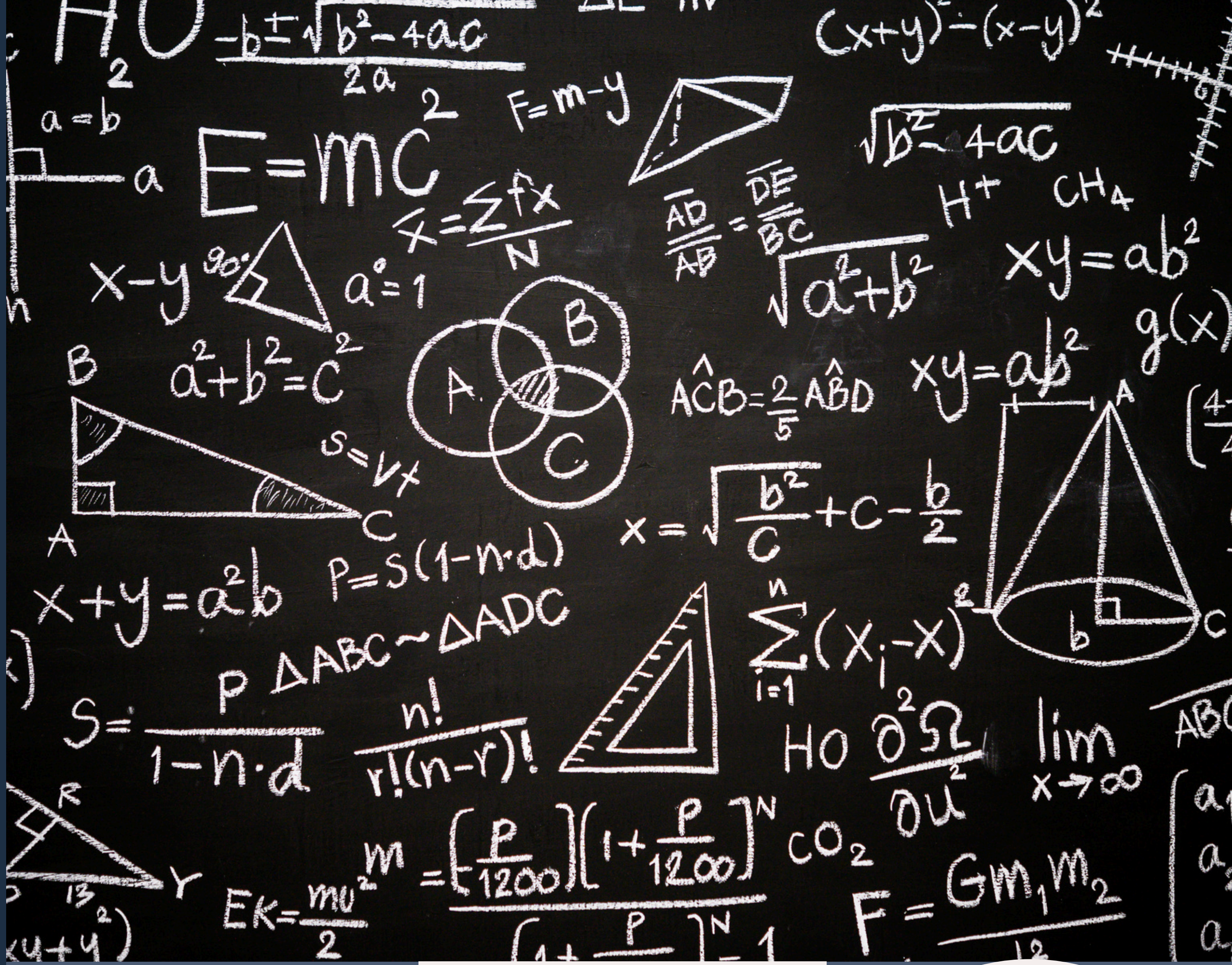
Designing Inclusive Math Courses:

Contract Grading and Technology for Learner Agency



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Universal Design

- enhances accessibility for all types of learners in education.
- promotes flexible learning environments that can accommodate individual learning differences effectively.
- encourages engagement, boosting motivation and improving educational outcomes for all students.

Contract Grading

Contract grading is an alternative assessment method where a student and instructor agree on a set of tasks or criteria to be completed in order to achieve a specific grade.

Contract grading differs from traditional grading schemes in their invitation to students to consider their own needs for how and when they will complete tasks to earn their desired grade.

Contract Grading

Benefits

- Empowers students to optimize their learning
- Reduces stress around traditional grading
- Supports all learners with different strengths

Types of Contracts

Student Created

Each student creates their own contract

Community Created

The Class decides together how the contract will be created

Traditional Contract Grading Example
(Discrete Math Course)

To earn:	Accomplish the following:
A	Earn at least **45 points on Daily Prep assignments**; *and* Attain fluency on **all 8 Core Learning Targets plus any 10 others**; *and* Earn Satisfactory marks on **at least 8 Weekly Challenges**.
B	Earn at least **40 points on Daily Prep assignments**; *and* Attain fluency on **all 8 Core Learning Targets plus any 8 others**; *and* Earn Satisfactory marks on **at least 7 Weekly Challenges**.
C	Earn at least **35 points on Daily Prep assignments**; *and* Attain fluency on **all 8 Core Learning Targets plus any 6 others**; *and* Earn Satisfactory marks on **at least 6 Weekly Challenges**.
D	Earn at least **25 points on Daily Prep assignments**; *and* Attain fluency on **Any 6 Learning Targets** (not necessarily Core); *and* Earn Satisfactory marks on **at least 4 Weekly Challenges**.

