

Warm-up question

- In your own words, **what is research?**

Fall 2023

JMU CS

"What is Research?"

Seminar Talk

Warm-up question

- In your own words, **what is research?**

(answers courtesy of a past CS 470 class)

What is research?

- *“Research is the process of finding information.”*
- *“Research is when you use your own time to understand and describe in words a topic you did not know about before.”*
- *“Looking for credible information pertaining to a specific topic.”*
- *“Utilization of academic, peer-reviewed publications in order to better understand or solve a problem.”*
- *“It's taking concepts or ideas and collecting valuable information pertaining to it, with some fact checking of course!”*

What is research?

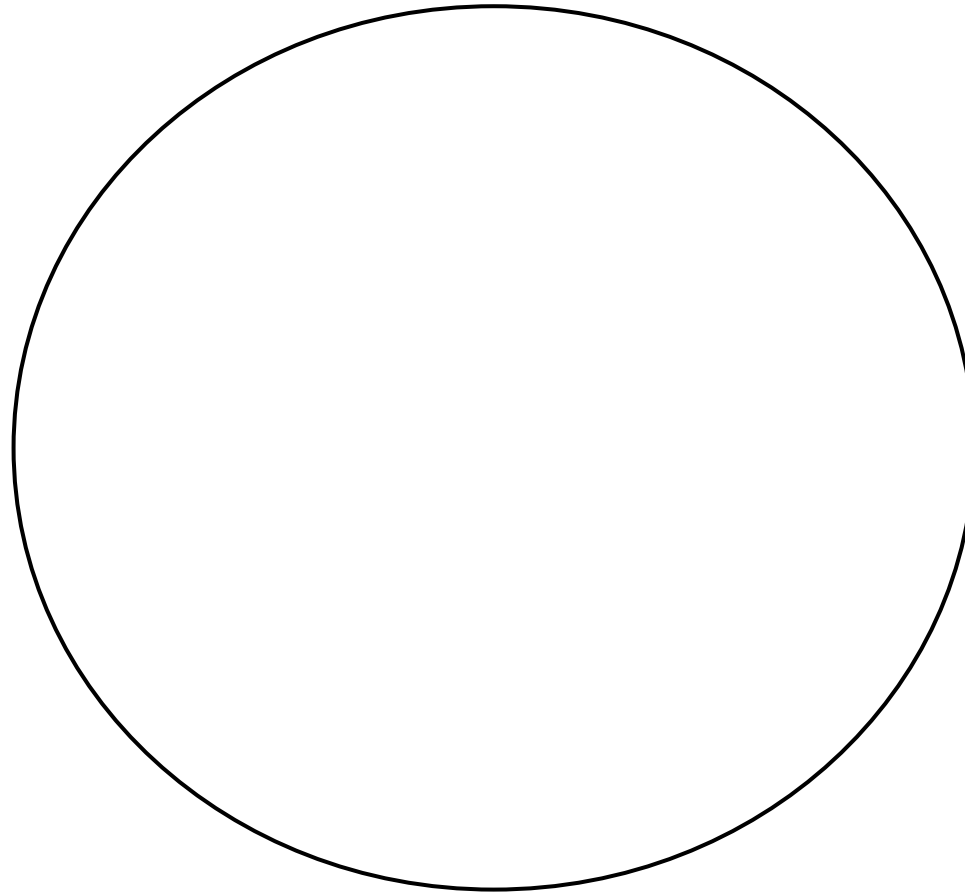
- *“Working at the edge of knowledge in a field attempting to push that frontier a little further with your work.”*
- *“Thorough investigation into a subject, with the end result of finding new information.”*
- *“Research is building on the work of others on a topic of the researchers choice to posit new arguments and find new discoveries that might interest yourself or the general public.”*
- *“Learning new things then doing those things then writing about those things.”*

What is research?

- The former is **secondary** research
 - Wikipedia: "*summary, collation and/or synthesis of existing research*"
- The latter is **primary** research
 - OECD 2015: "*creative and systematic work undertaken to increase the stock of [human] knowledge*"
 - Goal: **novelty!**
 - Many subcategories:
 - Purpose: **theoretical** vs. **applied**
 - Target: **formal** vs. **natural** vs. **social**
 - Methodology: **scientific** vs. **historical** vs. **artistic**

Knowledge (visualized)

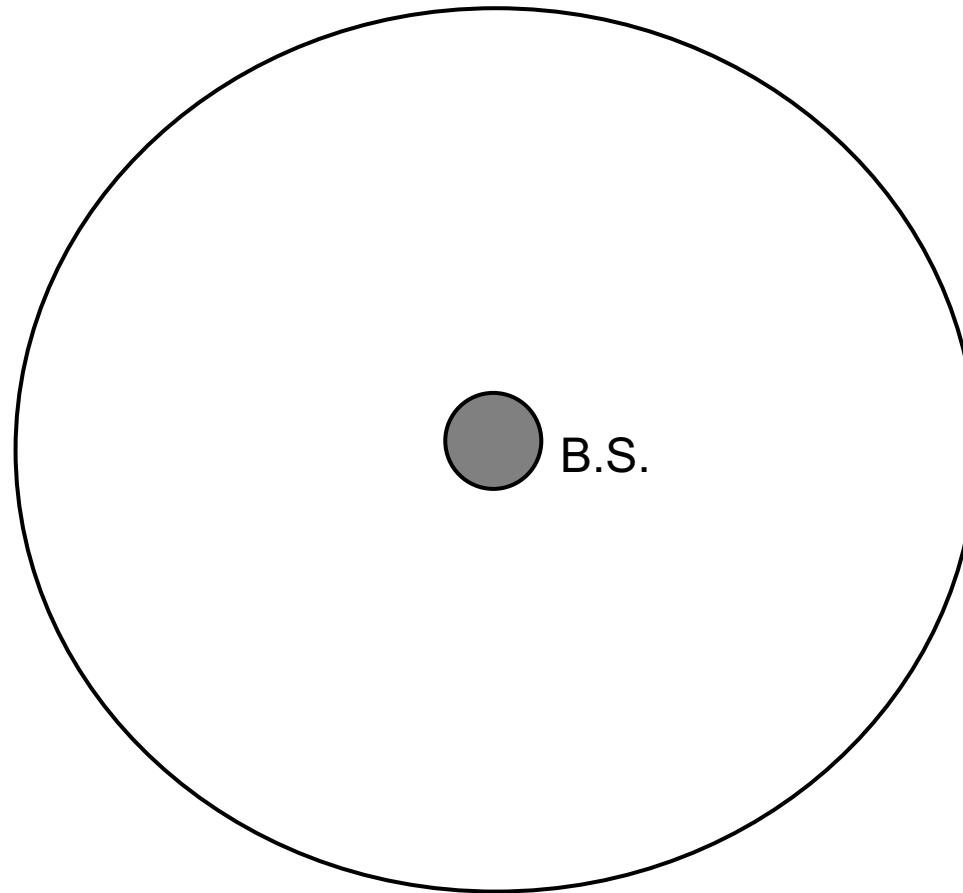
all current human CS knowledge



based on <http://www.happyschools.com/bachelors-vs-masters-vs-phd/>

Knowledge (visualized)

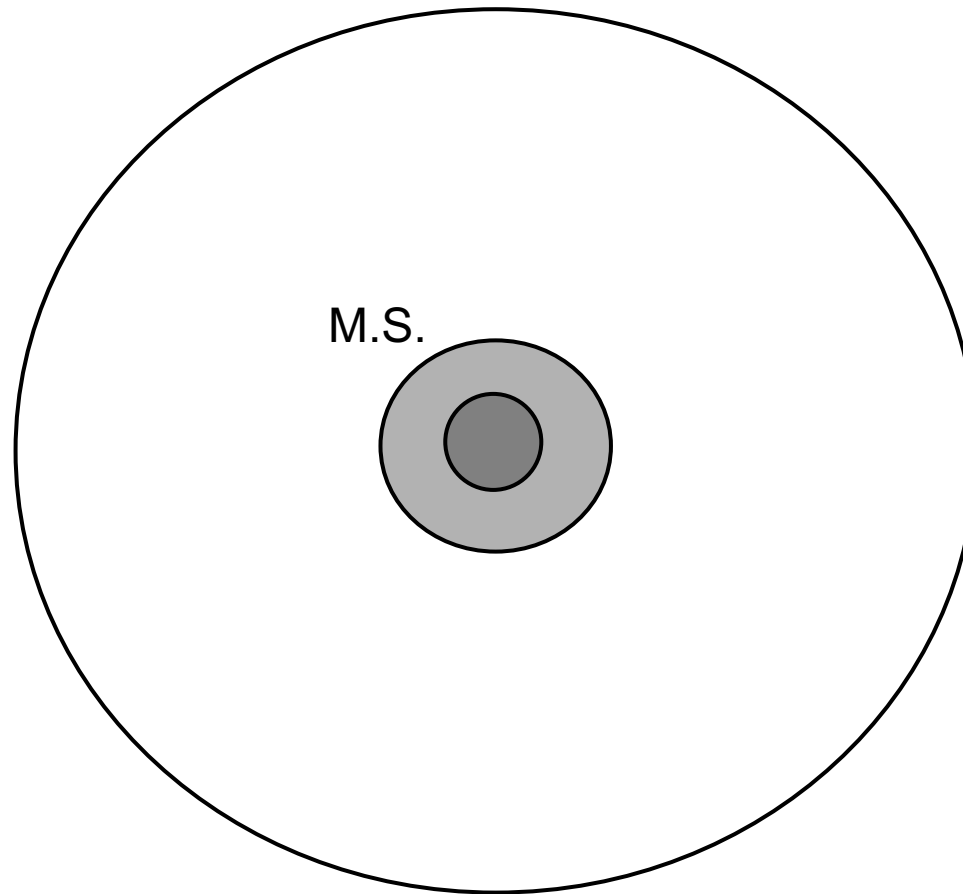
all current human CS knowledge



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Knowledge (visualized)

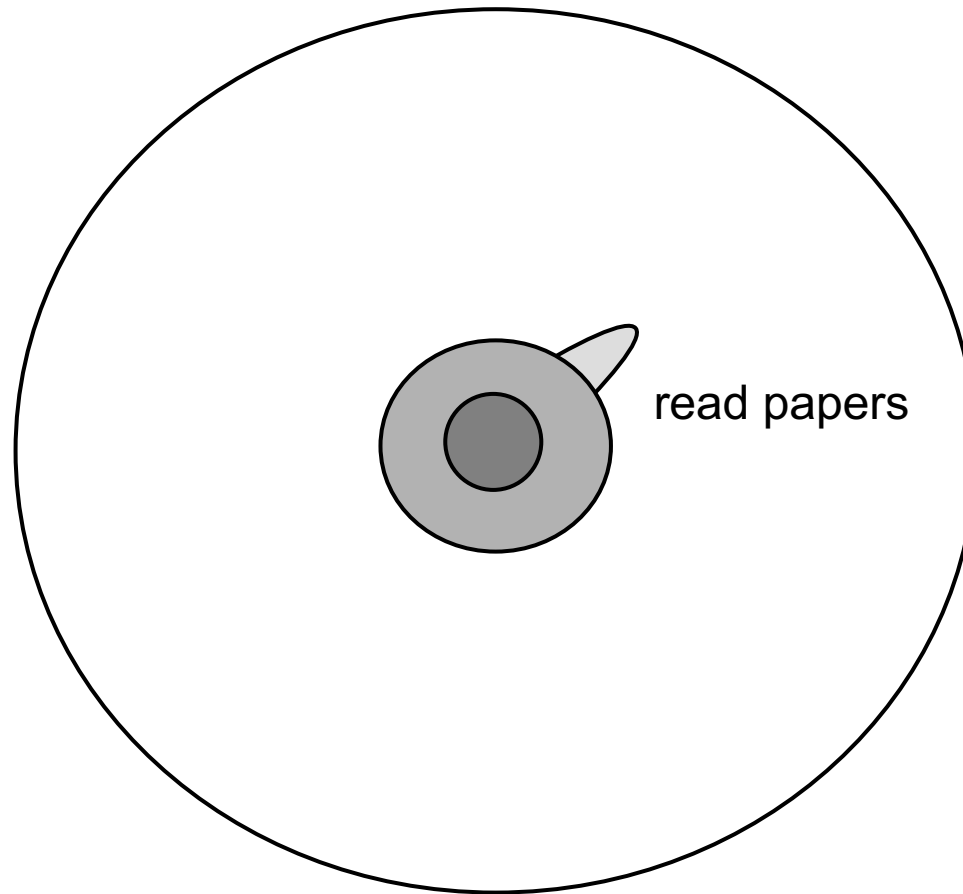
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Knowledge (visualized)

