Network Science

For Pre-service Elementary Educators

MAA MathFest

Philadelphia August 5, 2022

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Convener of Data Science
Program Director of MS in Applied Mathematics

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Elementary Education Majors

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Outline

- Context
- Motivation
- Classroom Activities
  - 2 class days virtual
  - 4 class days in person
- Example student work

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MATH 210: Mathematics for Elementary Educators

- Course created for pre-service teachers only
- 20 students enrolled in Spring 2022 section
- Examine mathematical ideas underpinning the K-6 curriculum
- Additional modules added from standard syllabus
    - Mathematical Modeling
    - Network Science

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Motivation

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Q: At what age can/do children understand networks?

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Where are networks in the curriculum?

AND

When do their teachers learn about networks?

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INTRODUCTION

- **Draw your community or family tree.**

Questions to consider:

- What do these images have in common?
- What is different about these images?
- Is there anything unique about a particular image?
- Other observations?

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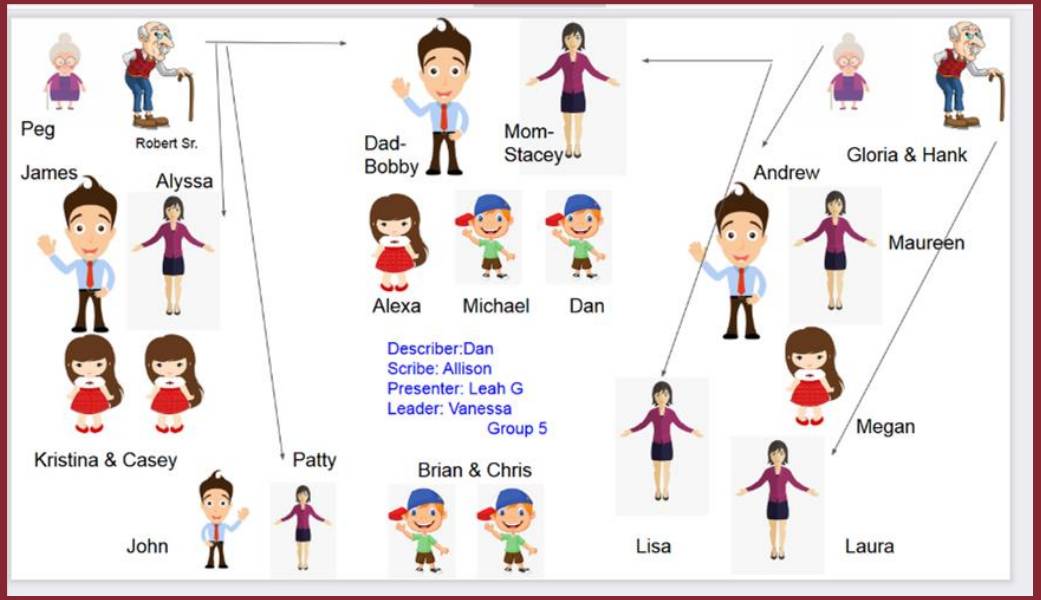
STUDENT EXAMPLES - VIRTUAL



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STUDENT EXAMPLES - VIRTUAL

Nana Begum (Grandmother From Mother side)

Yusuf Begum (Grandfather From Mother side)

Sarah (Mothers Sister)

Lisa (Mothers Sister)

Rashid(Mothers Brother)

Monoara (Mother)

Mary Taher(Grandmother From Father side)

Adam Taher (Grandfather From Father side)

Jackie (Fathers Sister)

David (Fathers Brother)

Abu (Father)

Monoara (Motaleb's Mother)

Abu (Motaleb's Father)

Johnny (Motaleb's Older Brother)

Motaleb

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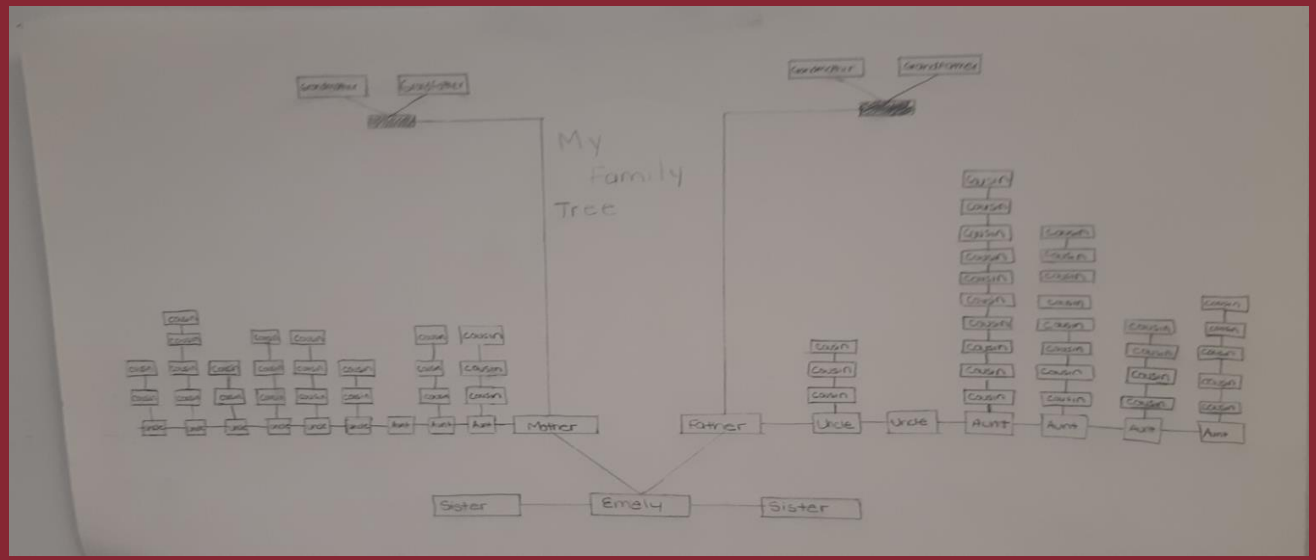
STUDENT EXAMPLES - IN PERSON



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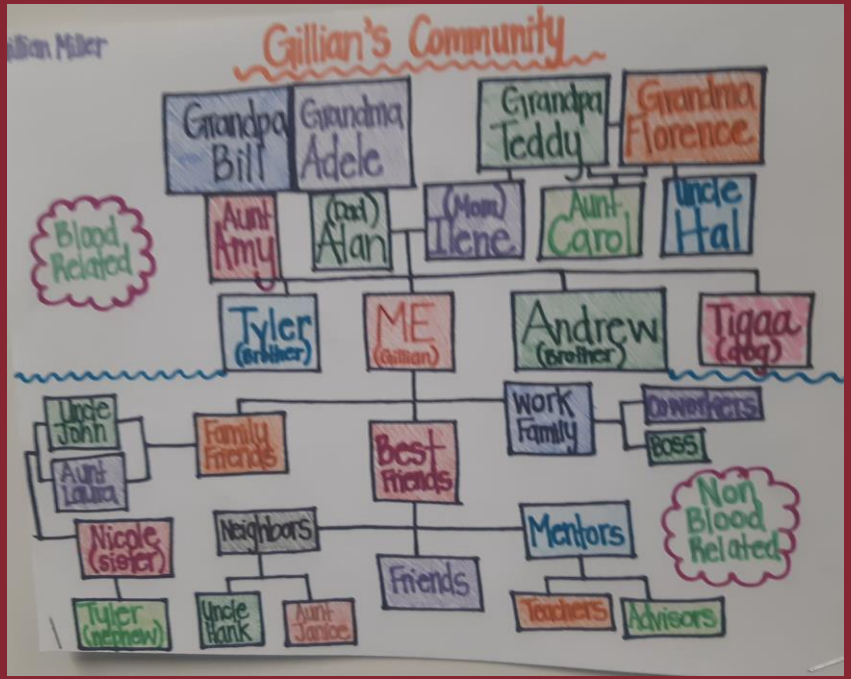

