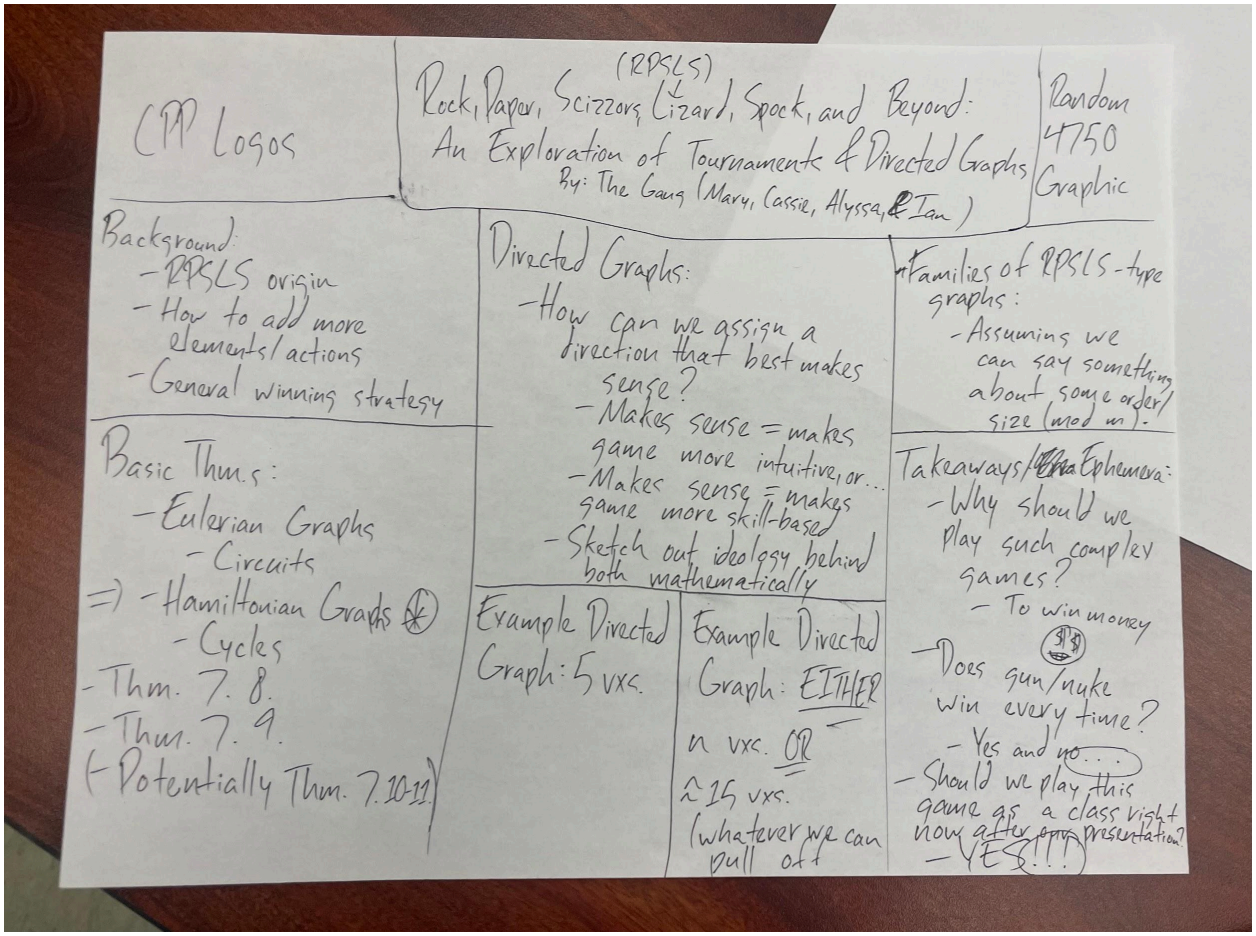


Background:

- Normal rock paper scissors game
    - Stupid graphic if we want to use it: (https://www.reddit.com/r/funny/comments/1geln2s/good_thing_the_game_is_balanced_now/)
- Rock Paper Scissors Lizard Spock
    - Sam Kass, original inventor of the game: https://www.samkass.com/theories/RPSSL.html
    - Try to quote Big Bang Theory episode so people are intrigued: (https://www.youtube.com/watch?v=pIpmITBocfM)
- We use directed graphs to show us the outcomes of tournaments.

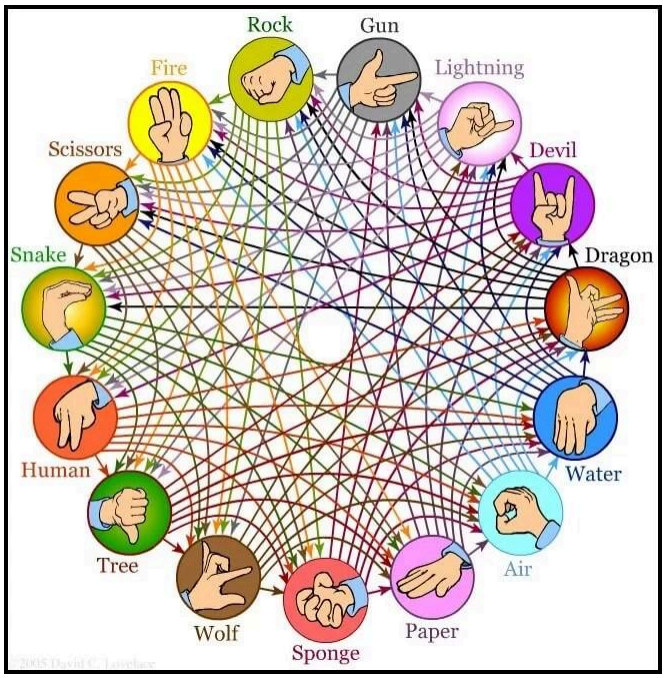
Basic Theorems and Definitions:

- A **tournament** is an orientation of a complete graph
- A tournament is Eulerian if every strategy beats exactly half of the other strategies. Because there must be an even number of other strategies, all Eulerian tournaments have odd n. ***VERY IMPORTANT**
- ***Alyssa doesn't need it anymore***
- **Theorem 7.8** Every tournament contains a Hamiltonian path.
- **Theorem 7.9** Every vertex in a nontrivial strong tournament belongs to a triangle.
- **Theorem 7.10** A nontrivial tournament T is Hamiltonian if and only if T is strong.