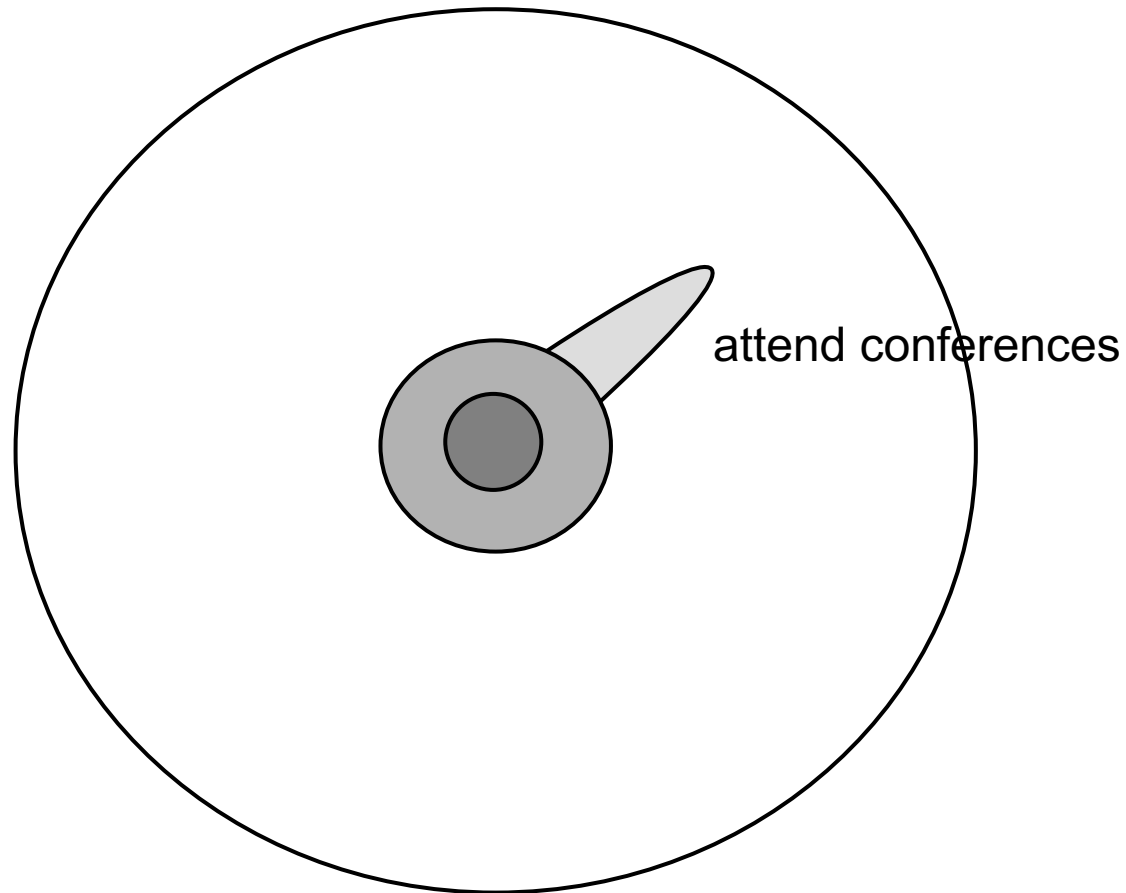
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Knowledge (visualized)

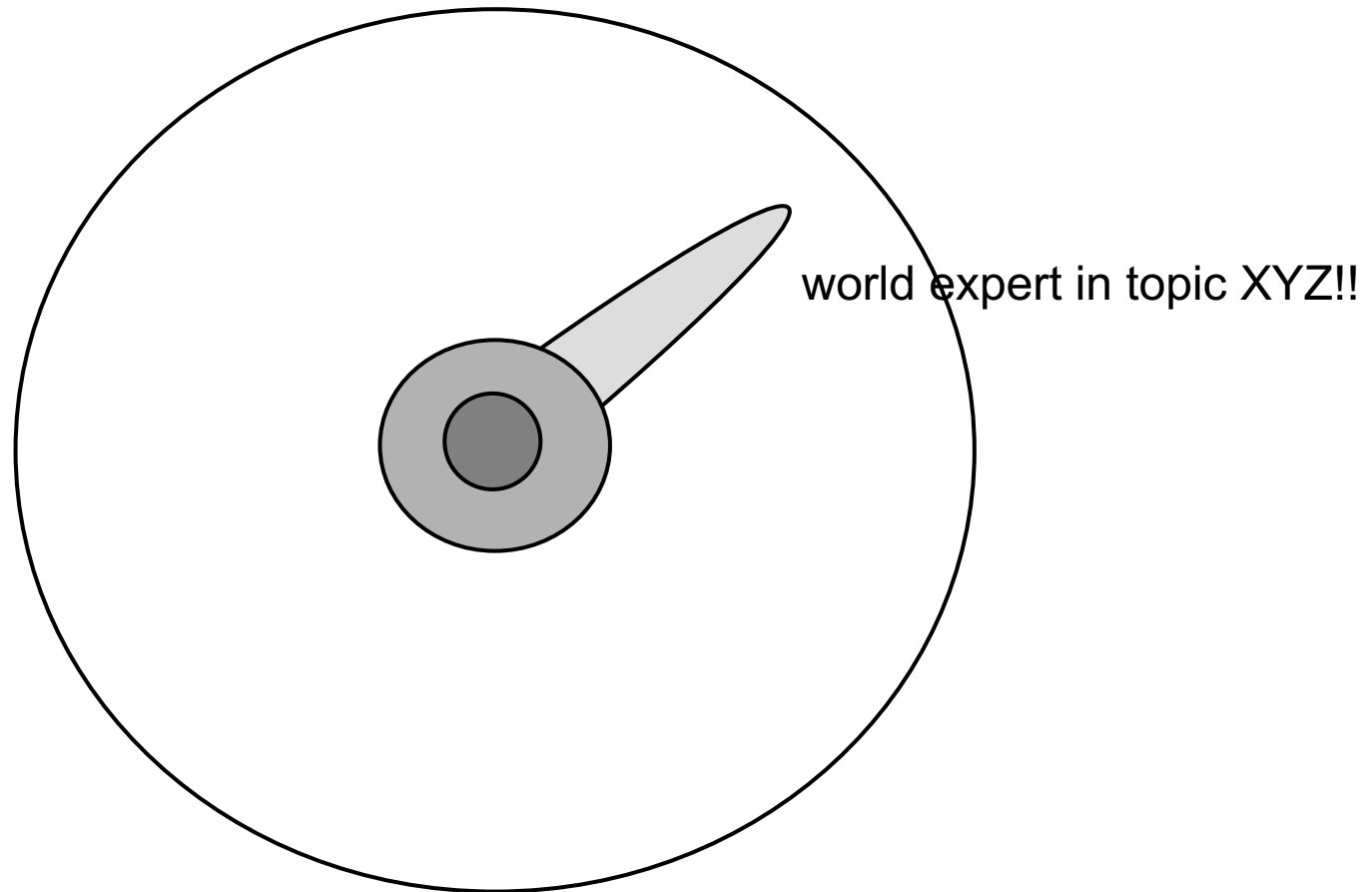
all current human CS knowledge



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Knowledge (visualized)

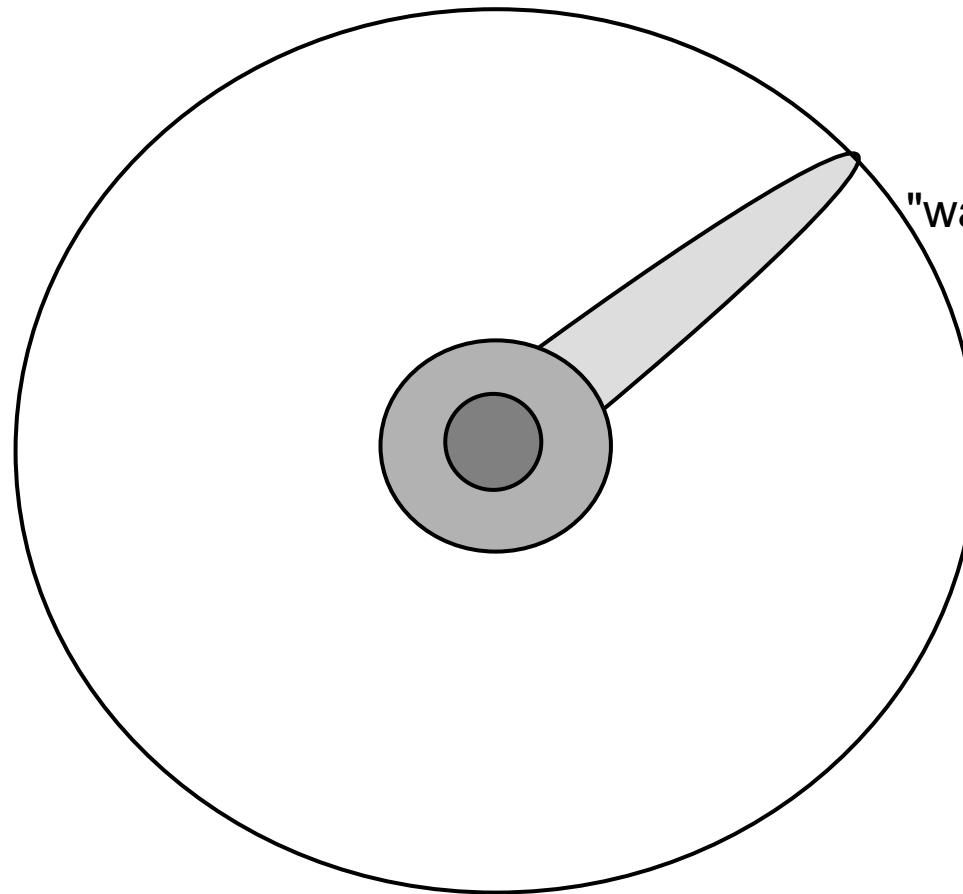
all current human CS knowledge



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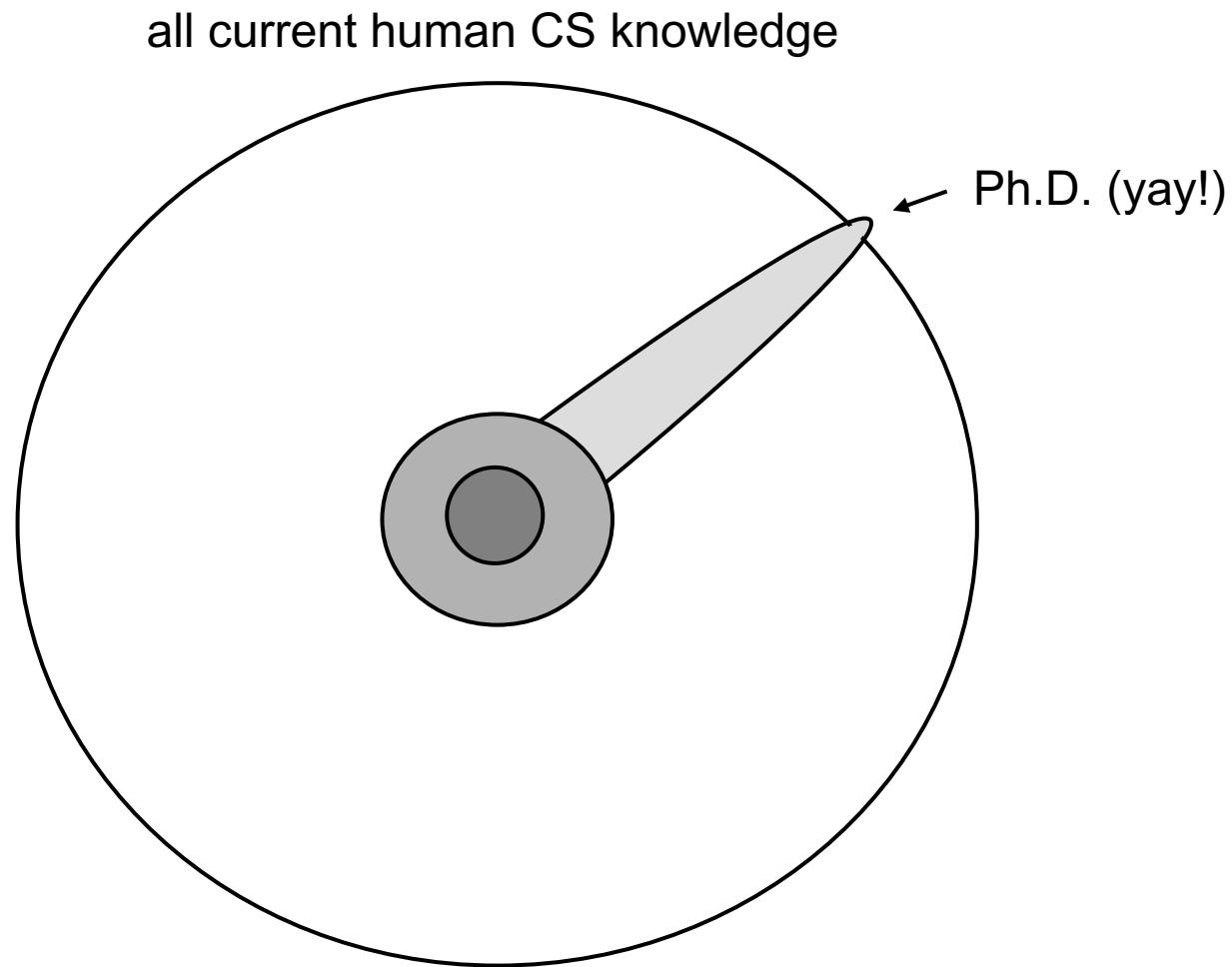
Knowledge (visualized)