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STUDENT EXAMPLES - IN PERSON

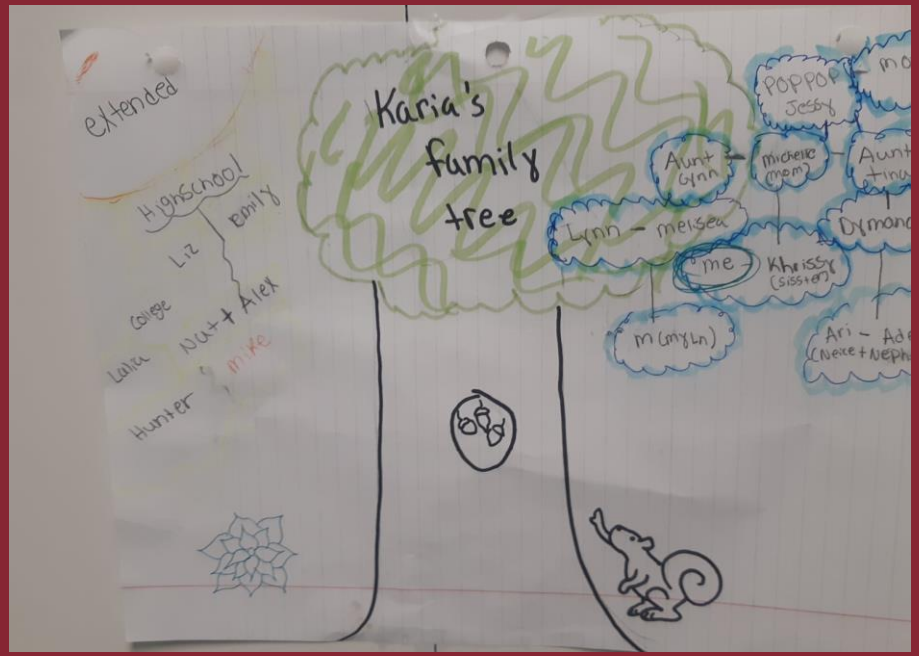

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IMAGE ANALYSIS OF COMMUNITY/FAMILY TREE

- **Direct relationships**
  - **Parent - child**
  - **Siblings**
  - **Marriages**
- **Indirect relationships**
  - **Grandparents**
  - **Cousins**
  - **Friends**
  - **Pets**

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Networks describe how things connect and interact.

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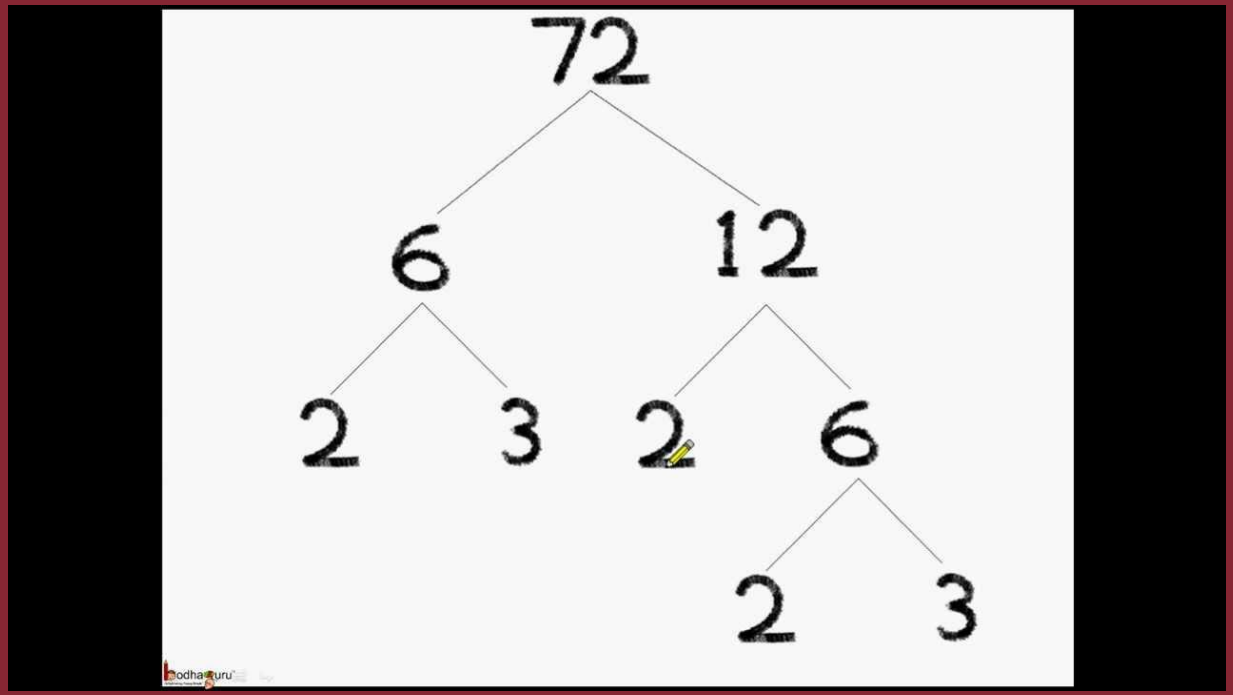
Factor Tree