Contract grading scheme for Calculus

Each Student chose weights for the graded categories (within given ranges)

Old grading Scheme:
Participation: 10%
Edfinity: 25%
Small Assessments: 25%
Midterm & Final: 40%

Choose your weights:
Participation: 5-10%
Edfinity: 15-35%
Small Assessments: 20-30%
Midterm & Final: 35-50%

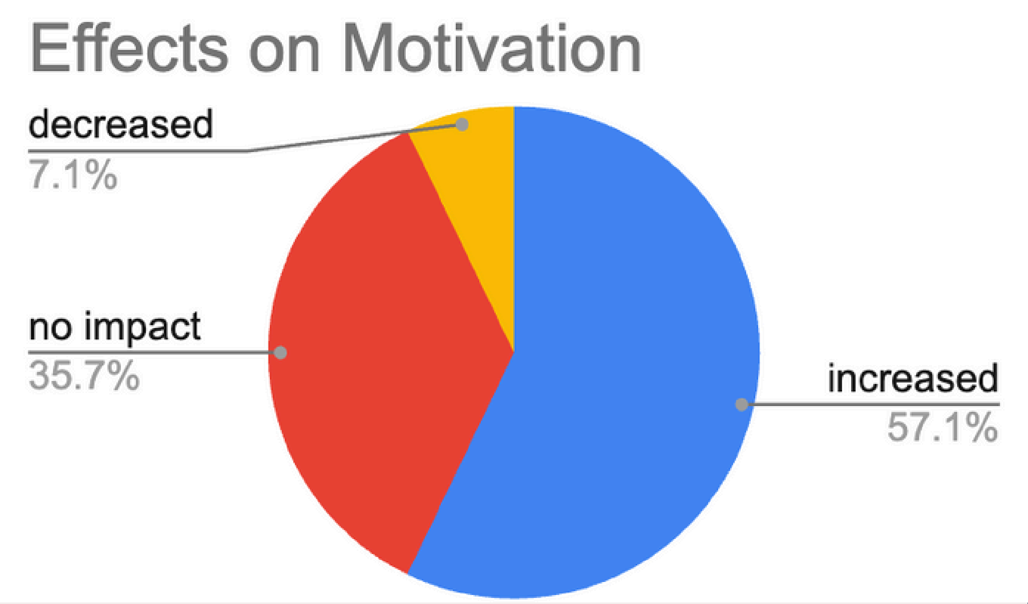
What we asked students at the beginning

- After describing the types of categories, they chose the weights they wanted for each category
- Asked them to check to make sure their weights added to 100
- Asked them why they chose the weights they chose

What we asked students at end

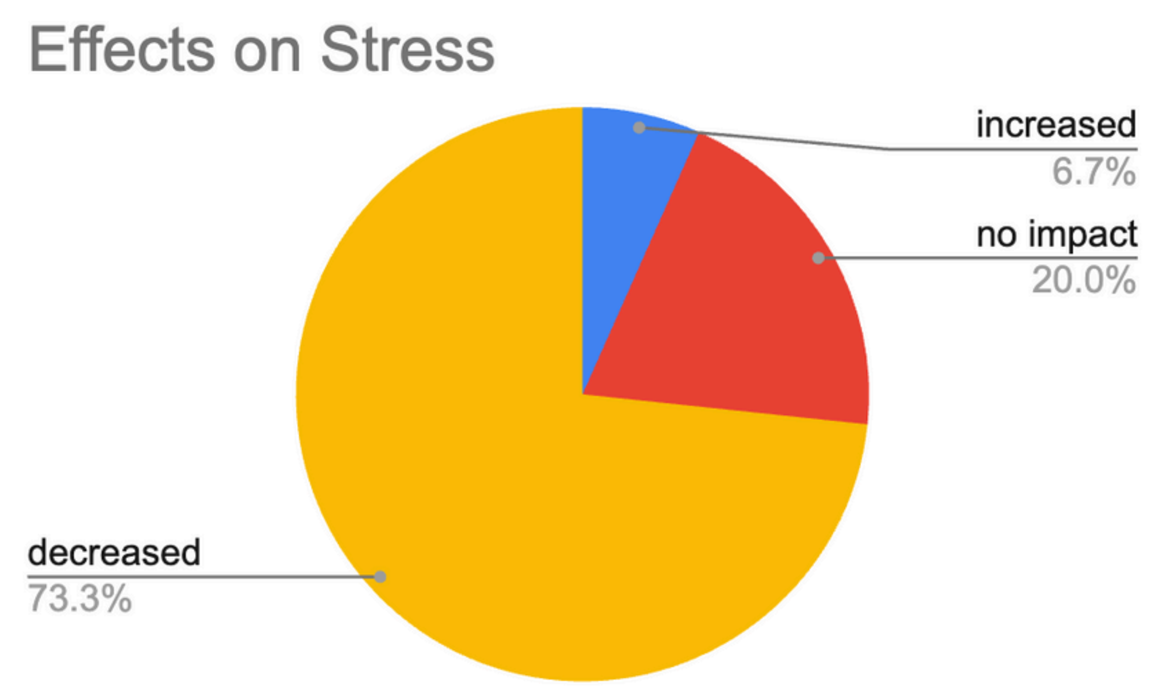
1. I felt confident when choosing my grade distribution at the beginning of the course. (SD, D, A, SA)
2. What feelings did you have when first choosing your grade weights?
3. The grade distribution I chose reflected my personal academic strengths. (SD, D, A, SA)
4. How did your choice align (or not align) with your strengths?
5. If I could redo the course, I would keep the same grade distribution I chose. (SD, D, A, SA)
6. Why would you change or keep your original choice?
7. My final grade accurately reflects my effort and learning because I chose my own grade weights. (SD, D, A, SA)
8. Why do you feel your final grade did or did not reflect your effort?
9. I would prefer to use a customizable grading system in future mathematics courses. (SD, D, A, SA)
10. Why would you want or not want to use this grading system again?
11. Having control over my grade weights (decreased/no impact/increased) level of stress.
12. Why do you think your level of stress was affected that way?
13. Having control over my grade weights (decreased/no impact/increased) motivation.
14. Why do you think your level of motivation was affected that way?