all current human CS knowledge



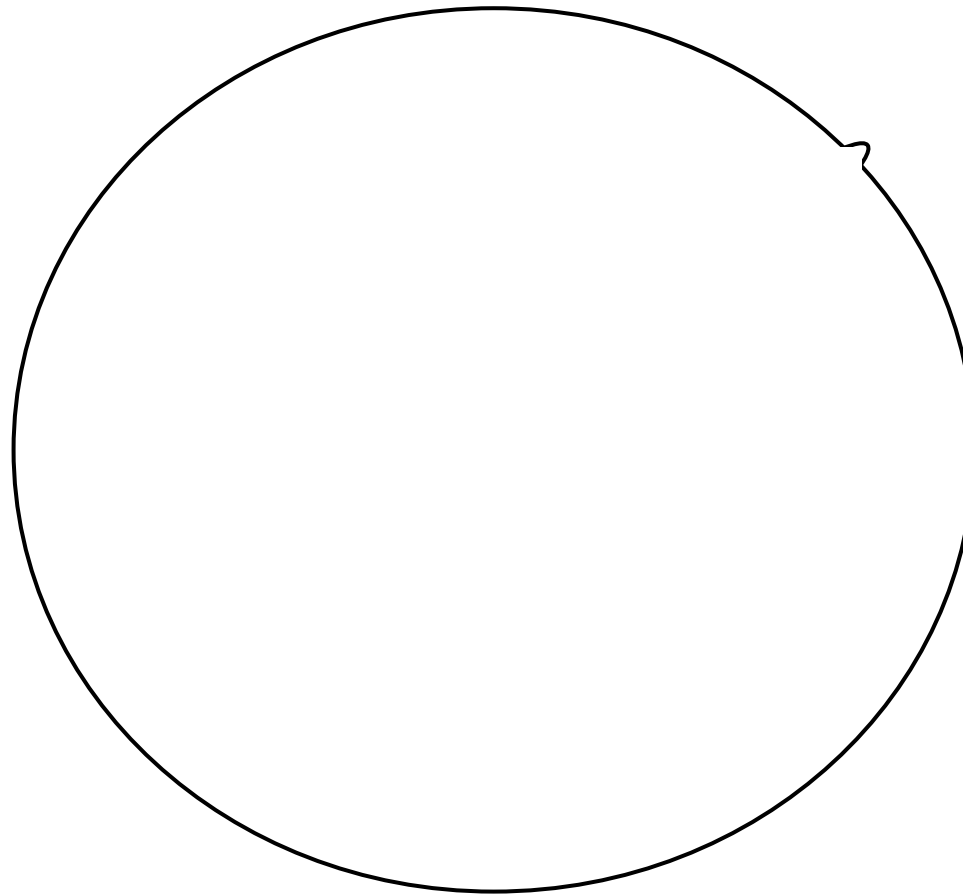
"wait, you're still in school?!?"

Knowledge (visualized)



Knowledge (visualized)

all current human CS knowledge



(the big picture)

Another perspective

- As faculty advisors ...
 - Undergrad projects: we have a reference solution
 - Graduate projects: we know a solution is possible
 - PhD projects: we **think** a solution might be possible

What is research?

- *“Research is the process of systematically casting a fishing rod into the unknown and hoping that you reel in something worthwhile.*
- *Sometimes you catch nothing, sometimes you get something worthwhile, and sometimes you get something that looks worthless until it's published by somebody else three years later.*
- *But regardless you slowly begin to learn about the world on the other end of that hook.”*

If that is what, now how?

- My Advisor from UVA (Bill Wulf)
 - “We don’t really know how so we use the apprentice model.”

If that is what, now how?

- My Advisor from UVA (Bill Wulf)
 - “We don’t really know how so we use the apprentice model.”
- More detailed references
 - How to pick an advisor
 - [“Getting Started in Undergraduate Research”](#)
 - How to read a paper
 - [“How to Read an Engineering Research Paper”](#)
 - What I wish I knew/organization
 - [“Organizing your Research and Developing your Research Skills”](#)
 - [“Everything I Wanted to Know about CS Graduate School at the Beginning But Didn't Learn Until Later”](#)

My research interests (Mike Lam)

- Program analysis (CS 430, 432)
- Systems-level software tools (CS 261)
- High-performance computing (CS 470)



ADAPT

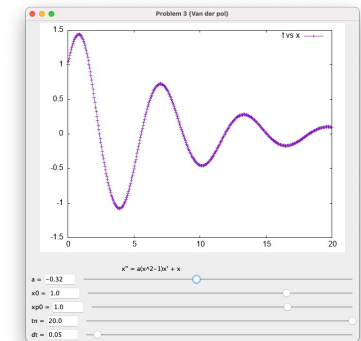
Tool to rigorously quantify each input's effect on an output

FloatSmith

Tool to automatically transform a program to use *mixed* precision

Jmodev

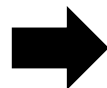
Visualization system for parameter changes in ODE solver
(*Collaboration with colleagues in Math & Stats department*)



Teaching Systems

Course design for CS 261 (project framework, labs, videos, etc.)

```
...  
double a = A;  
double x[N];  
double y[N];  
...
```



```
...  
float a = A;  
float x[N];  
double y[N];  
...
```





JMU CS Dept

- Lunch Chat - Fridays 11:30-12:20 in 140 King Hall (BYO food) 🍱
- Dept. Research Talks
- Distinguished Lecture Series
- Independent Study
- Honor's Project (*does NOT* require you are an honor's student)

External

- other departments in college (eg Engineering)
- outside JMU, eg REU





Prof. Bowers

- Studies how the graph of a series of **geometric constraints** effects the structure of **geometric objects**.
- First explored by **James Clerk Maxwell** (Scottish mathematician and scientist).
- Related to questions like:
 - Will my **bridge collapse**?
 - How does a **protein fold**?
 - Can we design **origami satellites**?
 - Can we design materials with **specified flexing properties**?