https://www.youtube.com/watch?v=WnR7SRFEICI

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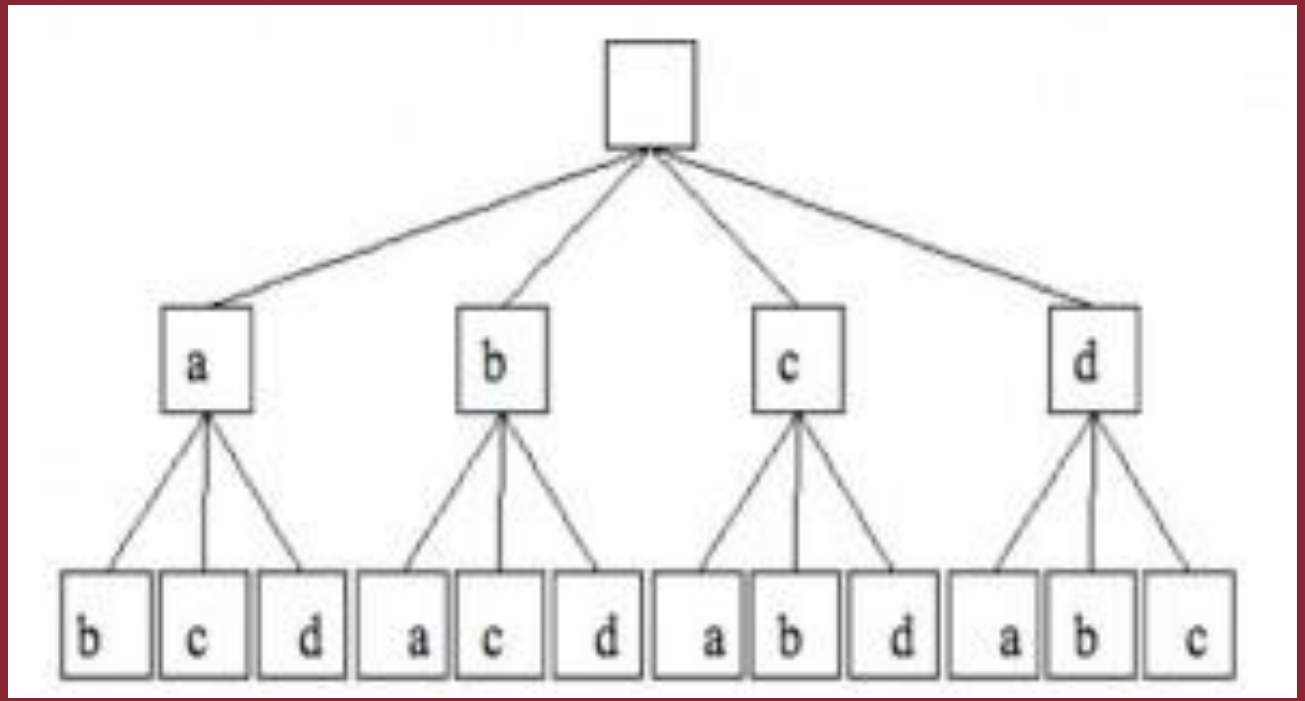
Math combinations



https://www.kaptest.com/

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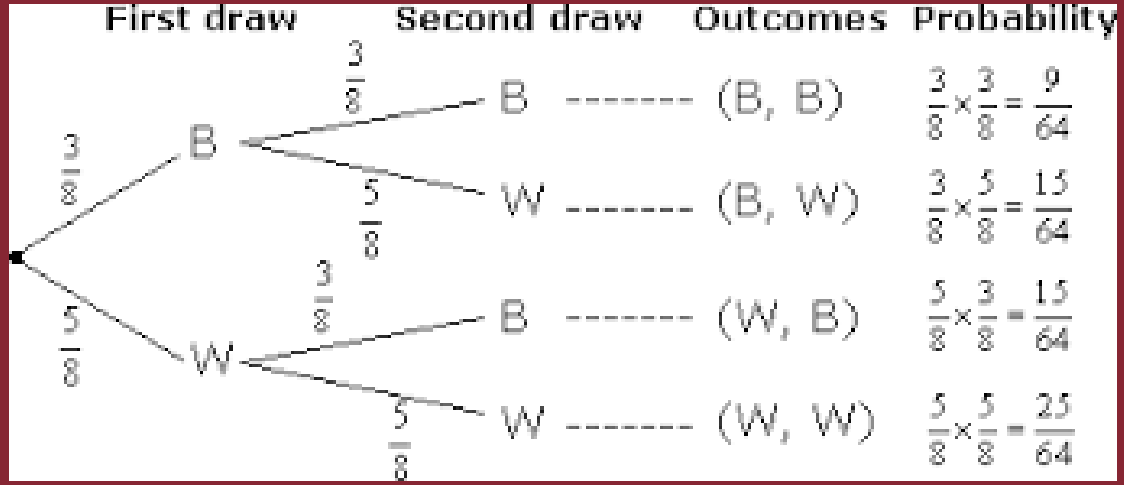
Probability Problems



https://www.onlinemathlearning.com/probability-tree-diagrams.html

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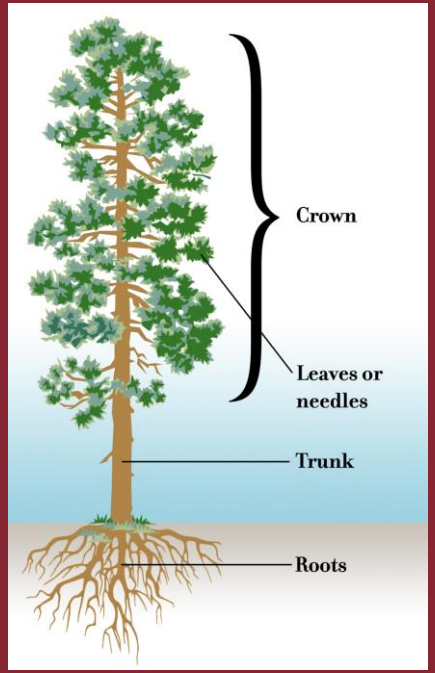
Biology



https://countrytraveleronline.com/2019/10/07/the-anatomy-of-a-timber-tree/

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Bark and Leaf Tracing

https://www.firstpalette.com/craft/leaf-rubbings.html

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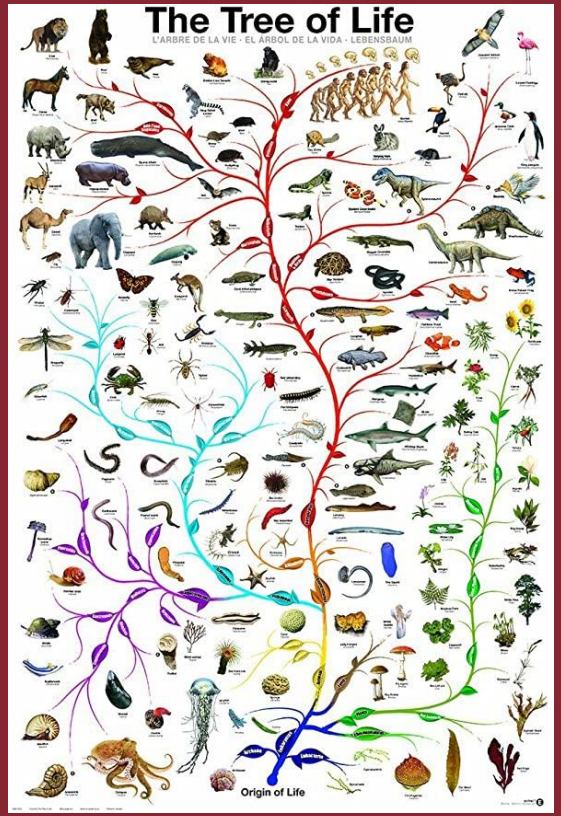
Evolution