What students said



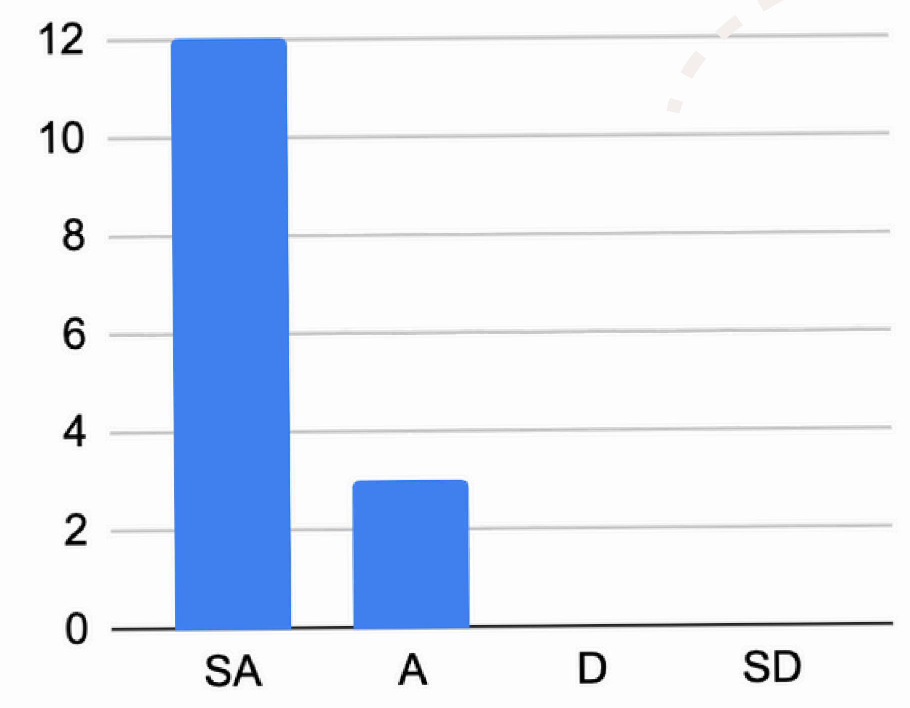
Motivation

The grading scheme was motivating for over half, it reinforced existing tendencies for some while providing structure and control for others



Stress

Students appreciated reduced exam pressure, control over grading, and motivation from a system where all efforts mattered. They liked that one bad test wouldn't ruin their grade and valued clear expectations. Some initially felt stressed about customizing weightings but later saw the benefits.



Preference for future

Responses suggest that a flexible grading system promotes student agency, improves confidence, reduces anxiety, and enhances the learning experience by aligning assessment methods with individual strengths.

Technology in Mathematics

- Utilizing multiple tools: calculators, Excel, AI platforms
- How real-world problems can be solved with diverse technologies

Estimating a Bear's Weight

Details: Over the course of several years, 100 wild black bears in the Eastern US were anesthetized, and their bodies were measured and weighed.

The goal of the study was to find a way for forest rangers to estimate a bear's weight using some other characteristic that could be measured quickly with a tape measure (or approximated from a distance).

This would be useful because in the field it is easier to measure a length than it is to weigh a bear with a scale.

The bear data file includes several possible simple measurements.

age (in years)	weight (in pounds)	length (inches)	head length (inches)	head.width (inches)	neck girth (inches)	chest girth (inches)
5	65	45	10	5	15	23
5	70	47.5	11	6.5	20	24
5	74	57	12	6	17	27
5	142	59.5	12.5	5	20.5	38
5	121	62	12	6	18	31
5	80	53	11	5.5	16	26
5	108	56	12	5.5	17	30.5
5	344	67.5	16.5	9	28	45

Your Task:

- Investigate the measurements and how each relates to weight.
- Determine which could be used to predict weight using a linear relationship.
- Provide an example showing how to use the line you find to estimate the weight of a bear.

Build a report that includes:

1. A summary of the problem.
2. A graph of each scatterplot you created including their regression lines. Be sure to label the unit of measure used on each axis and identify each scatterplot with an appropriate title.
3. An explanation identifying which measurement is the best weight predictor *if the park ranger can actually measure a sleeping bear* and a brief description of why it is the best one.
4. The equation for the best regression line and an example of how to use the line to make a prediction.
5. Would you use the same measurement to approximate the weight of a bear you see while on a walk in the woods? Why or why not? If you said no, what measurement would you use instead?

ChatGPT

I have a bunch of data about 100 different bears (ex. weight, head girth, chest girth, length, head width, etc.). I want to do linear regression to see what is the best predictor of weight. Is weight the independent or dependent variable in my equations?

In your case, **weight is the dependent variable** in the linear regression equations.