Rigidity Theory

And Geometric Constraint Systems

SphericalSketch

```
objs.addAll([shrinkDisk(v.data, oldToNewDisk) for v in cppoly.verts])
objs.addAll([getInvCPlane(f, oldToNewDisk) for f in cppoly.faces])

sketch.saveScene("Scene 6: Inversive distance c-polyhedron")

# Scene 7: Another inversive distance c-polyhedron

objs.clear()

oldToNewDisk2 = {}

def shrinkDisk2(disk, diskMap):
    norm = disk.dualPointOP3.toPointE3().toVectorE3().norm()
    eps = (3 * (norm - 1.0) / 4) * (random.random() * 1.5)
    fact = (1.0 + eps) / norm
    newDisk = DiskS2(disk.a * fact, disk.b * fact, disk.c * fact, disk.d)
    diskMap[disk] = newDisk
    return newDisk

objs.addAll([shrinkDisk2(v.data, oldToNewDisk2) for v in cppoly.verts])
objs.addAll([getInvCPlane(f, oldToNewDisk2) for f in cppoly.faces])

sketch.saveScene("Scene 7: Another inversive distance c-polyhedron")

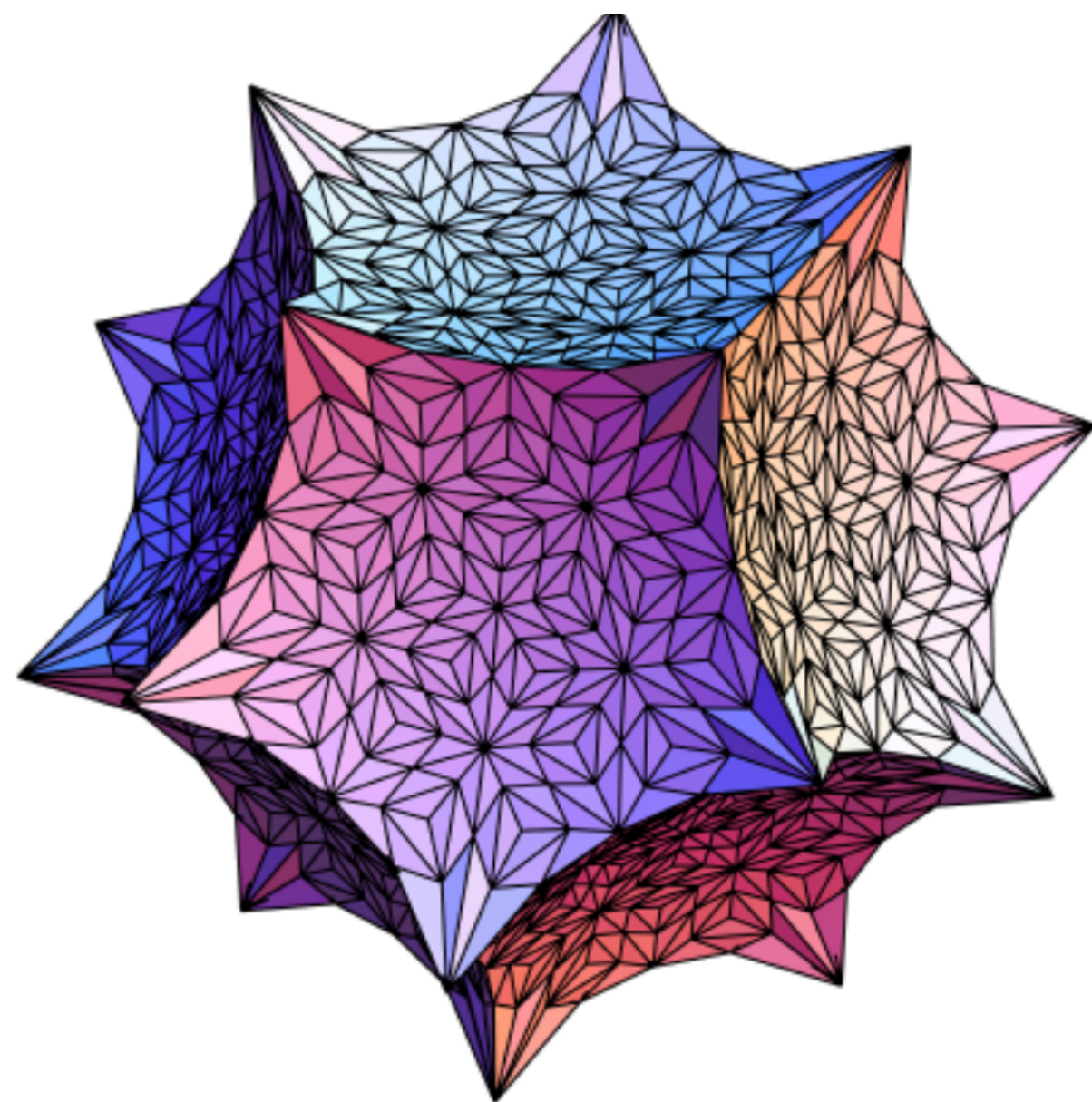
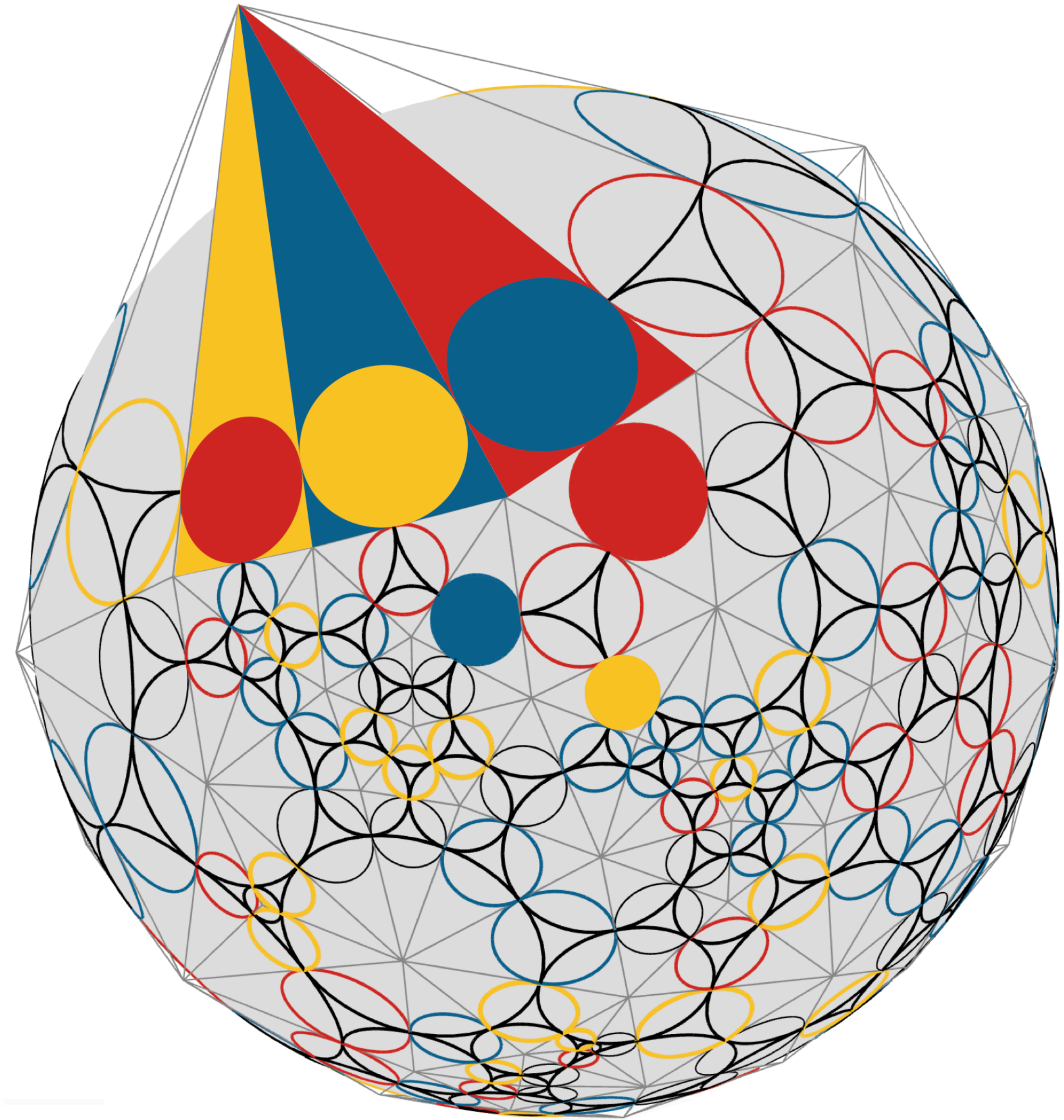
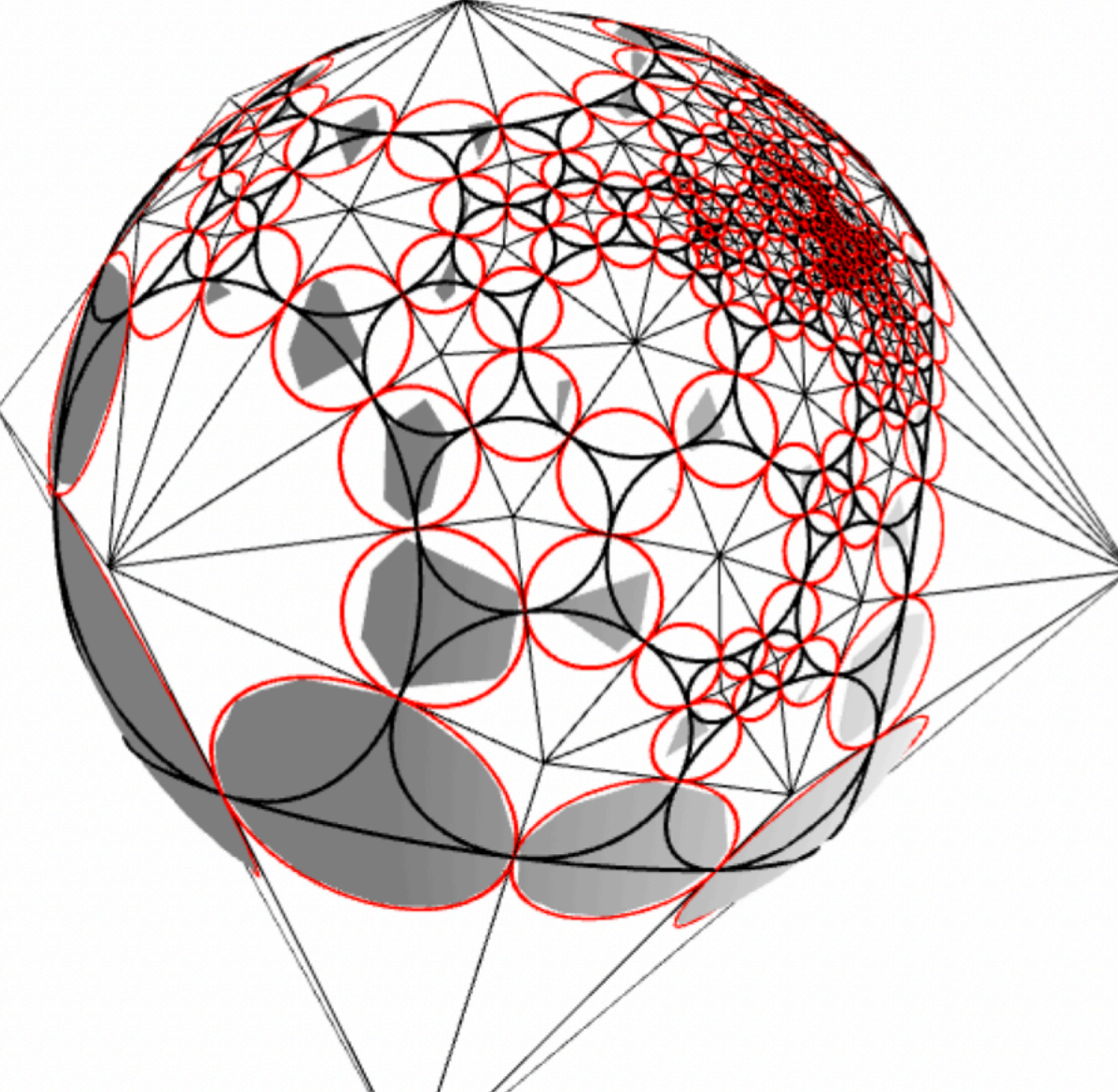
sketch.restoreScene("Scene 1: Random 100-vert polyhedron")
#sketch.restoreScene("Scene 5: without the Koebe-polyhedron")

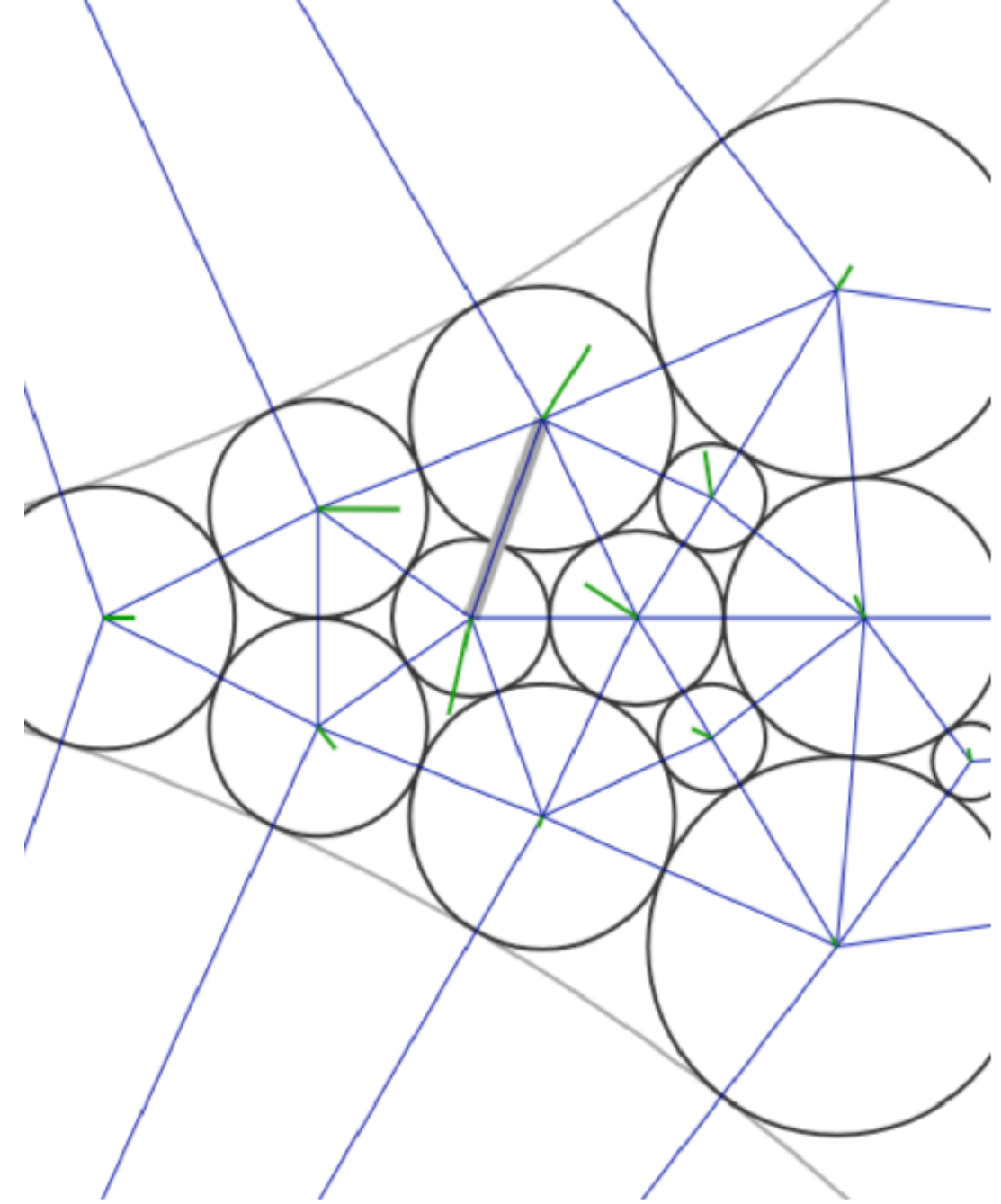
print "Loaded."
```

Python Console Output

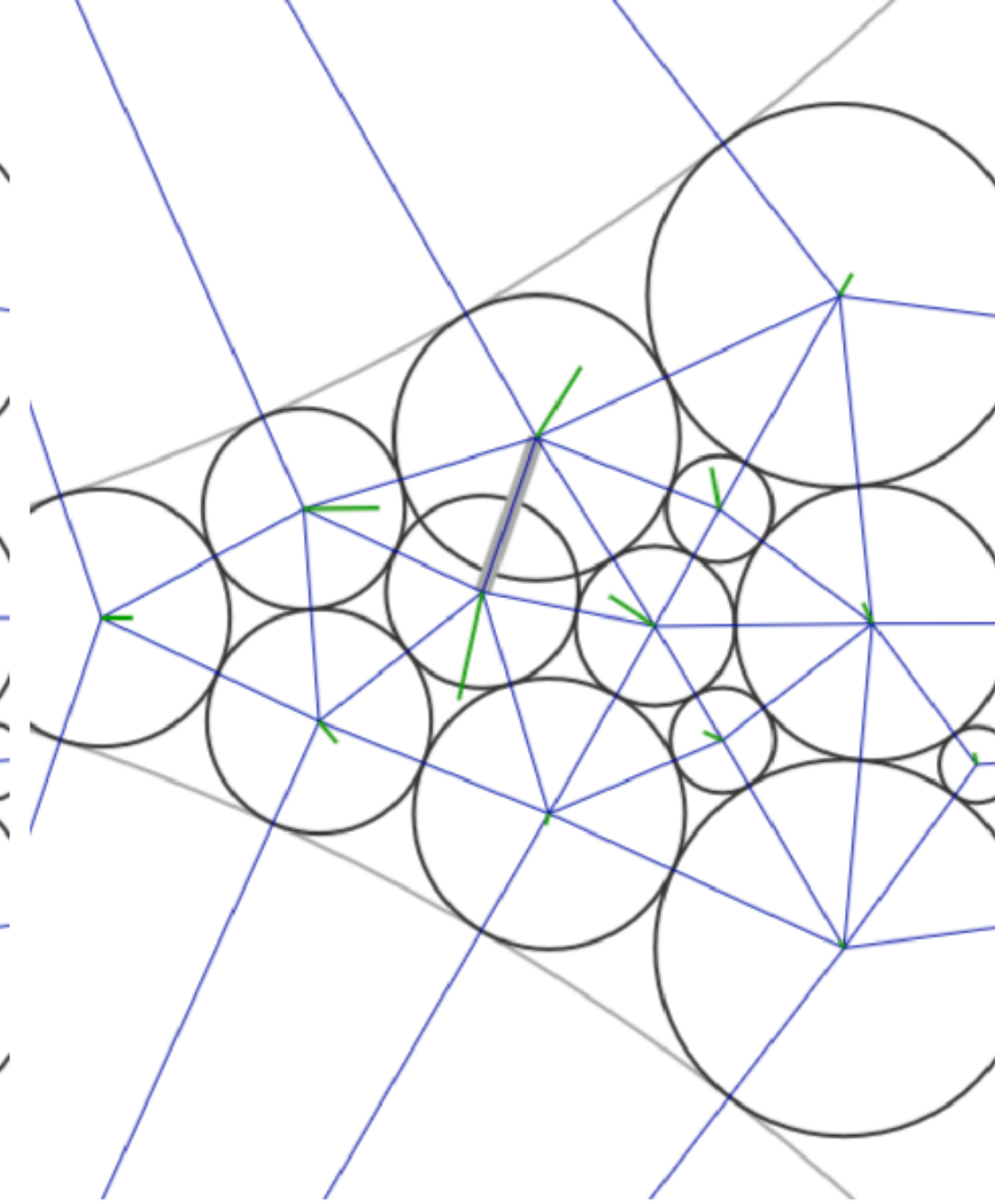
Loaded.