https://www.amazon.com/Evolution-Color-Science-Information-Poster/dp/B008K9ZCL0

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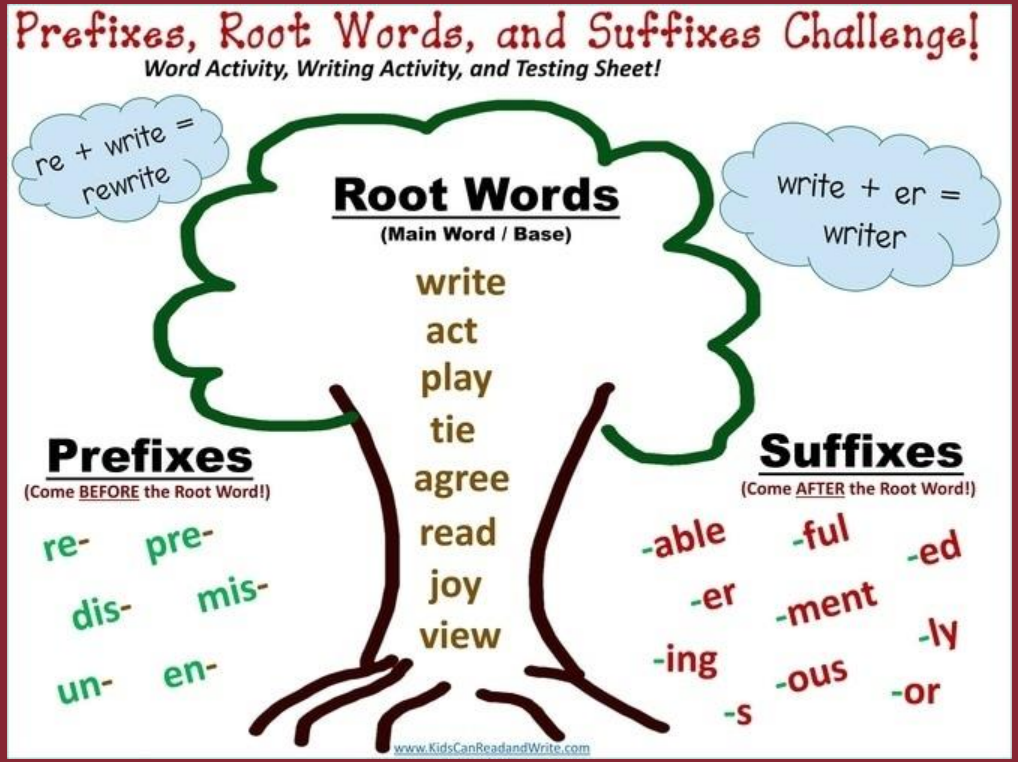
Root, prefix, and suffix of words



https://www.pinterest.com/pin/527906387573862954/

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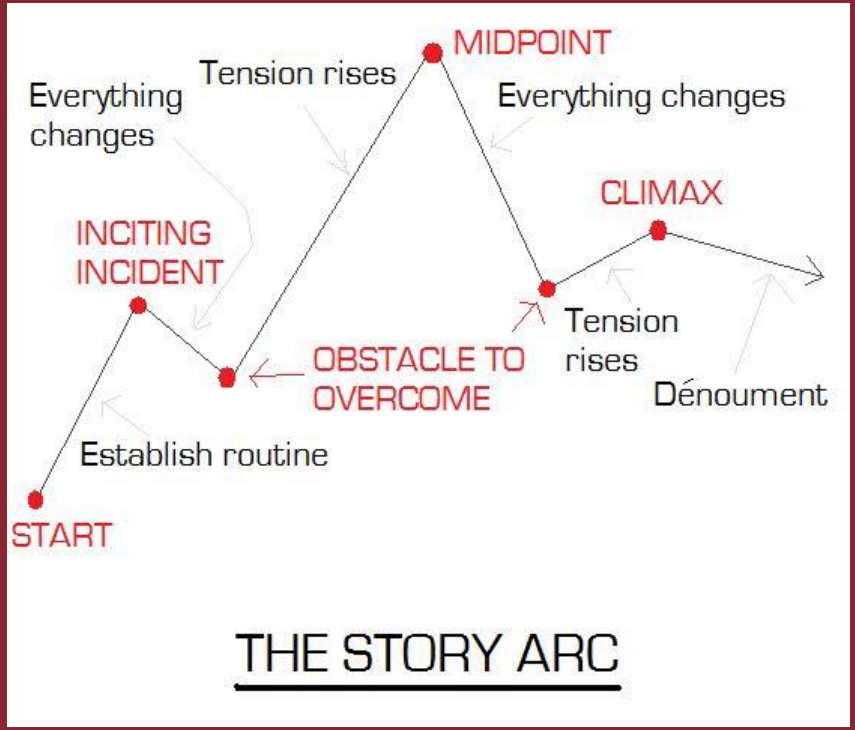
Plot of a book



https://fcmalby.com/2014/05/14/narrative-arc-shaping-your-story/

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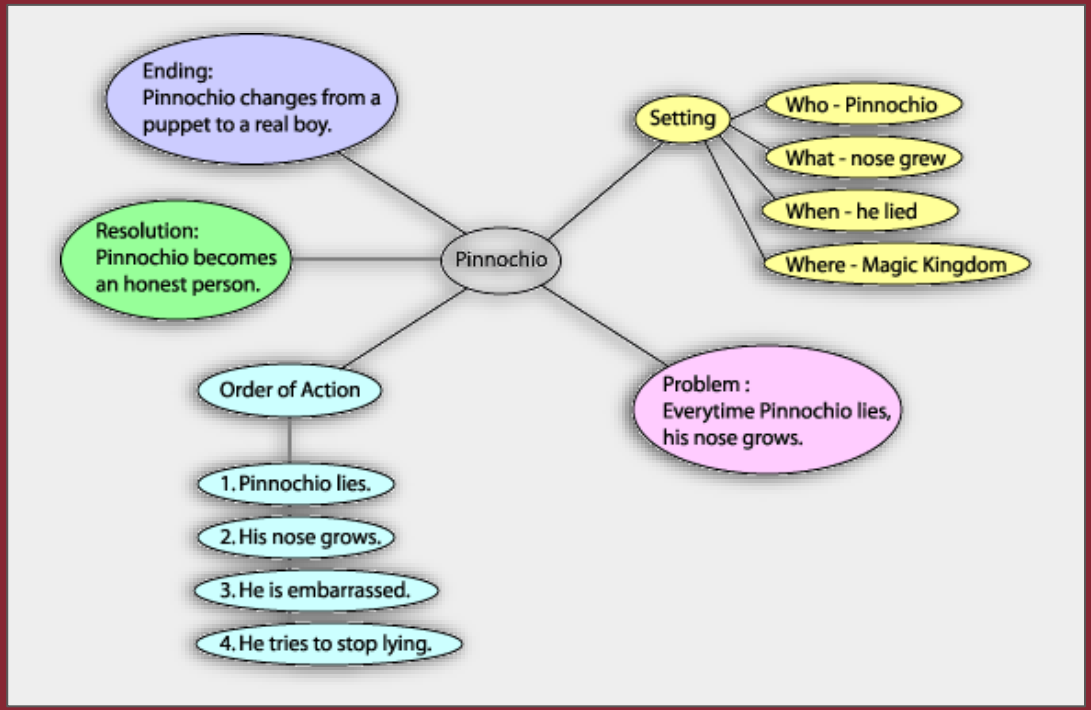
Web Diagram of a story