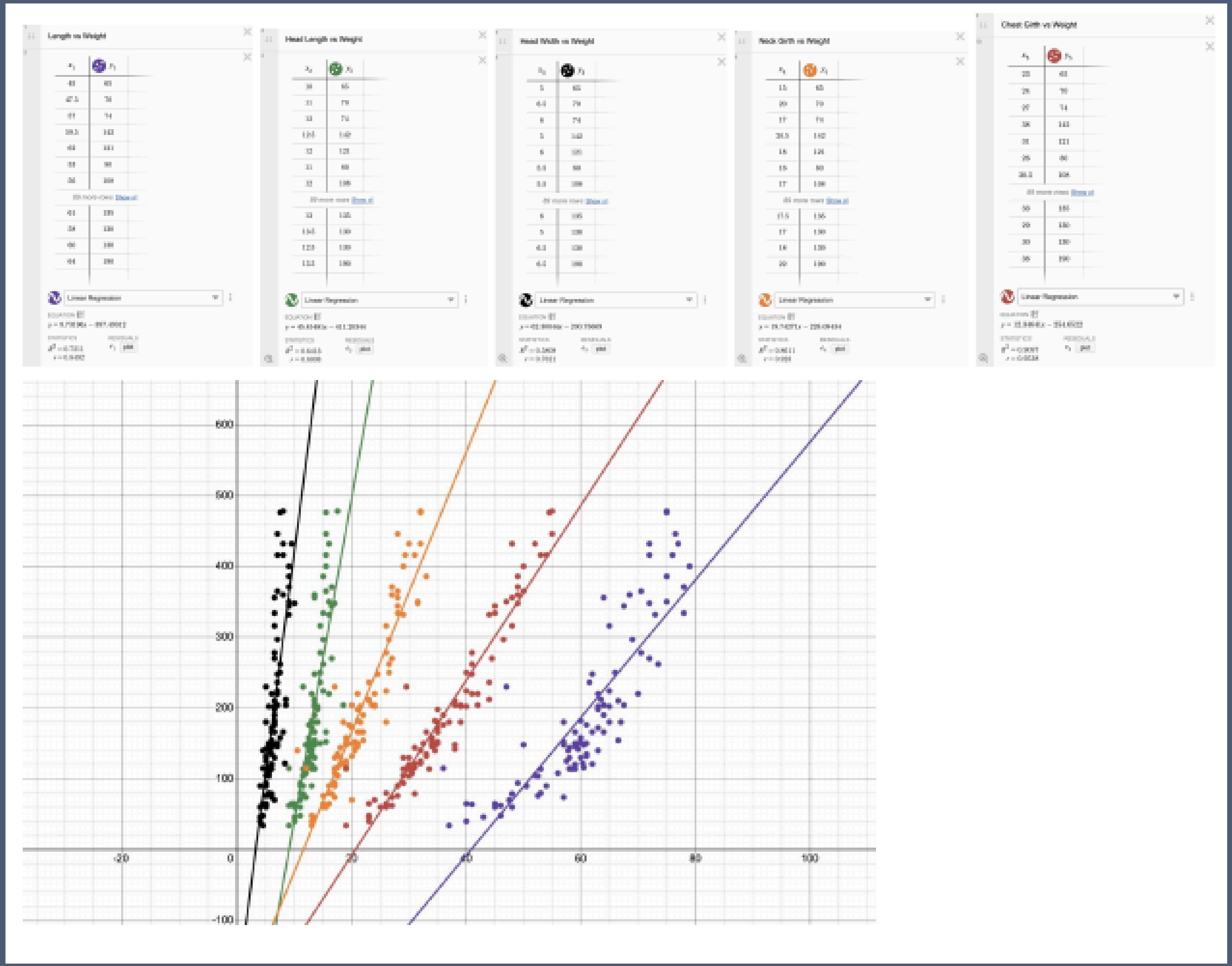
Why:

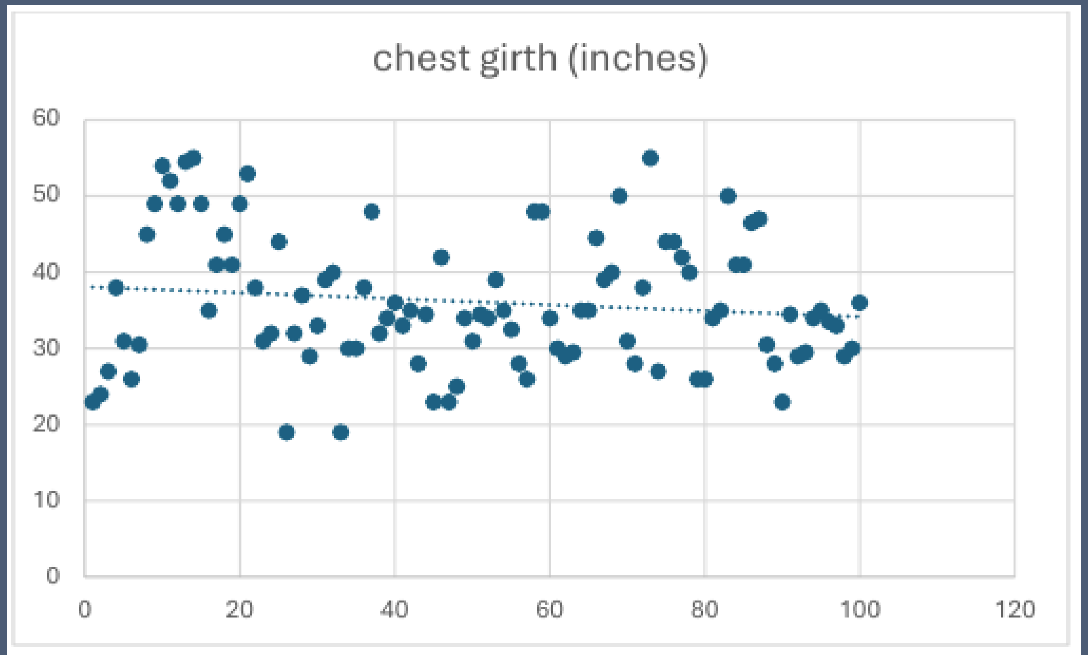
- The **dependent variable** is what you're trying to predict or explain — in this case, **weight**.
- The **independent variables** (or predictors) are the other measurements you mentioned — **head girth, chest girth, length, head width**, etc.

length (inche	weight (in pc	head length	weight (in pc	head.width (	weight (in pc	neck girth (ir	weight (in pc	chest girth (i	weight (in pc
45	65	10	65	5	65	15	65	23	65
47.5	70	11	70	6.5	70	20	70	24	70
57	74	12	74	6	74	17	74	27	74
59.5	142	12.5	142	5	142	20.5	142	38	142
62	121	12	121	6	121	18	121	31	121
53	80	11	80	5.5	80	16	80	26	80
56	108	12	108	5.5	108	17	108	30.5	108
67.5	344	16.5	344	9	344	28	344	45	344
78	371	16.5	371	9	371	27	371	49	371
72	416	15.5	416	8	416	31	416	54	416
77	432	16	432	8	432	32	432	52	432
72	348	17	348	10	348	31.5	348	49	348
75	476	15.5	476	7.5	476	32	476	54.5	476
75	478	17.5	478	8	478	32	478	55	478
75	386	15	386	9	386	33	386	49	386
62	166	15.5	166	6.5	166	22	166	35	166
70	220	13	220	7	220	21	220	41	220
78	334	15	334	6.5	334	28	334	45	334
73.5	262	15	262	7.5	262	26.5	262	41	262
68.5	360	13.5	360	8	360	27	360	49	360