Open Save Clear Console

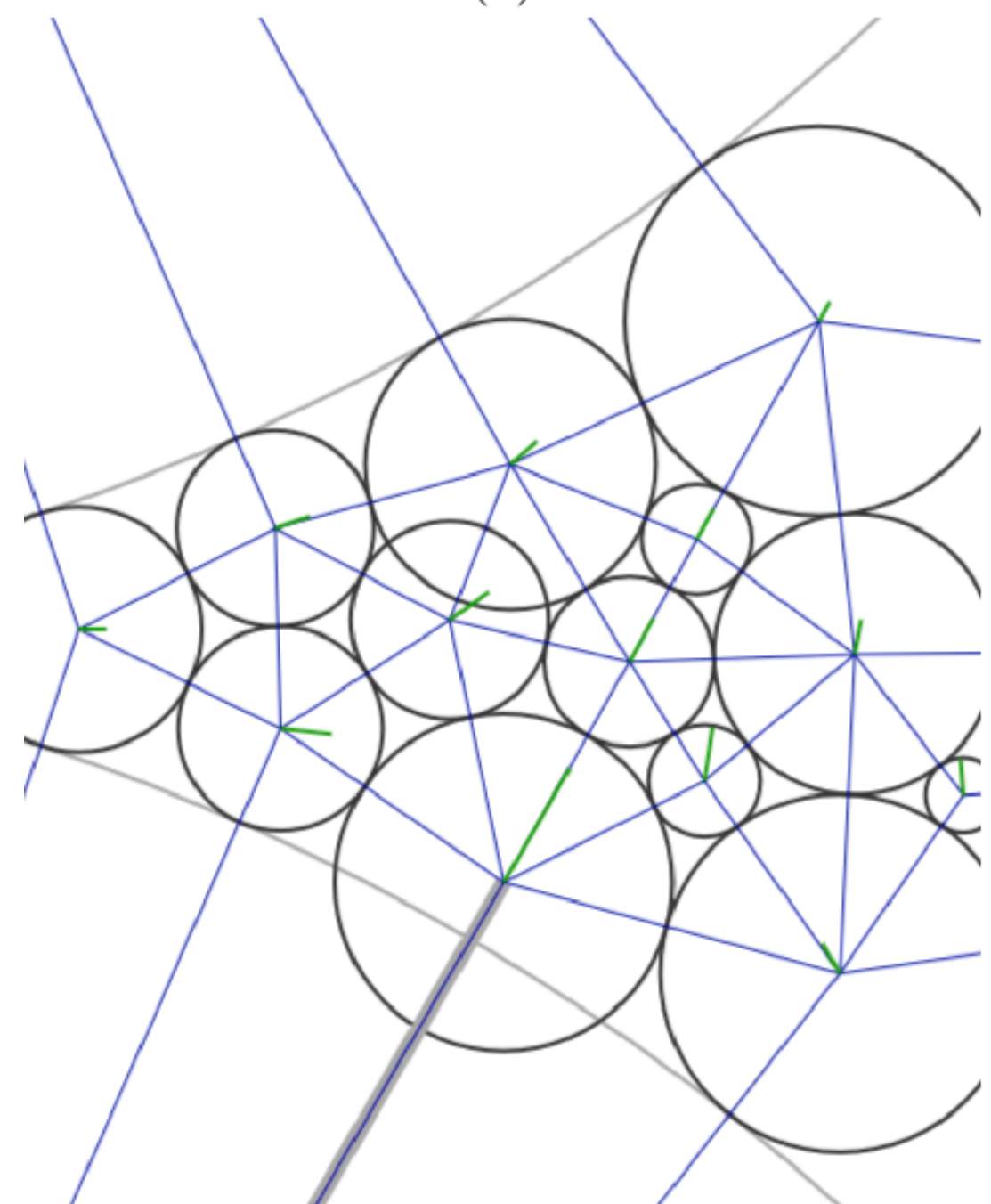




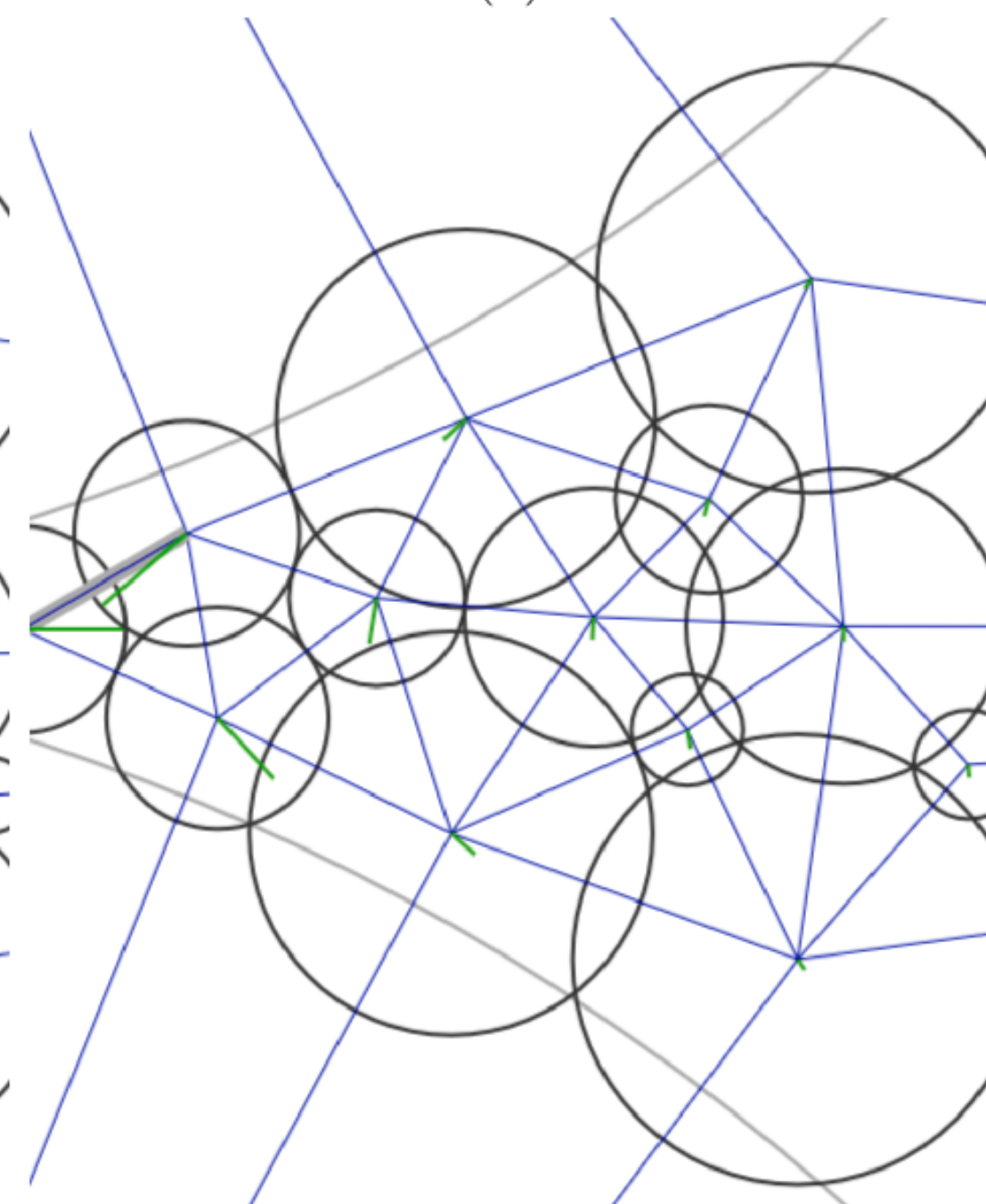
(a)