https://coe.jmu.edu/learningtoolbox/spore.html

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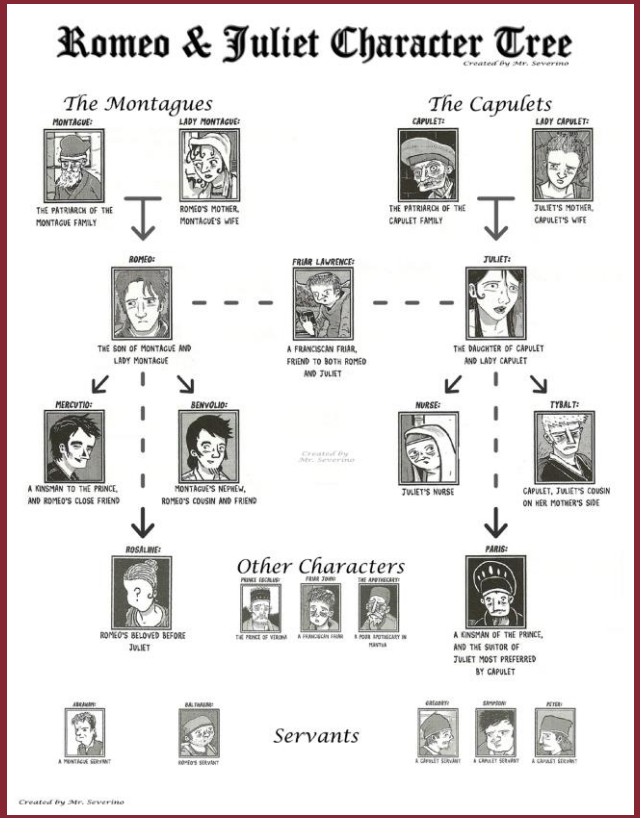
Character Tree



https://www.sutori.com/en/item/the-character-tree-shows-the-lines-drawn-between-the-houses-and-other-characters

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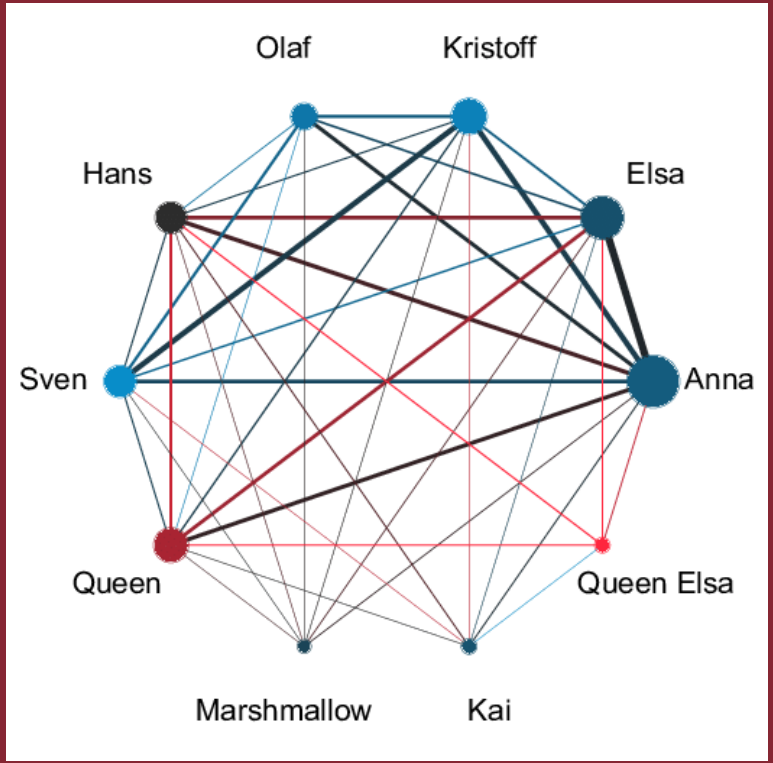
Characters in story



Fortuin, Vincent & Weber, Romann & Schriber, Sasha & Wotruba, Diana & Gross, Markus. (2018). InspireMe: Learning Sequence Models for Stories.

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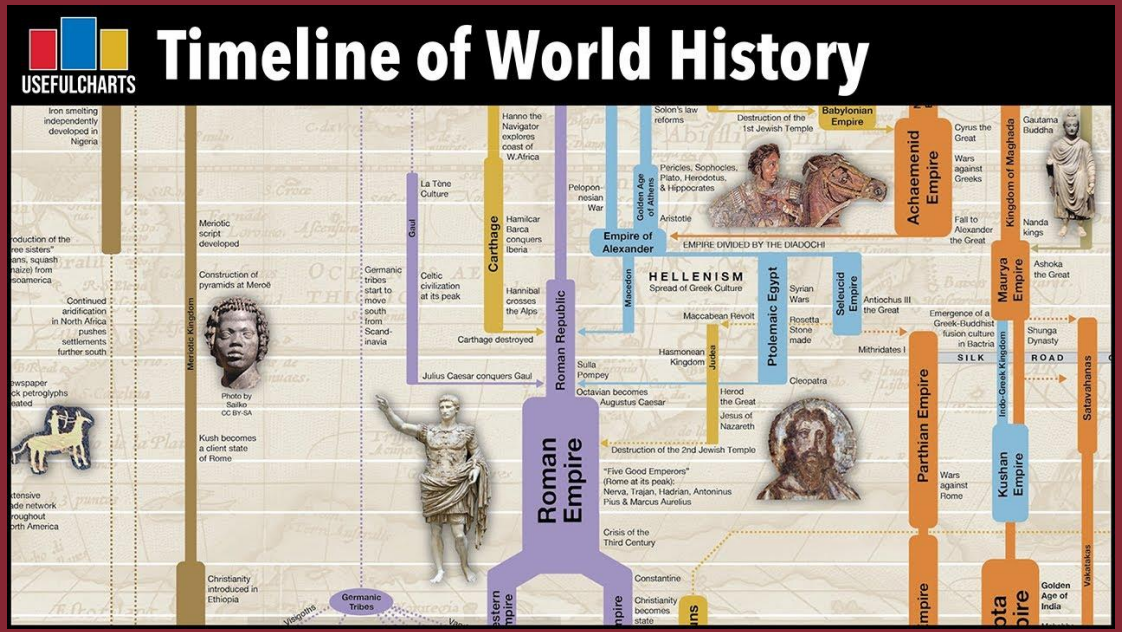
Timeline or flow of events



https://www.amazon.com/Timeline-World-History-Poster-24x36/dp/B005NLLKWS/ref=asc_df_B005NLLKWS/?tag=hyprod-20&linkCode=df0&hvadid=266182251588&hvpos=&hvnetw=g&hvrand=14643104168636947056&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9051781&hvtargid=pla-574372008132&psc=1