How to use Directed Graphs:

- How can we assign a direction that makes our outcome more intuitive or more skill based?
- A tournament doesn't make sense unless someone is beating someone else, so we need to make a graph to determine who wins and so there are no ties when there are two unique entries.
- Every action is equal in expected value, aka directed graphs show that all RPSLS outcomes are equally likely to win

Examples (see pic in group chat and use all of them [i.e. use K_3 K_4 and K_5], and example of K_{15})



Families of RPSLS -type graphs: ***Alyssa does this lol :)***

What needs to go onto the poster

- T_3 graph and T_3 with one direction reversed.

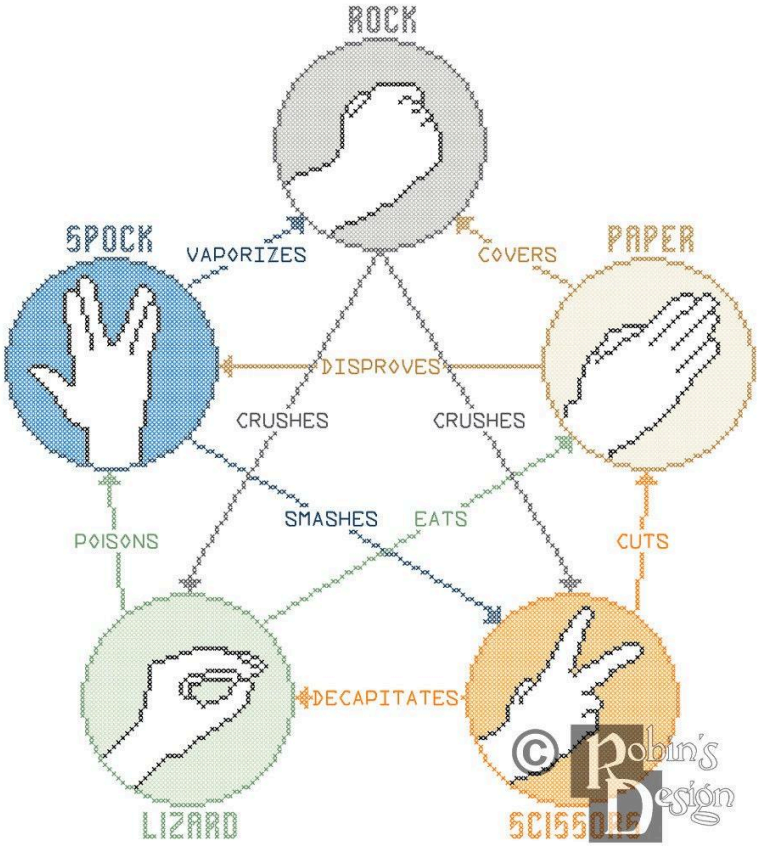
- Def of outdegree should be stated before this or defined here.
- Base T_5 graph, aka RPSLS,
- One other order 5 graph that is not regular with a red X next to it, optional

- "What we can do when generating graphs like T_3, this is isomorphic to the graph for RPS, however it isn't the only possible tournament of order 3. We can reverse the directions of the graphs and see that now we have one vertex with an outdegree of 2 but no longer resembles RPS. This is why it is important when adding a vertex to the tournament it is important to consider the direction of the edge. Adding one vertex to T_3 would add 4 new possible tournaments to T_3 and 4 tournaments in the other T_3. Meaning there are 8 tournaments of order 4, higher and we find there are 12 tournaments of order 5. But there does not exist a graph with a regular outdegree in T_4, thus we aim to find one within a T_5graph. This is desirable as in RPS it is an even chance of winning no matter what two options are chosen, therefore if we were to expand upon the graph we would want one that has RPS as a subgraph, but also have one where any 3 option also make a subgraph isomorphic to RPS. Therefore our decision of this graph of T_5out of the 12 possible options grants the desired result. These are graphs that resemble complete graphs, and so far have been found in $\mathbf{K_3}$ (1-reg) and $\mathbf{K_5}$ (2-reg), but DNE in $\mathbf{K_4}$ as stated above. Using this same method we can generate more Graphs like $\mathbf{K_{15}}$.(7-reg)

Takeaways:

- How can we use directed graphs in the real world? We can use them to better demonstrate the odds of winning or losing when rules are simple, and we can use it to make our own tournaments too. Aka we can make a lot of money when we know the odds $$
- Does a gun/nuke win every time? You can make it so that a gun and nuke could win every time, however there is a unique graph for each tournament of size ≥ 3 that shows even outcomes for all of the different choices in the tournament.

- Who would win overall in our class playing Rock Paper Scissors Lizard Spock? Let's see!
- Rules: see our directed graph for the rule set!



Good links:

- Stack Exchange: https://math.stackexchange.com/questions/3229686/generalizing-rock-paper-scissors-game (Shows general RPS game played with n # of possible actions)

- arXiV: https://arxiv.org/pdf/2410.13560 (Mainly deals with variants, but gives good insight into eulerian graphs and general tournaments)