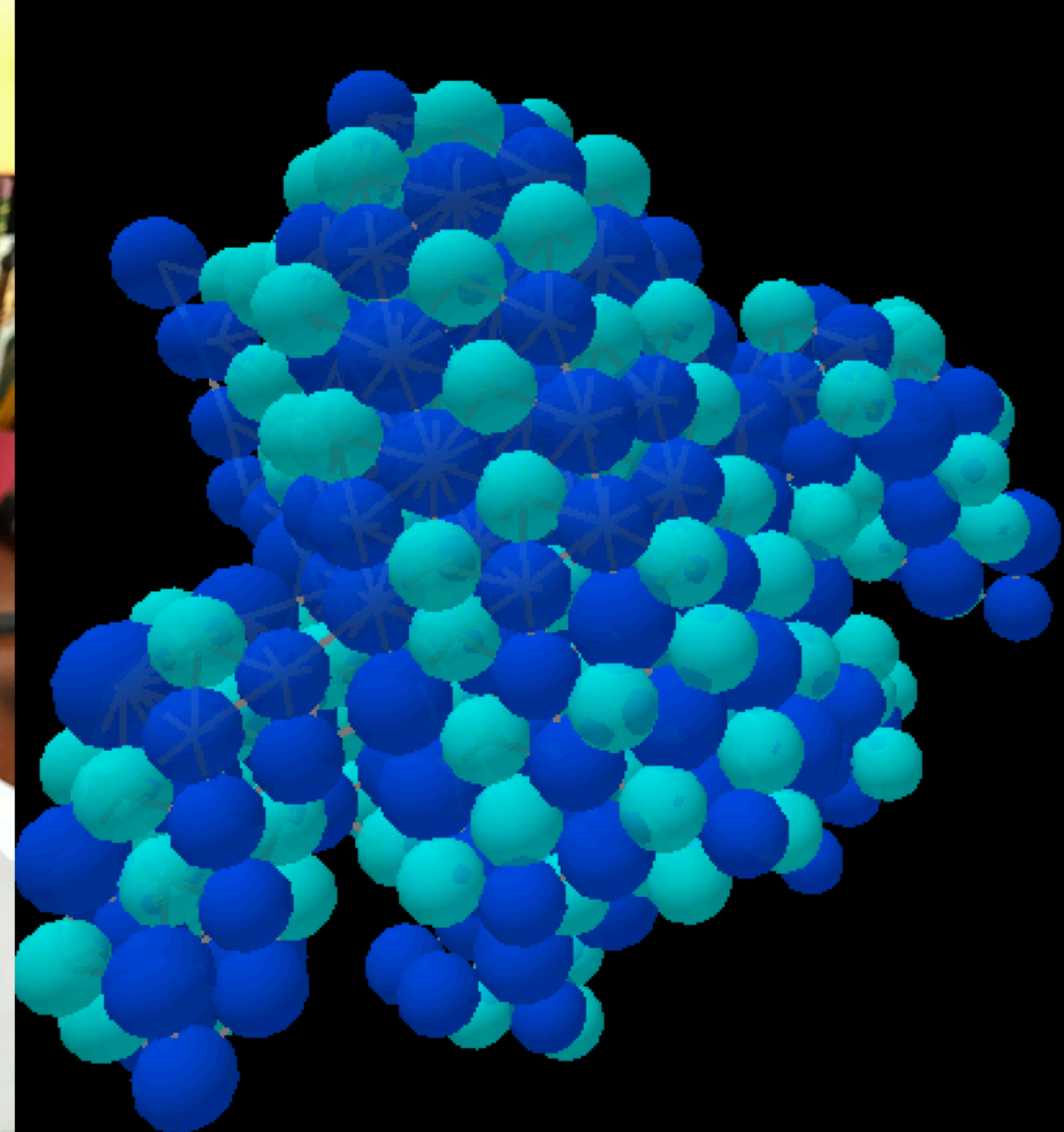
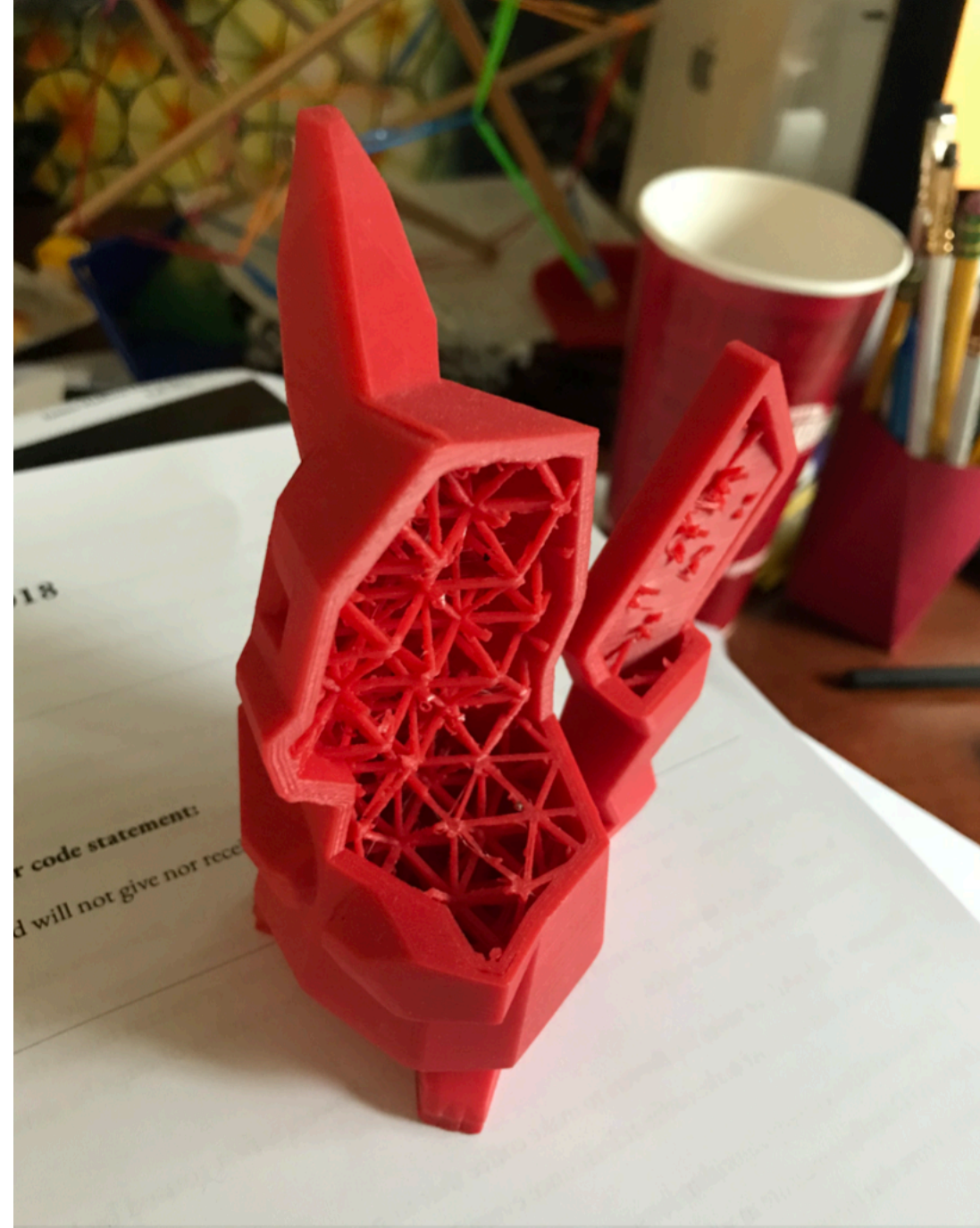
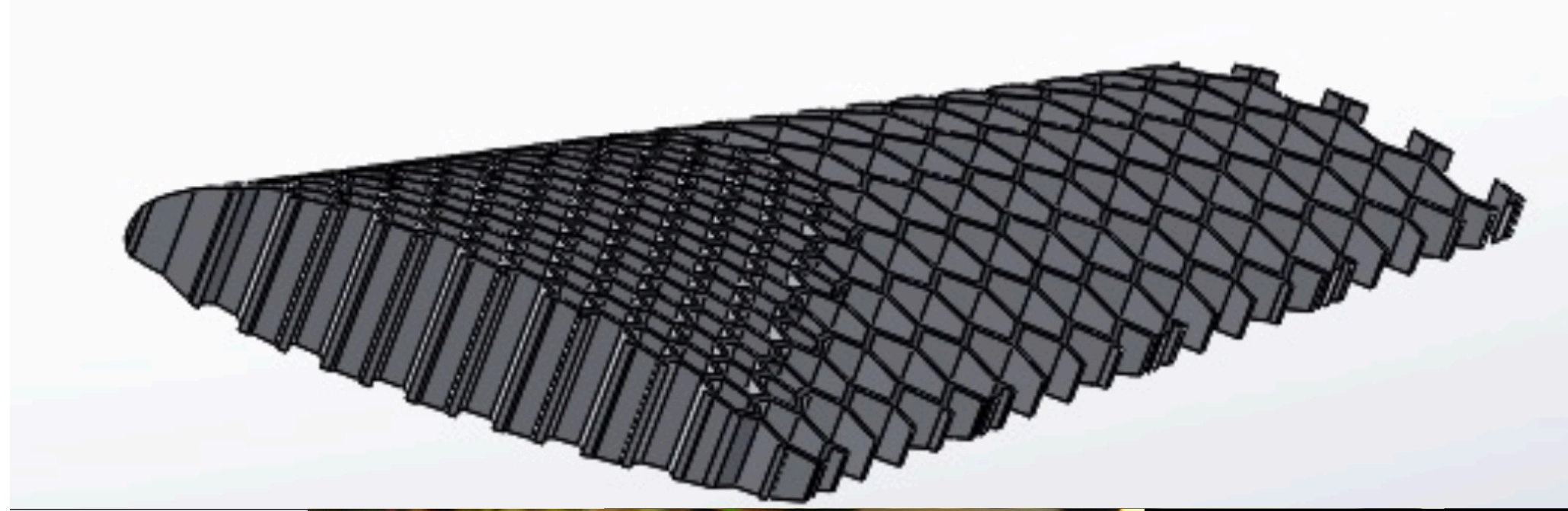
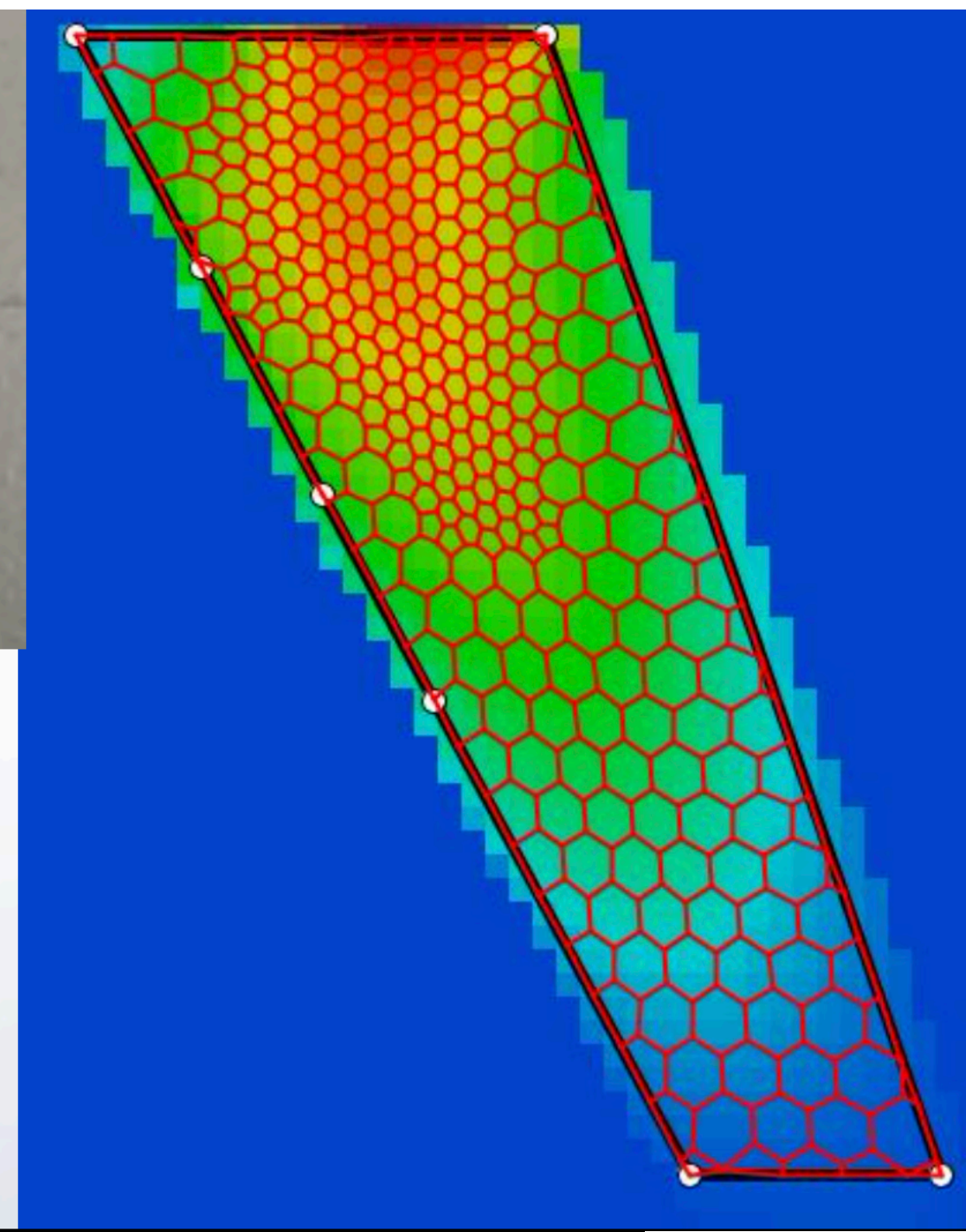
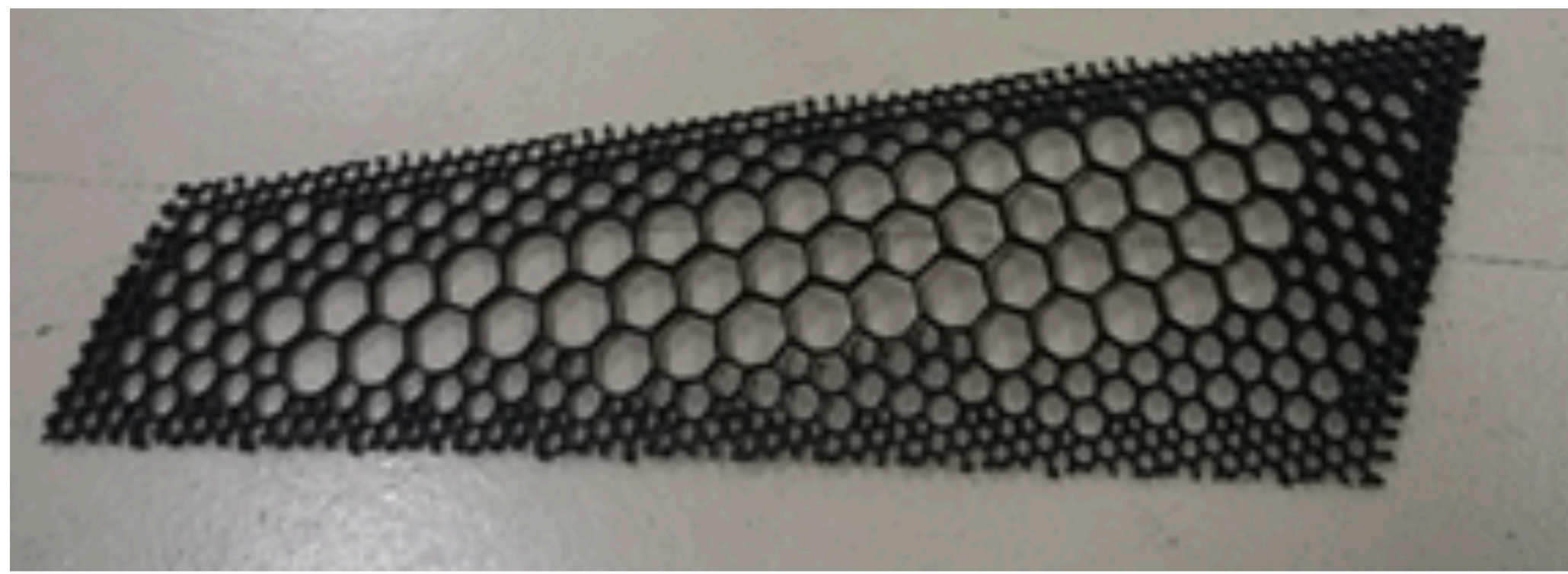
(b)



(c)



(d)



About me

- **Name:** Zhuojun Duan, PhD
- **Teaching:**
 - This fall: CS149 & CS240
 - Spring 2023: CS159 & CS240
- **Research:**
 - Game theory in IoTs
 - Computer Science Education
 - Data Analytics

My current research

- Using data mining and visualization techniques to investigate the climate change, like lightning production under pollution, wind, and so on
 - Three cities: DC, Kansas City, and Salt Lake City.
 - We bought datasets from NLDN(National Lightning Detection Network)
 - I am using Python
- So far:
 - Finished data cleaning
 - Finished data analysis part, such as clustering have been done
 - Now CS side: re-investigate the problems we met in the project, try to solve them and write articles for publications
 - Examples:
 - spatial-temporal cluster and visualization
 - Speed up the code: MPI or other parallel techniques.

Opportunities for CS students

- This fall: no stipend
 - Possible publications
 - Priority when deciding the internship for Spring 2023
- Spring 2023:
 - Recruit one or two CS students for internships.