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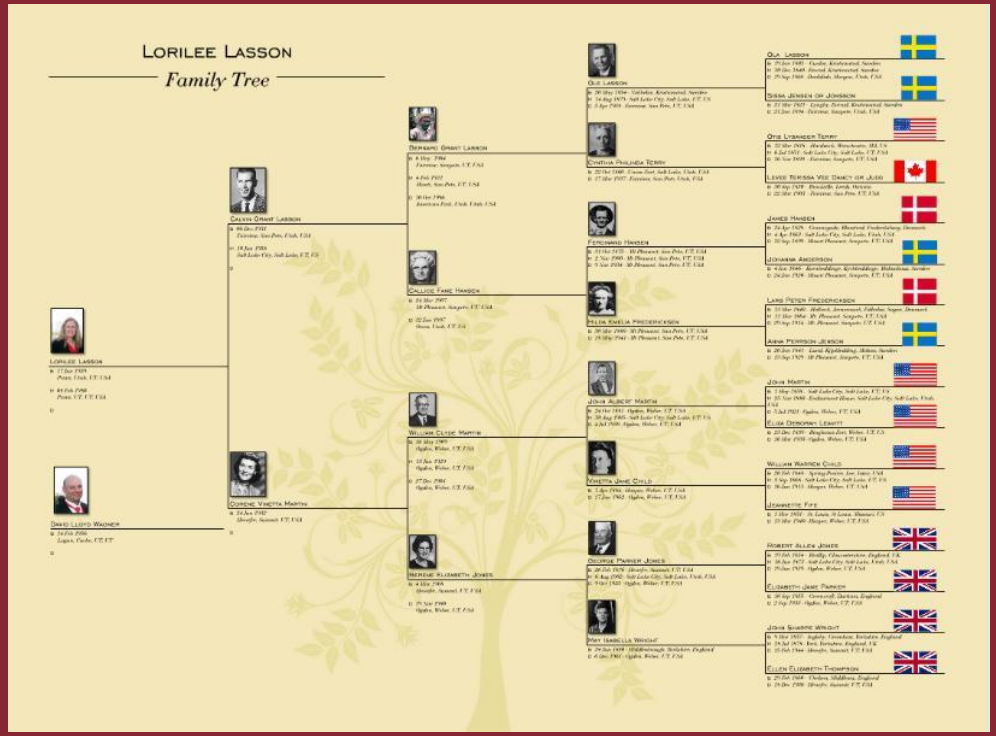
Cultural Heritage



https://familyhistorydaily.com/genealogy-help-and-how-to/family-tree-charts/

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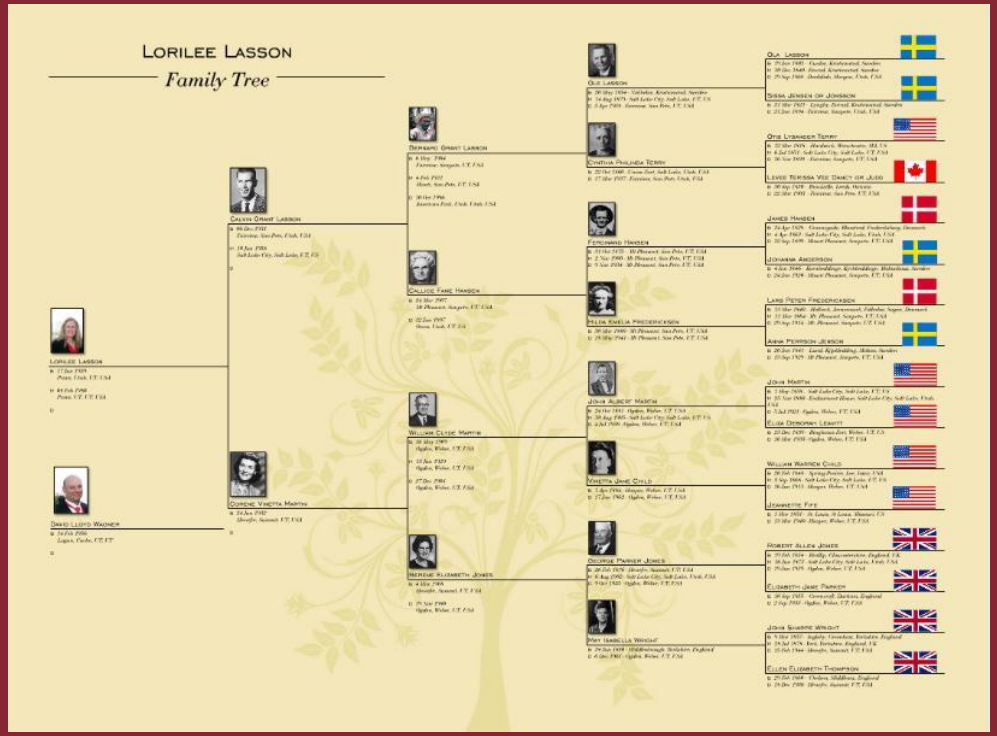

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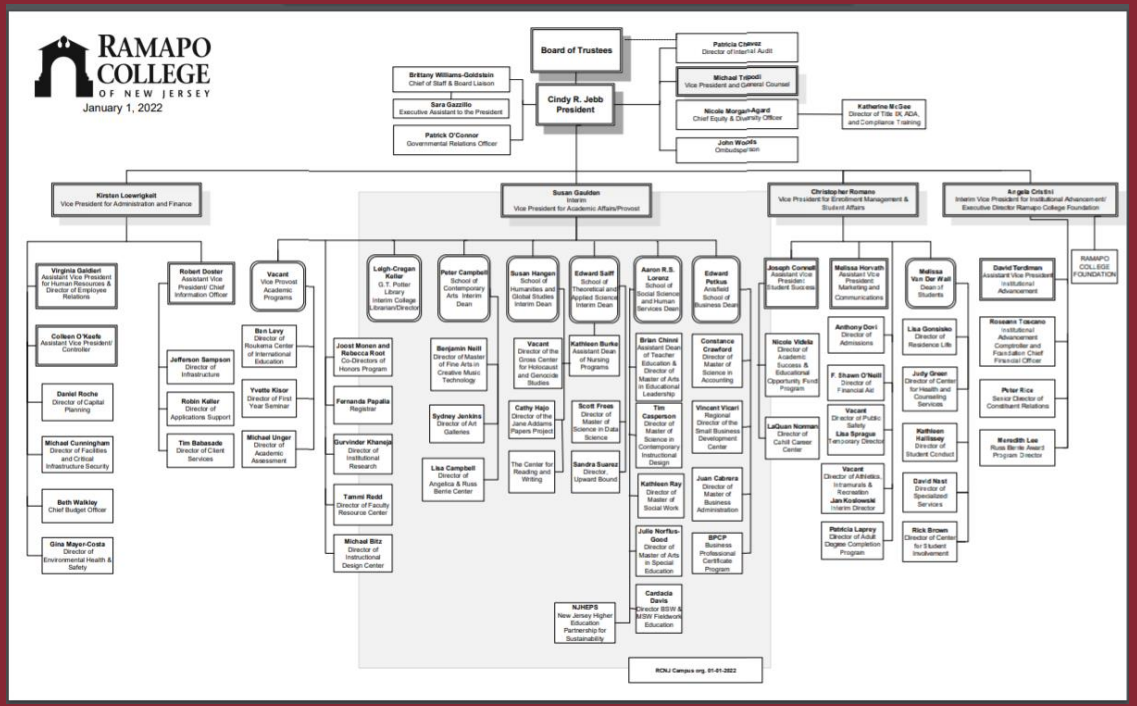
ORGANIZATIONAL CHART



