a string in all lower case.
viserion
10) Who wins the Kingsmoot on the iron isles? Please enter a character a-e.
    a) Asha Greyjoy
    b) Reek
    c) Balon Greyjoy
    d) Euron Greyjoy
    e) Ramsay Bolton
Wrong. It was Euron
You scored 7 questions correctly. Wow, you know your Game of Thrones!
```

- Example code

```
print(
"""1) Which Dire-wolf belonged to Robb? Please enter a character a-e.
a) Lady
b) Summer
c) Grey Wind
d) Nimeria
e) Ghost""")
ans = input()
if ans == "c":
    return 1
print("Sorry, that is wrong. The answer is c) Grey Wind.")
return 0
```

```
print("You scored %d questions correctly. " %(score), end="")
if score >= 7:
    print("Wow, you know your Game of Thrones!")
elif score >= 5:
    print("You are a fan but need to brush up. \
        I suggest re-watching all of the seasons.")
elif score >= 3:
    print("Really, you think you are a fan? I beg to differ!")
else:
    print("This is about the score of random guessing... \
        I think you should try watching Game of Thrones...")
```

CarBot (Input/Output, Arithmetic)

- Example program output

```
Cyberdyne Systems: Hello, what is your name? >> Joe
Cyberdyne Systems: Nice to meet you Joe. I am Skynet, a neural
net-based AI designed to assist mankind... In order to add you
to the database, I will need some basic information from you.
                    [output omitted for brevity]
Cyberdyne Systems: If my calculations are correct, the monthly
payment for your new BMW i8 will be $2483.60.
Cyberdyne Systems: Thank you for choosing to be part of
Cyberdyne's new Skynet technology Joe.
```

- Example code

```
monthly_interest_rate = interest_rate / 12 / 100
monthly_pymt = (cost * monthly_interest_rate) / (1 - (1 + monthly_interest_rate) ** -(years * 12))
total_accrued = years * 12 * monthly_pymt
```
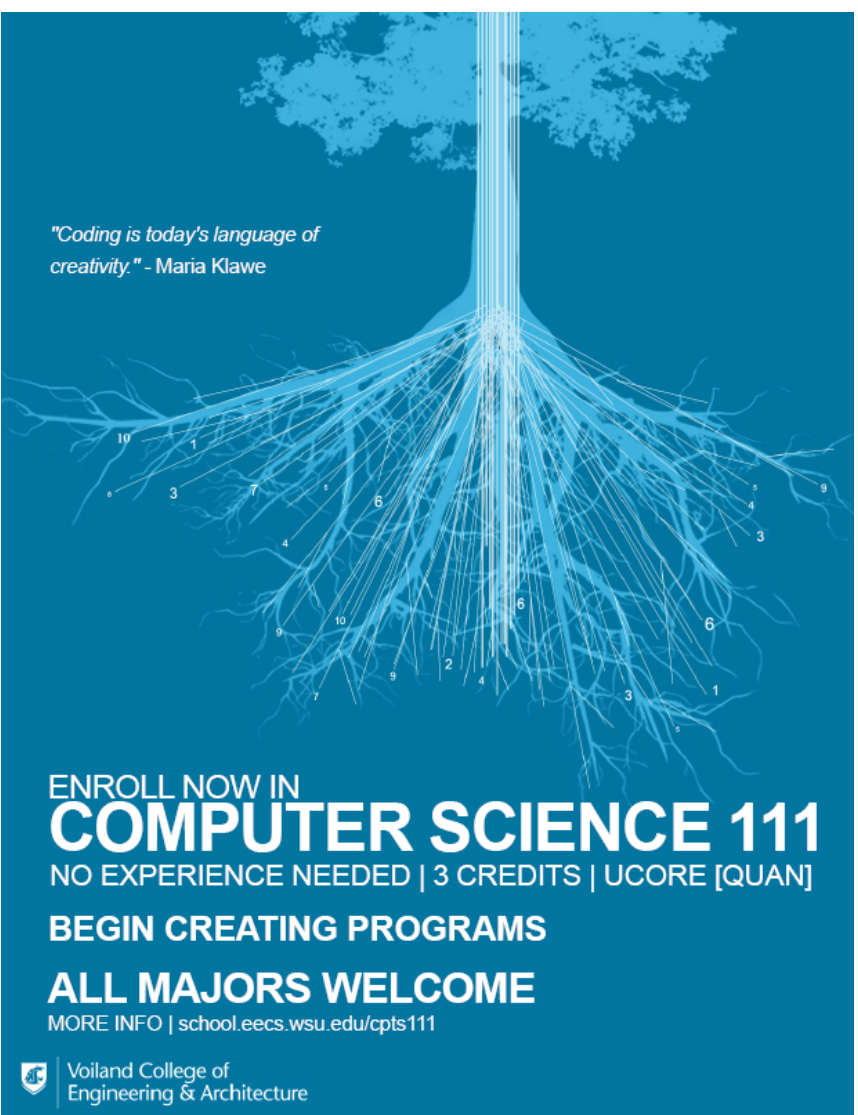
Publicity and Outreach Efforts

Advisors

Advisors encouraged to inform students about CptS 111 provide handouts to give to students during advising sessions.

Website

http://school.eecs.wsu.edu/cpts111/

Describes the course, emphasizes no prior programming experience is necessary, showcases course projects, includes student testimonials.

Posters Displayed On Campus

TO CODE IS TO create
Enroll Now in Computer Science 111
No prior knowledge needed! 3 credits
All Majors Welcome!
for more info, visit school.eecs.wsu.edu/cpts111

"Coding is today's language of creativity." - Maria Klawe
ENROLL NOW IN
COMPUTER SCIENCE 111
NO EXPERIENCE NEEDED | 3 CREDITS | UCORE [QUAN]
BEGIN CREATING PROGRAMS
ALL MAJORS WELCOME
MORE INFO | school.eecs.wsu.edu/cpts111

16 students (18.39%) saw a poster prior to enrolling; 3 said the poster influenced their decision to enroll in CptS 111:

- "The 'All Majors Welcome' was very encouraging."
- "Made it seem interesting"
- "I thought about it and decided that I wanted to gain a stronger understanding about computers"

Summary

Impact

NCWIT has published research concluding that students are more motivated, perform better, and are more likely to persist when a CS lesson connects to their life, interests, goals, and values. These outcomes are of increasing importance as demands for CS-related jobs continue to rise and as universities endeavor to produce innovative graduates to enter diverse and interdisciplinary technical fields.

Future Work

Future work includes collecting more quantitative and qualitative feedback from students about the assignments, as well as:

- Tracking CS0 student success in CS1 and CS2
- Designing more assignments
    - Utilize Python turtle graphics –>
- Attract more diverse majors, minors, and certificate programs into CS0