- How to apply?
 - Email: duanzx@jmu.edu
 - Drop by: Office: ISAT/CS 246B (Next door to Paige's office)



Dr. Sprague

Research Topics

Dr. Ahmad Salman

salmanaa@jmu.edu

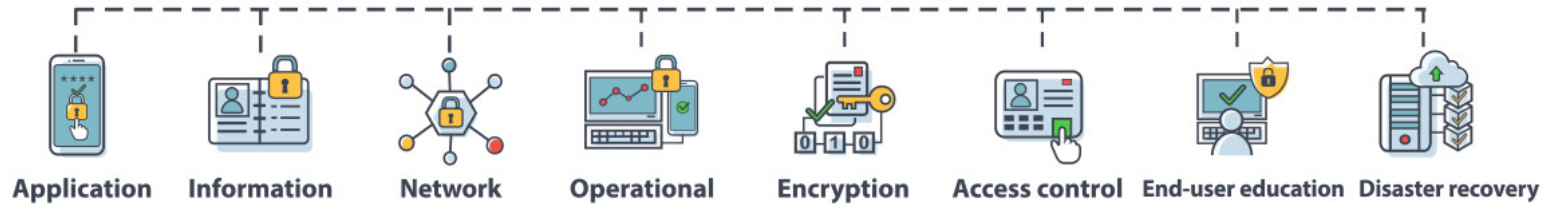
King Hall 123

Security



Privacy

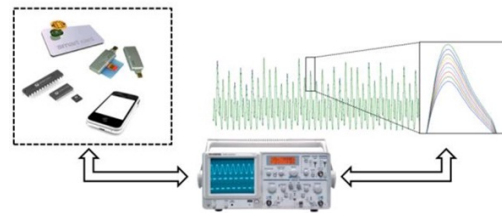
CYBERSECURITY



Drone Security



Transportation Security



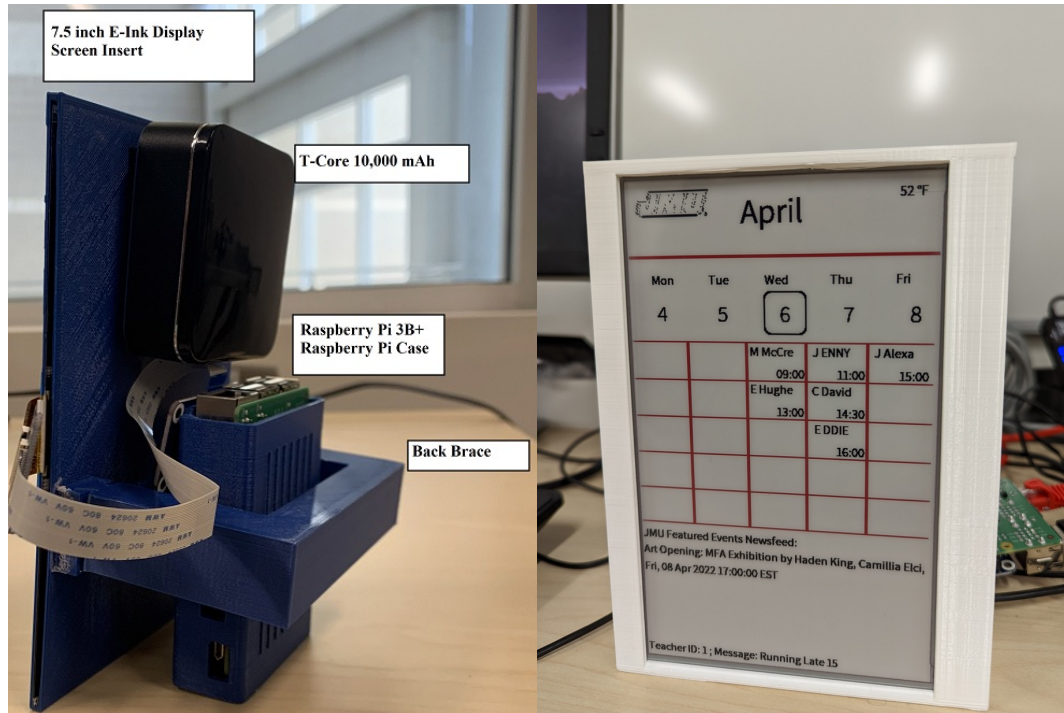
Hardware Security



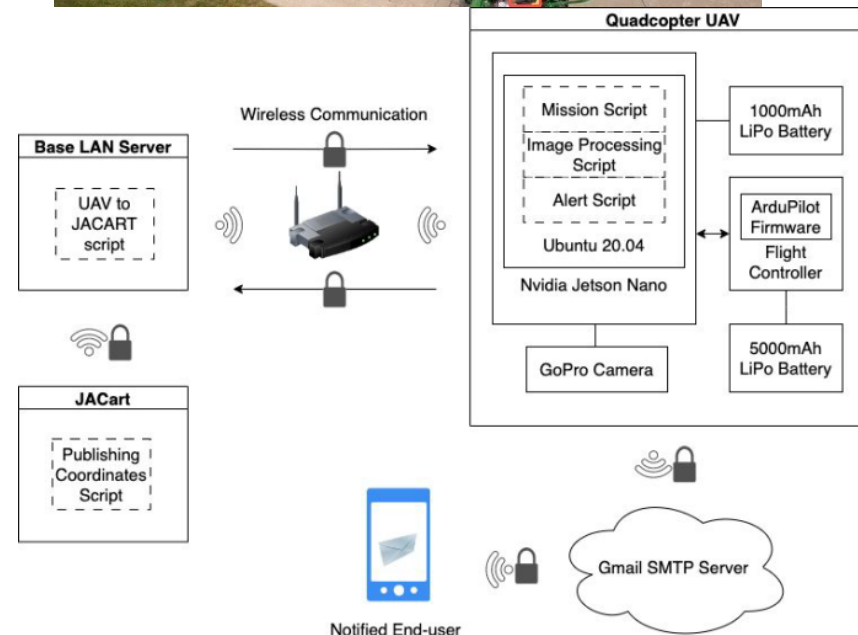
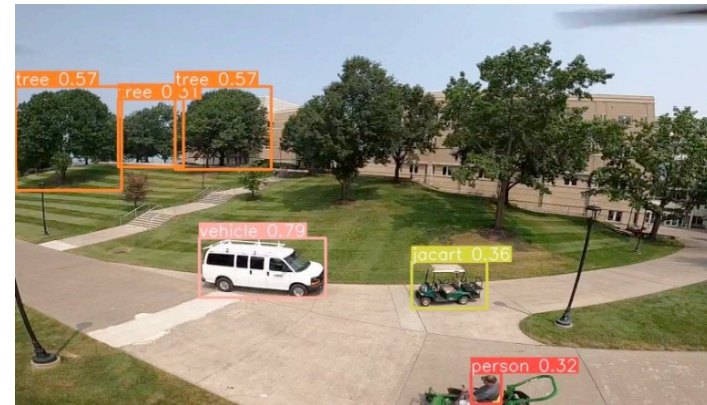
IoT Security

Research Projects I

SAWBRID: SmArt WhiteBoard Replacement Interactive Device



Intelligent Transportation Support System

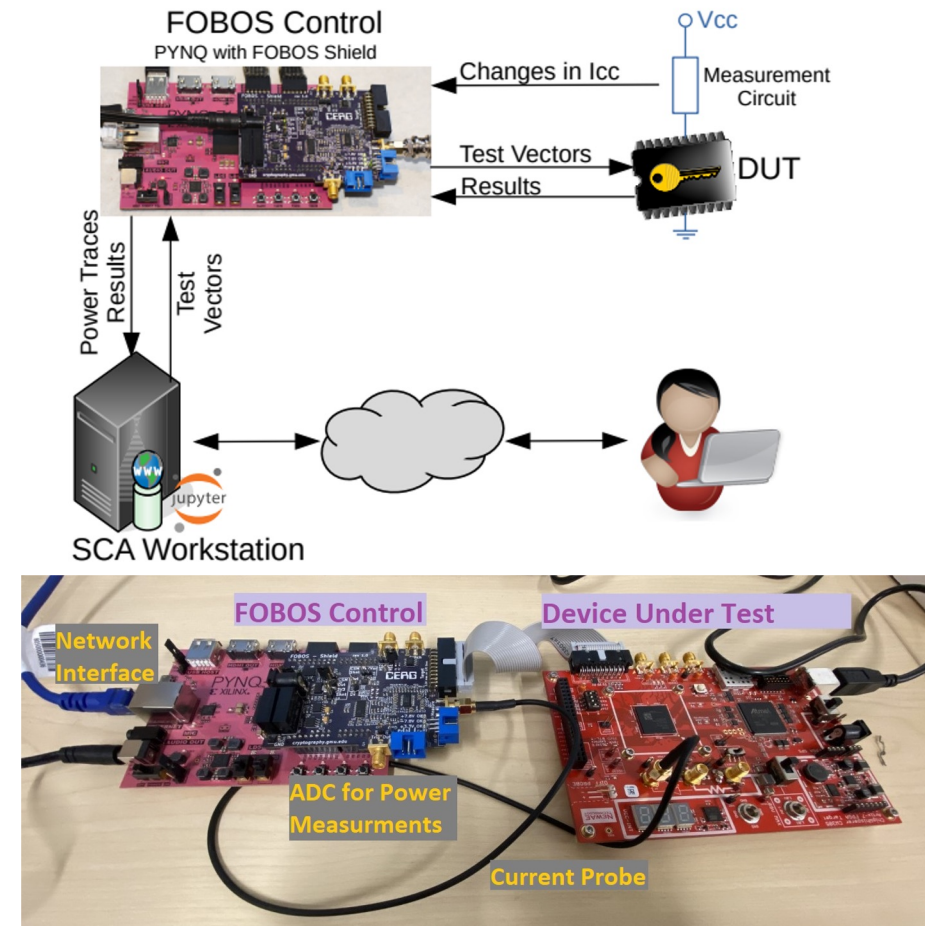


Research Projects II

Horizontal Gaze Nystagmus (D&D Test)



Side-Channel Analysis & Attacks



Prof. Riley



Telecommunications, Networking and Security Lab (TNS Lab)

JACart Research Group

Intelligent Transportation Research



By:

Dr. Samy El-Tawab

Associate Professor, James Madison University

Program Director, Information Technology



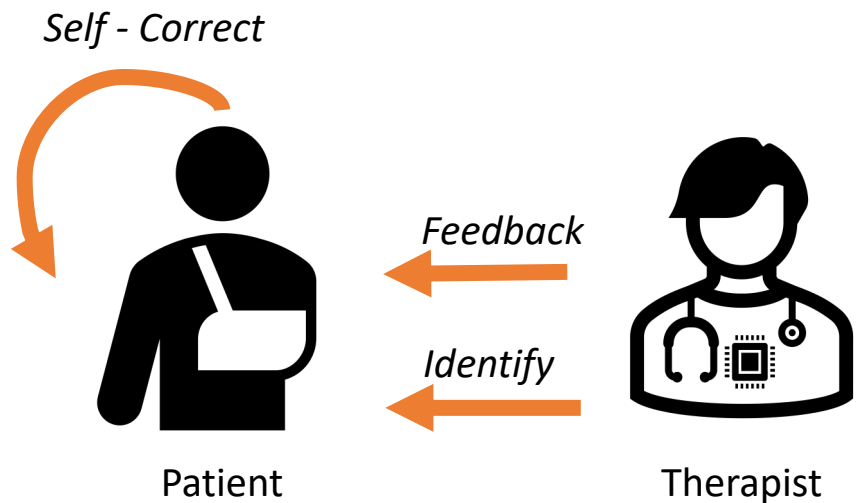
■ Projects - High-level

- Improving **Transit Bus Operations** using Low-Cost Internet of Things Technology
- **Smart Parking** using the Cloud
- **LoCATE**: Localization of Health Center Assets Through an IoT Environment
- Independent Mobility for the Elderly: Machine-Learning-Based Passenger-Aware User Interfaces for **Autonomous Vehicles**
- Monitoring Traffic, Incident Detection, VANET Applications...etc

■ Projects – Who are our Collaborators

- Improving **Transit Bus Operations** using Low Cost Internet of Things Technology → **UVA (4VA)**
- **Smart Parking** using the Cloud → **VT(Madison Trust)**
- **LoCATE: Localization of Health Center Assets Through an IoT Environment** → **VT (4VA)**
- **Independent Mobility for the Elderly: Machine-Learning-Based Passenger-Aware User Interfaces for Autonomous Vehicles** → **(Nara Institution of Technology, Japan; GMU) (Jeffress Trust Awards Program in Interdisciplinary Research, CCI)**
- **Monitoring Traffic, Incident Detection, VANET Applications, VANET Security...etc.** → **ODU, GMU (CCI)**

Wearable Computing for Physical Therapy and Rehabilitation



DEPARTMENT OF
ENGINEERING


JAMES MADISON UNIVERSITY

Dr. Jason Forsyth
Associate Professor of Engineering



Major Research Questions / Challenges

RQ1: What are the effective methods for **capturing** a person's pose and activity during exercise? 

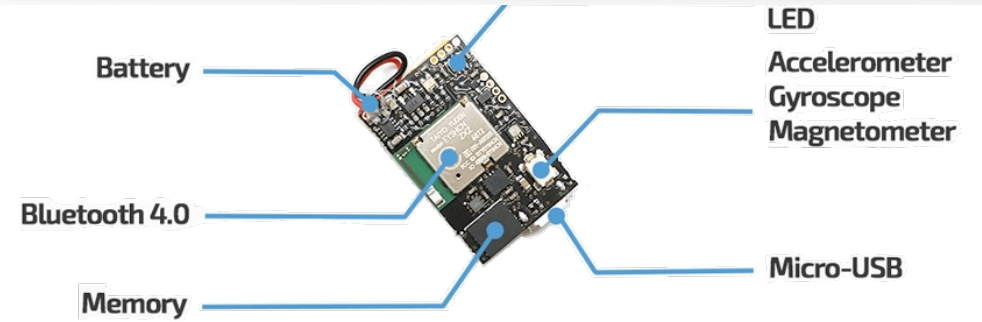
RQ2: How can a system **assess** a person's posture/actions and automatically determine motion guidance? 