https://www.ramapo.edu/fa/2022/02/15/faec-meeting-minutes-jan-26-2022/

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SOCIAL NETWORKS

https://www.freepik.com/free-photos-vectors/social-network

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INFECTIOUS DISEASES

https://oneill.law.georgetown.edu/reflections-on-the-history-of-contact-tracing/

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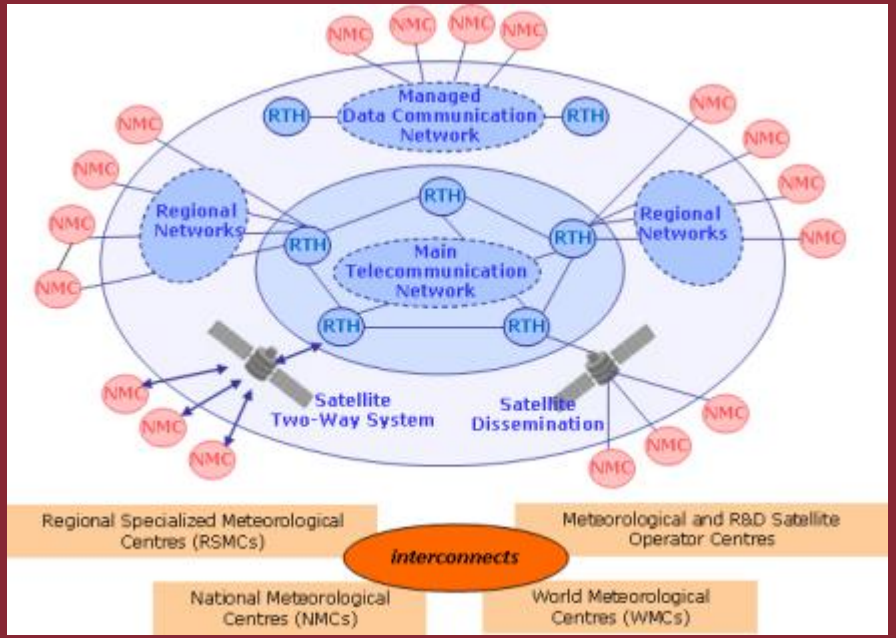
TELECOMMUNICATIONS



https://community.wmo.int/activity-areas/global-telecommunication-system-gts

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AIRLINE INDUSTRY

https://www.etsy.com/hk-en/listing/268070105/flight-patterns-world-map-poster-24x36

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QUESTIONS

- What are some questions you might want to ask about a network?
  - Your community?
  - Your example of network?

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Visualizations can help provide an understanding of networks.

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LANGUAGE OF NETWORKS

- Parts of a Network - Vertices/Nodes, Edges/Links, multiple edges
- Types of Networks - (un)Directed, weighted
- When are two networks the same?

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CREATE A NETWORK

- Elements: 10 numbers in the envelop in front of you.
- Relationship: ???You decide???
  - Write your relationship on the index card in the envelope
  - Connect those that share the relationship (or directed) and do not connect those that do not
- Lay them out on the paper in front of you. You may organize (or reorganize) them as you wish.

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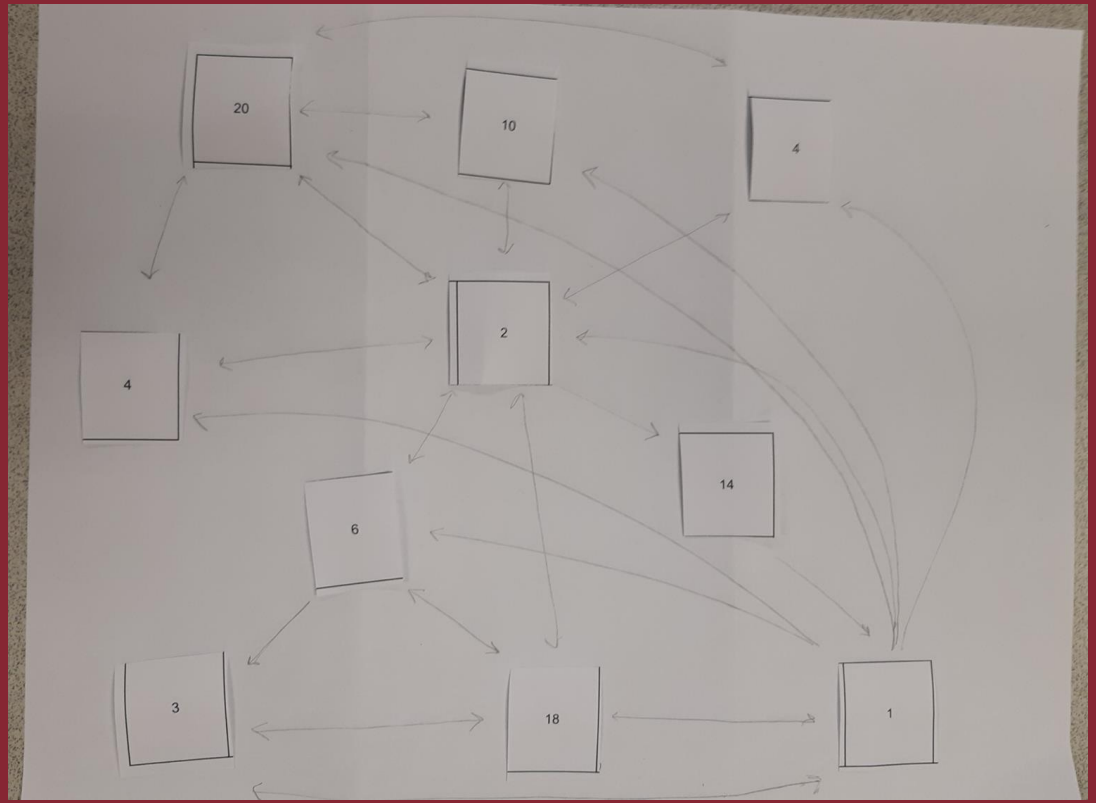
STUDENT NETWORKS



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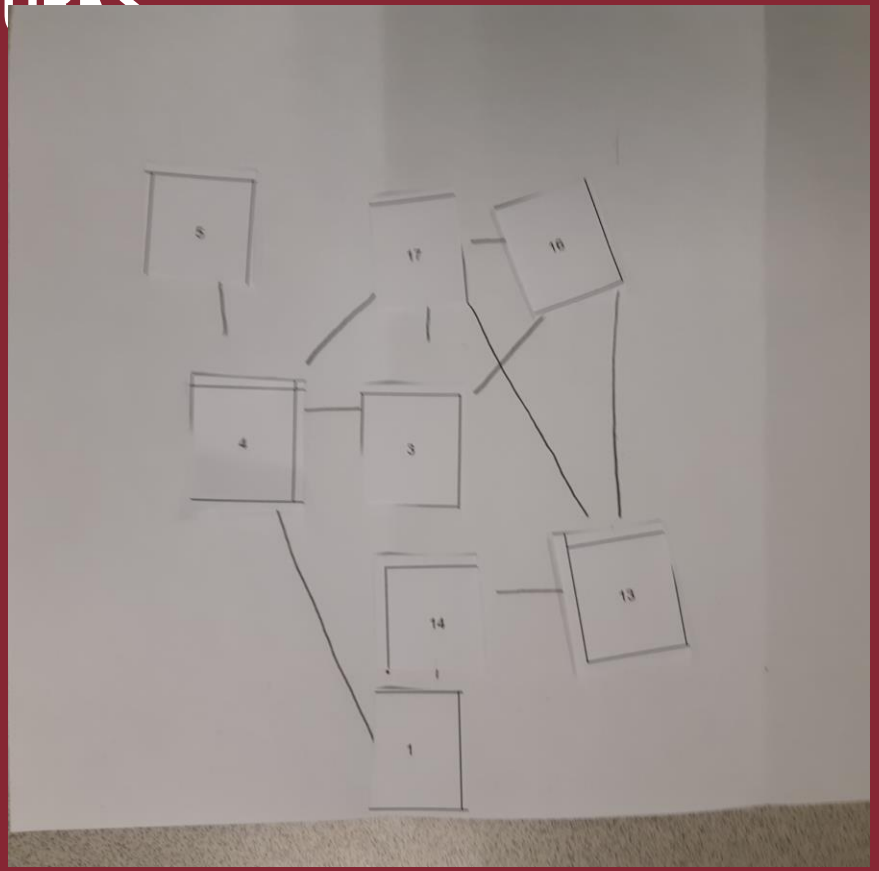