Excel

Desmos





Google Sheets & Excel

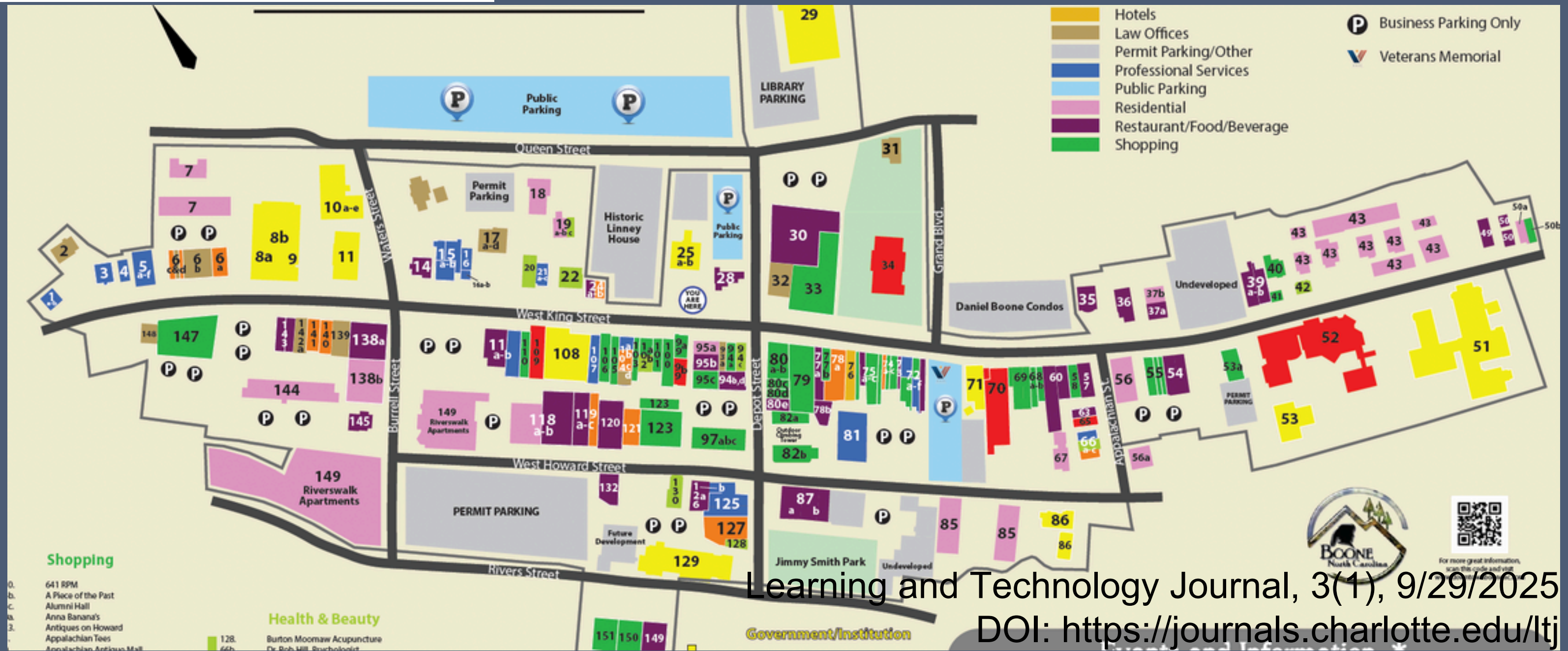
Clearing Snow in Downtown Boone

Introduction:

After a significant snowfall, the Town of Boone must ensure that all streets are cleared efficiently to restore safe travel conditions. Snowplows must traverse every street while minimizing unnecessary travel and avoiding backtracking whenever possible.

This project challenges you to design an optimal snow removal route for Boone using **Euler circuits and graph theory**. You will model the town's street network as a graph, analyze its structure, and determine the most efficient way to clear all roads. By applying Euler's Theorem, you will determine whether a Euler circuit (a path that covers every street exactly once and returns to the starting point) exists or if modifications are needed to optimize the route.

This real-world application of graph theory will help you develop problem-solving skills while gaining insight into the mathematical principles that inform urban planning and logistics.