RQ3: What are effective **feedback** methods to a person after/during exercises to correct motion and improve performance?  

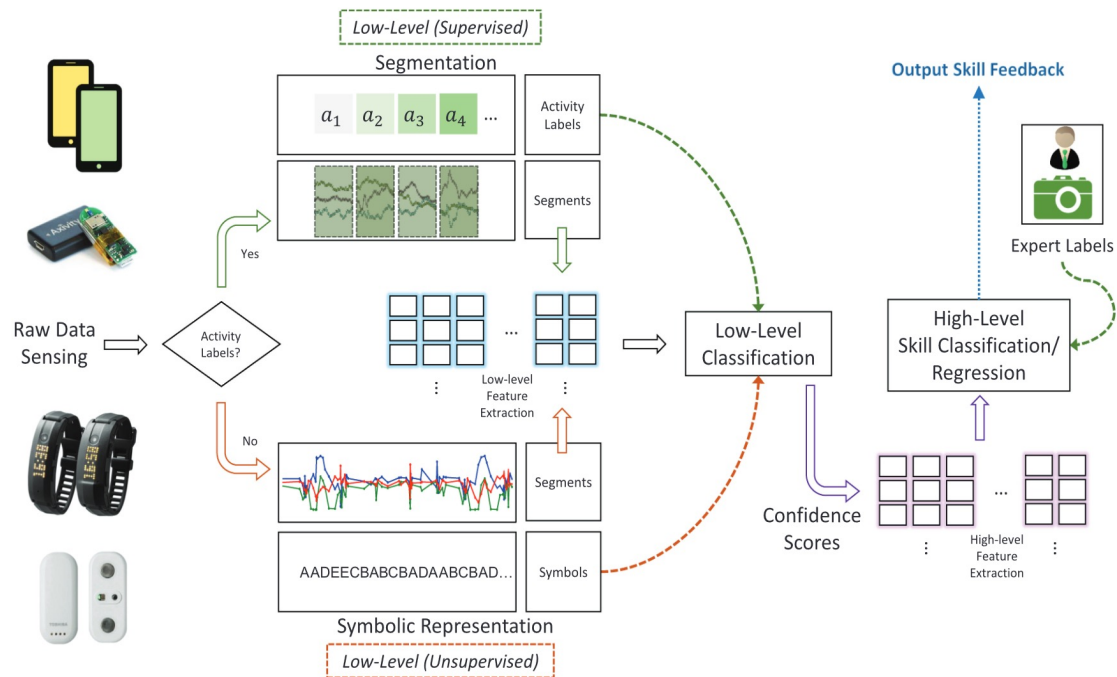
RQ 4: How can a person's performance be estimated and used to inform/assess **future training and responses**?   



Hardware Development + Feedback



Camera + Wireless Sensor Management



Human Activity Recognition and Skill Estimation



Open: Wearable Health and Safety



Dr. Johnson

Learning CS with Brain and Body

- collaborate with Drs. Isaac Wang and Chris Johnson
- use Unity and VR to facilitate embodied interaction in CS learning exercises like code tracing and memory manipulation
- prerequisites: CS 240, empathy

Twoville

- collaborate with Chris Johnson
- contribute to a programming language for 2D cutting and fabrication
- visit local middle school on Wednesday afternoons
- use JavaScript and SVG
- prerequisites: like shapes and middle schoolers

About Dr. Stewart

Human

- from Charlotte, NC
- puedo hablar un poquito de español
- je parle une petit peu de français
- 2.5 siblings
- 1st gen college student
- 2nd gen immigrant to USA
- have an invisible disability
- 2.9 undergrad GPA
- partner + 2 children
- likes to cook, eat, travel, hike, play games (board, video), build technologies, teach students!, and conduct research in **Human** Computer Interaction

Computer



Industry

IBM

'07, '10

Red Hat

'07-'09

**Xerox Research Centre
Europe**

'13

Amazon

'20-'21

UNC

- BS in CS '07
- Other foci: Math, Women's Studies



Academia

Virginia Tech

- MS in CS '13
- PhD in CS '18

JMU

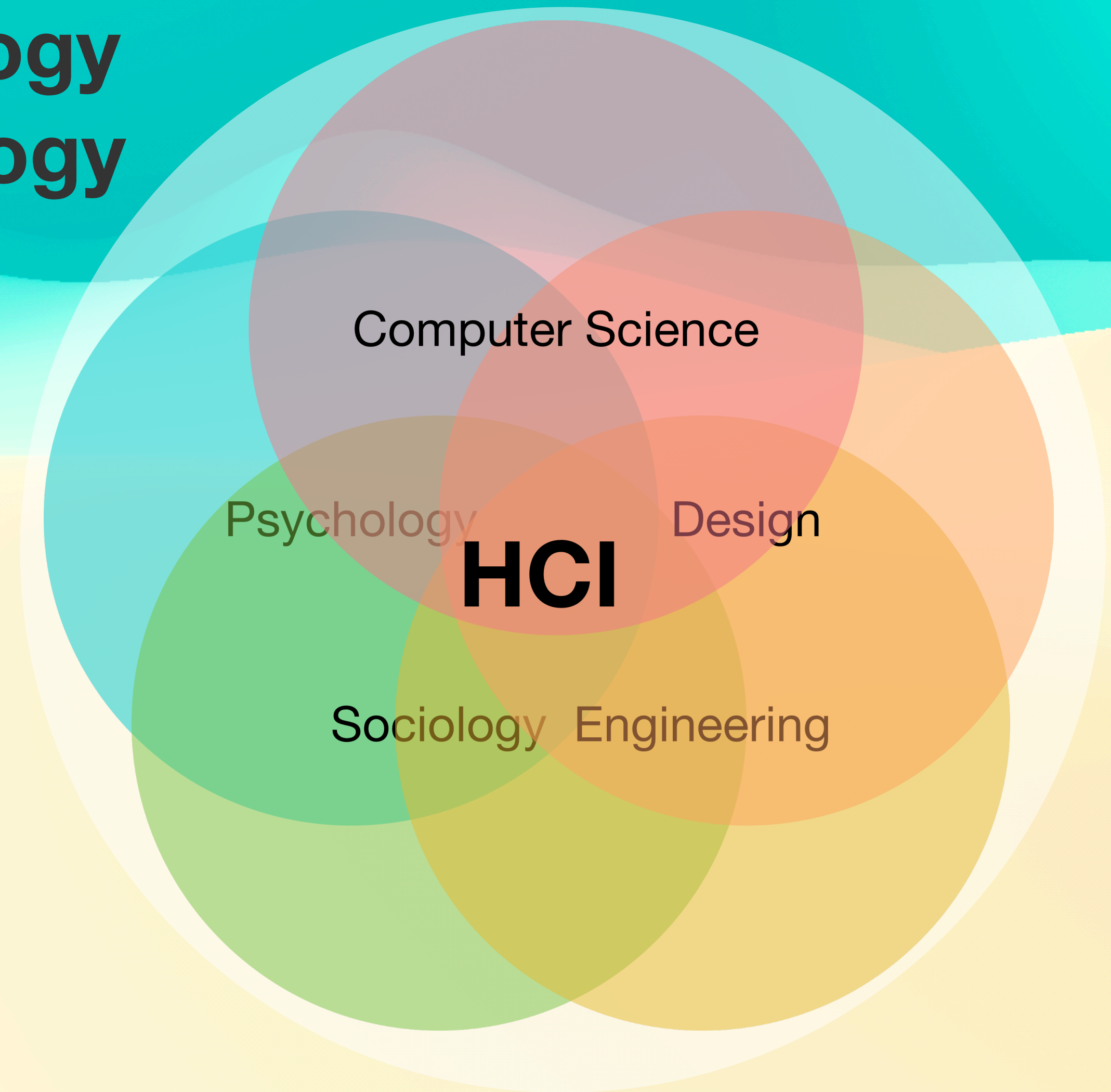
- teach: 159, 159, 343, 347, 447



Human-Computer Interaction

Interdisciplinary research area centered around the way people use technology (or don't) and the effects of technology use on people.

1. **Gather qualitative and quantitative data about people and systems (evaluate)**
2. Produce Implications for Design
3. Design
1. **Evaluate (Gather qualitative and quantitative data about people and systems)**



Generally

- Power
- Togetherness
- Education
 - CS
- Computational Thinking
- EdTech

Currently

- effecting change to practice, canon, tradition through tech
- (tech) design for belonging, community

The screenshot shows a web application interface for a music practice tool. At the top, there is a navigation bar with links for "Music CPR", "Courses", "Assignments", "About", and "Logout demodave". The main content area is titled "Air for Band" and "Perform Melody Activity". Below the title, there is a sub-header "Practice the melody and then record yourself performing it." The interface displays musical notation on a staff, with a tempo marking of "♩ = 80". The notation is in bass clef, 4/4 time, and features a key signature of two flats. A vertical scroll bar is visible on the right side of the notation. Below the notation, there is a microphone icon and the text "No takes yet. Click the microphone icon to record." On the left side of the interface, there is a sidebar with a menu containing "Melody", "Bassline", "Create", and "Reflect".

Dr. Taalman in Math & Stat is seeking students interested in:

1. Math
2. p5.js
3. Crochet

The patterns shown here can occur from basic crocheting of one linear piece of multicolored yarn.

Let's find out WHY and HOW and write a paper about it and make stuff...

1st and 2nd year students are especially encouraged to apply :)

Check it out: mathgrrl.com/crochet-color-pooling/

Crochet Color Pooling

Just want to see pretty patterns?
Press "r" for random colors, then "f" to shuffle those colors.
Then play with the clusters slider!

Choose a yarn, type of stitch, and direction of work. You can also enter your own colors and magic stitch counts below, or press "r" for random colors and numbers.

Yarn Samples

Random (press r for more) ▾

Stitch Type

Staggered (moss, shells) ▾

Work Direction

Flat (back and forth) ▾

Try out different values for the Clusters until you find a design you want. This is the fun part! You can also use the right/left arrow keys to change this clusters number.

Clusters = 53



While you're working you can use the Focus button to double-check the colors in your current row. You can also use the up/down arrow keys to change this row number.

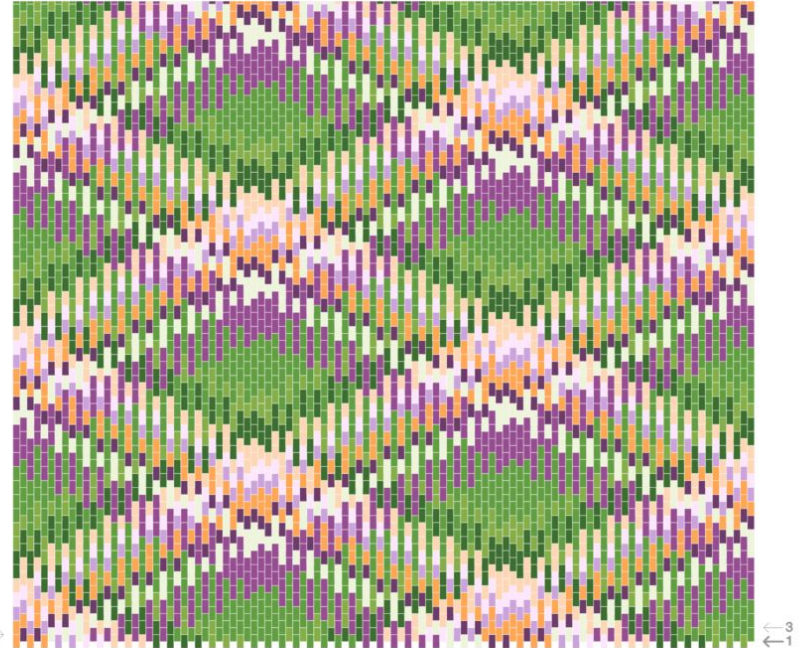
Focus Row = 1

b = toggle borders

c = cycle starting color

s = download screenshot of image

p = download written crochet pattern



Apply here: bit.ly/JEM-code-crochet

Dr. Taalman will review applications throughout the month of September and on a rolling basis. You can expect to hear back on or before October 1 as to the status of your application.

JEM Lab student research project application - code and crochet

Dr. Taalman in the department of Mathematics & Statistics is in search of a student or pair of students who are interested in (1) math, (2) p5.js, and (3) crochet, for a project in the JMU Experimental Mathematics (JEM) Lab. Apply here if you might be interested!

Details: This is a small side research project, but one that will result in a short published research paper in early spring, and potentially a trip to present at a conference in Richmond over the summer. Most of the exploratory research work and writing would occur from November through March; we can work around your schedule as needed and use a combination of in-person and Zoom meetings. There is no funding for this project (except for possibly travel funding), but students can get 1 credit of coursework if desired.