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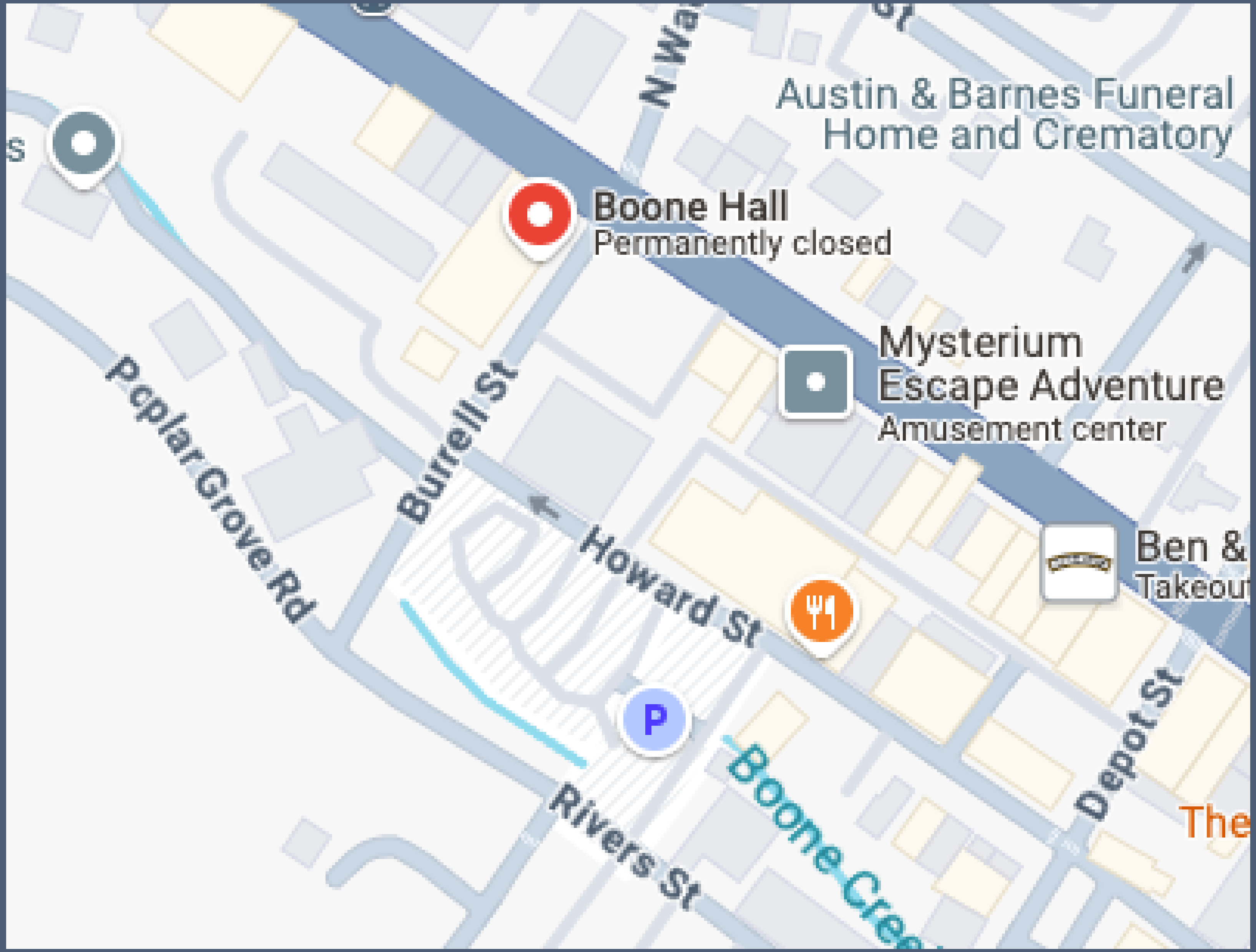
Preliminary Discussion & Assumptions:
Before beginning calculations, take time to discuss the problem with your group. Use the provided map to analyze the street network and identify key features relevant to your discussion. Consider the following questions and agree on key assumptions to guide your approach:

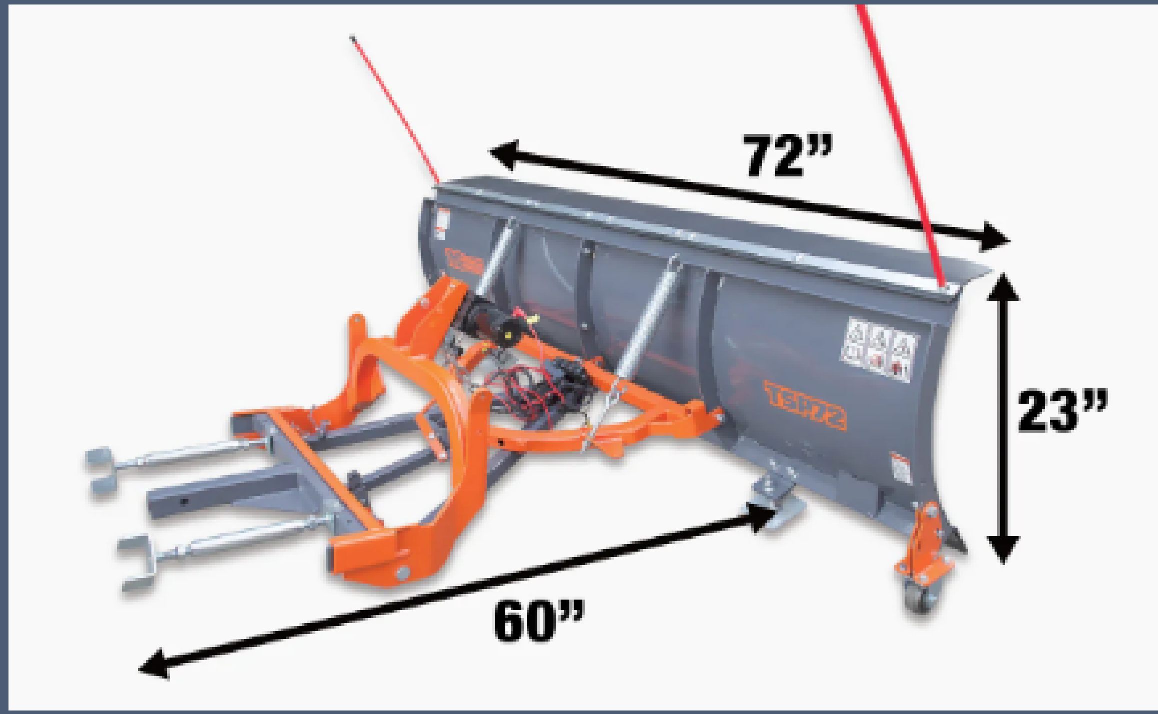
1. **What do we need to know?**
    - What are the specific boundaries of the area we are working with?
    - Are there any one-way streets or restricted areas?
    - Where will the snowplow start and finish its route?
    - How wide is the path that the snowplow clears in a single pass?
2. **What assumptions should we make?**
    - For this assignment, assume that a single snowplow is responsible for clearing all streets.
    - Should we assume all roads are equally important, or should some streets take priority?
    - Should we assume the plow can turn around anywhere, or only at intersections?
    - Are there any real-world factors (traffic, parked cars, hills) that we will ignore for simplicity?
    - Should left turns be allowed, minimized, or avoided altogether?
3. **How will we organize our work?**
    - How will we record the streets we've traveled?
    - What strategy will we use to determine if an Euler circuit exists?
    - If no Euler circuit exists, how will we modify the graph to find an optimal route?

As a group, discuss and write down your agreed-upon assumptions before proceeding. If there are disagreements, take a moment to reason through different perspectives and come to a consensus. Once your group has finalized these details, you may begin modeling the problem.

Google Earth



Google Maps



AI Overview

The usual width of a lane on a road is 12 feet (3.66 meters) in the United States, especially on highways and interstates. However, lane widths can vary depending on the type of road, design considerations, and even local regulations. For example, city and county roads may have lanes closer to 8-11 feet.

Google

Examples of Student Assumptions

Are there any real-world factors (traffic, parked cars, hills) that we will ignore for simplicity?

Yes we will assume that the roads are free from parked cars, and hills arent a problem since it's a high horsepower truck and the roads are empty since the snowfall was so heavy.

Should left turns be allowed, minimized, or avoided altogether?

Snowplows need to turn around anywhere and make left turns whenever necessary because their job is too important to slow down. If roads are bad enough for plows to be out, most people aren't driving anyway.

Summary:
We need to clear snow from the streets of downtown Boone. To make the most efficient path, we will use Eulerian graph theory– crossing each side of the street at least once, and starting & ending at the same point.
We wanted to use a V snow plow that is approximately the length 8'6, so it clears the length of 1 lane.
Assuming we can go both ways on Howard street.
All roads are equally important as they need to be plowed on both sides.
The snow plow can turn around/back up at any point, or make any turns it needs, assuming most people are not driving on snowy roads anyway.

Preliminary Discussion & Assumptions

- Boundaries: The area includes the main roads in downtown Boone—West King Street, West Howard Street, Appalachian Street, Queen Street, Rivers Street, Burrell Street, Depot Street, Waters Street, and Grand Boulevard.
- One-way Streets: West Howard is assumed to be two-way for the sake of this project.
- Start/End Point: The snowplow starts and finishes on West King Street.
- Plow Width: The plow clears an 8-foot-wide lane per pass, so each street must be passed twice to clear both sides.
- Turns: The plow can turn around at any intersection or wide enough point, including in the middle of the road when needed.
- Ignored Factors: For simplicity, traffic, parked cars, and hills are ignored.
- Left Turns: Left turns are allowed with no restrictions.
- Priority Streets: All roads are treated with equal priority.

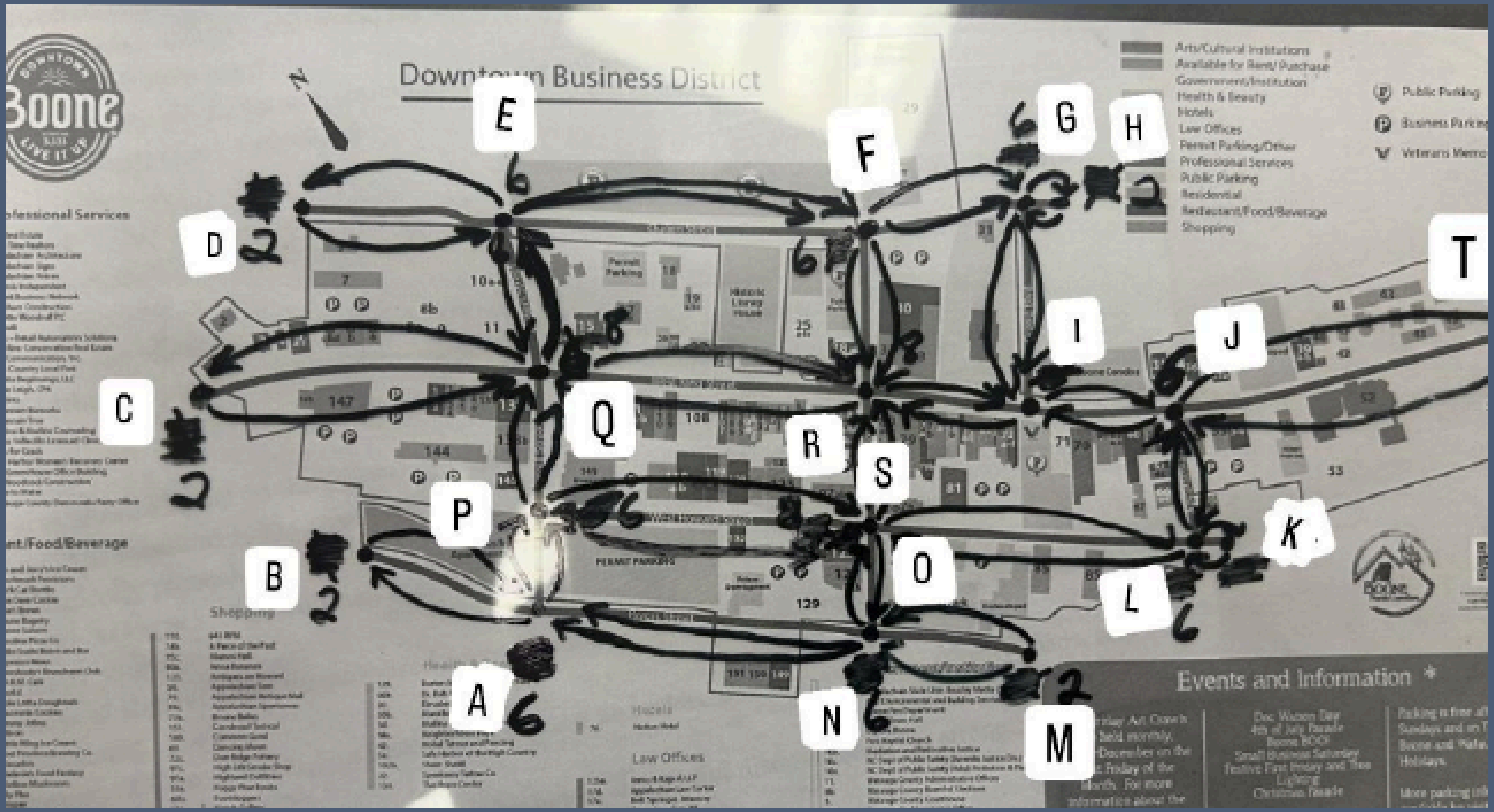
The Task

Your Task:
Using the map provided and the discussion from your group, develop a plan for clearing all streets in Boone as efficiently as possible. Your approach should be mathematically justified using Eulerian graph theory and should consider real-world constraints such as one-way streets, turnarounds, while ensuring that only one snowplow is used. Your final plan should demonstrate an understanding of **Euler circuits, Euler paths, and necessary modifications to the network if an optimal route does not exist**. Be prepared to justify your decisions and explain how your plan minimizes unnecessary travel while ensuring complete snow removal coverage.

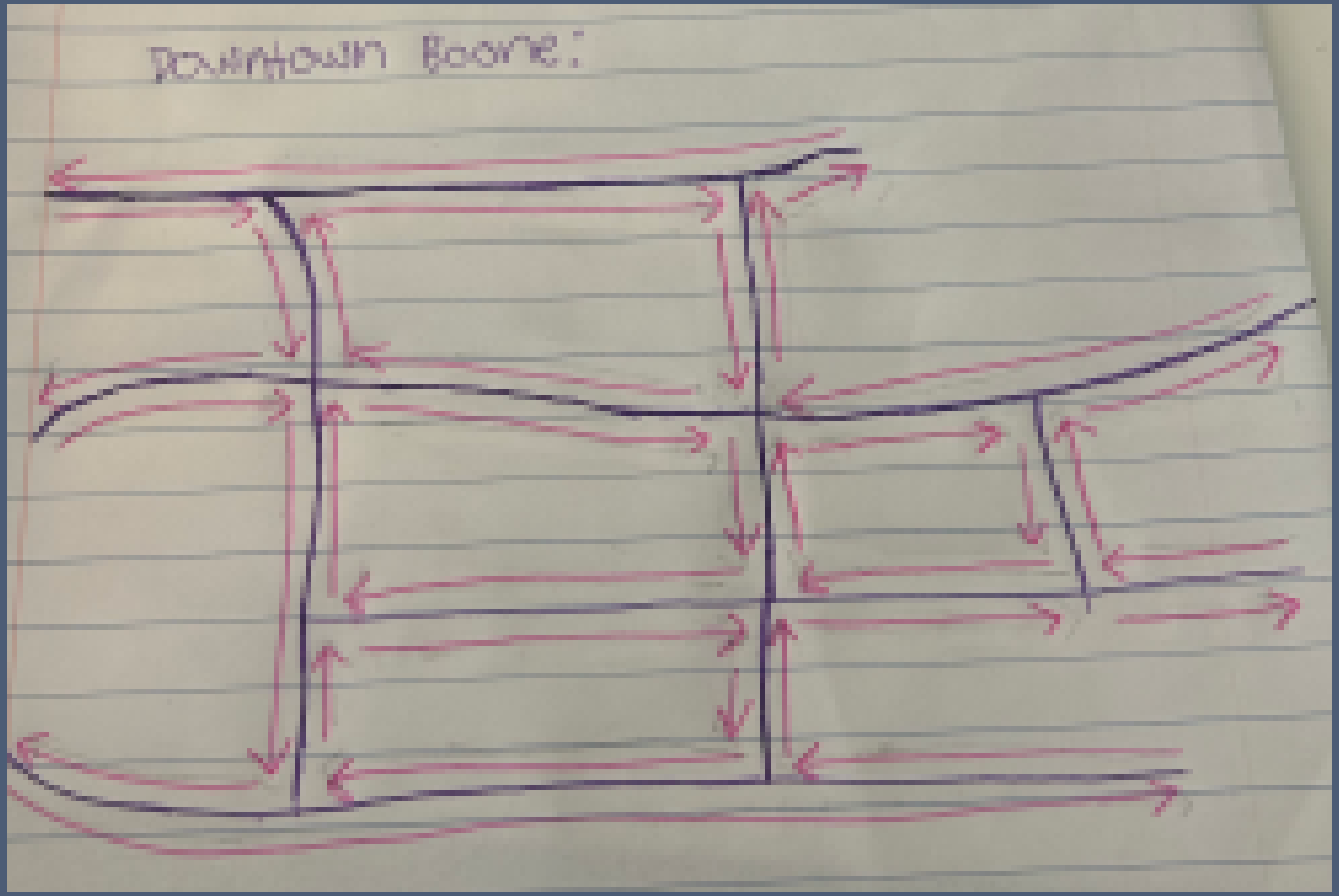
Build a Report That Includes:
Each student will submit a final report that includes:

1. **A summary of the problem:** Provide an overview of the snow removal challenge and how Eulerian graph theory applies to solving it. Additionally, include answers to the questions discussed in the Preliminary Discussion & Assumptions section, such as the area boundaries, starting and ending points, one-way street considerations, and any turning constraints that impact the snowplow's route.
2. **A clearly labeled map and graph:** Highlight the proposed snow removal route and indicate any necessary modifications to the original street network.
3. **Mathematical justification:** Explain how Euler circuits or paths were used to optimize the route. Describe how you determined the degree of each vertex and used that information to decide whether an Eulerian circuit exists. If modifications were needed, explain what changes were made to ensure all streets could be covered efficiently.
4. **Discussion of constraints:** Address real-world factors such as one-way streets, priority roads, and the impact of using one or multiple plows.
5. **Reflection:** Summarize the strengths and limitations of your solution and discuss any alternative approaches that could have been considered.

Student Graphs



-Next go to first one way street (B)
-Turn around and go to street (A) again
-Go up to street (P)
-Go to street (Q)
-Go to One way street ©
-Go back to street (Q)
-Go up to (E)
-Go to street (D)
-Turn around and go to street (E) again
-Go to street (F)
-Go to street (G)
-Go to street (H)



Get in Touch

We are here to answer your questions. Feel free to reach out anytime for support and insights!

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