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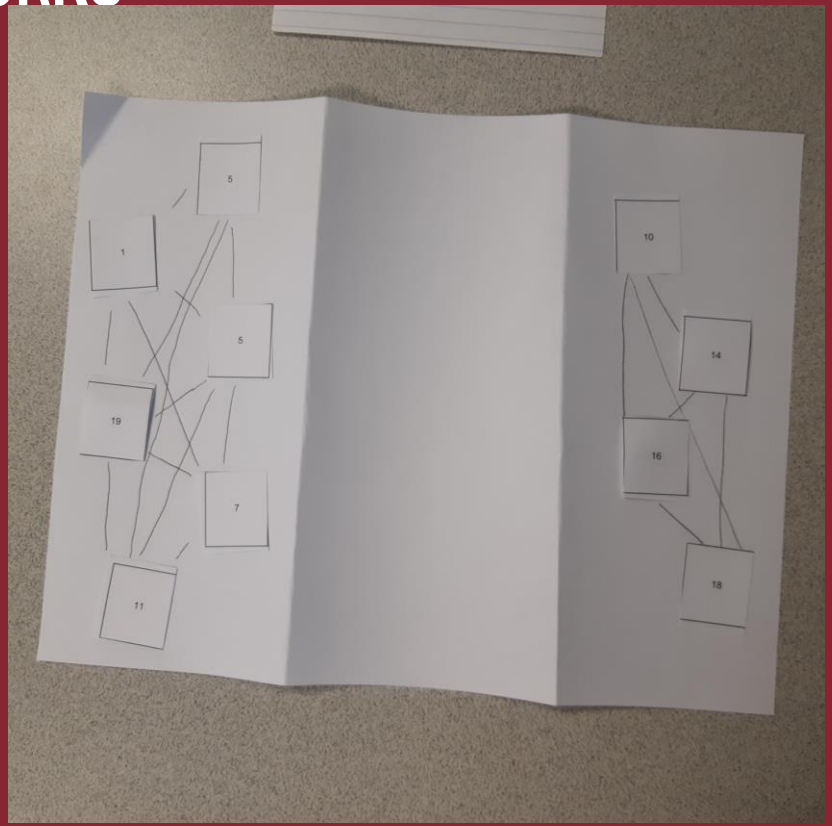

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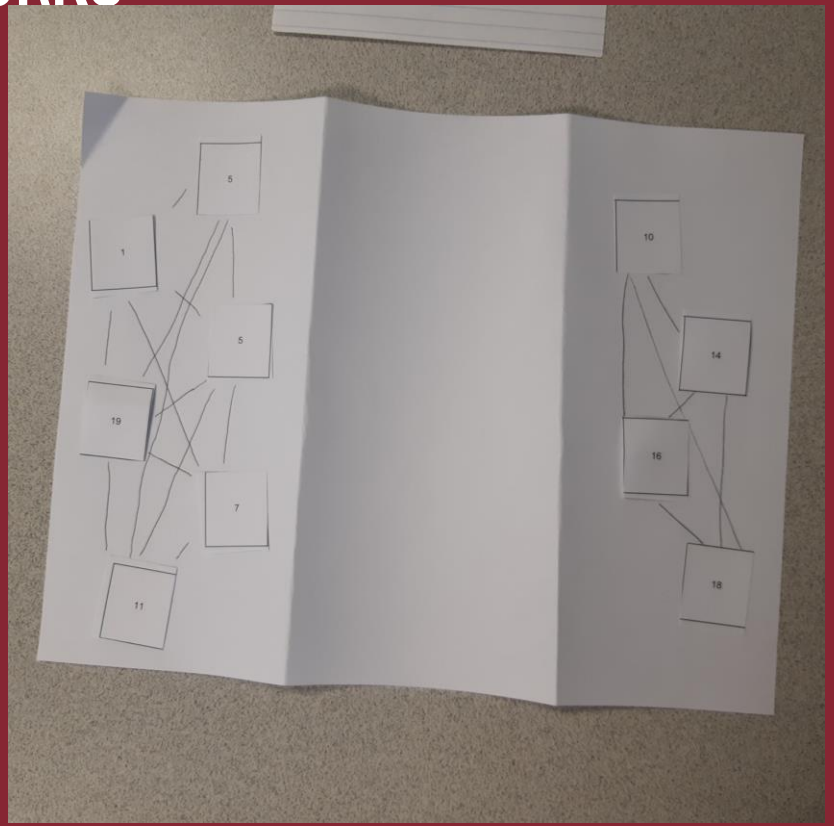

Networks can help reveal patterns.

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HOW DO WE STUDY NETWORKS?

- Degree of a node - in-degree and out-degree
- Degree sequences
- Walk, Trail, and Path
  - Path Length
  - Diameter

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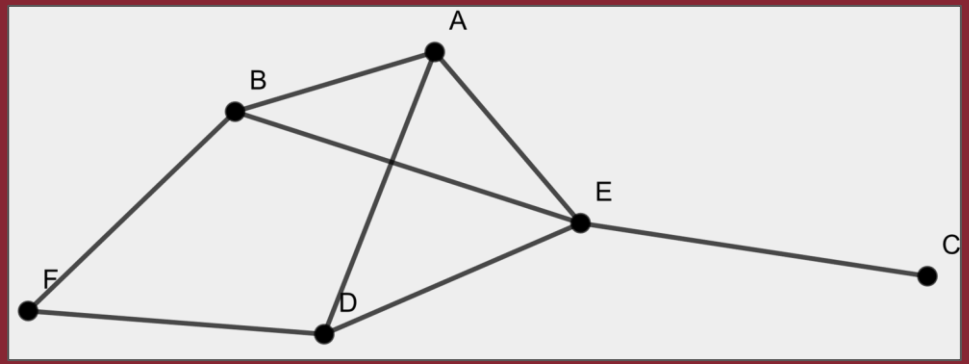
EXAMPLE

- Write the degree of each node
- Write all shortest paths between every two nodes
- Determine the path length between every pair of nodes.



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CENTRALITY MEASURES

- ***Degree Centrality*** – measures the number of connections a node has
- ***Betweenness Centrality*** – measures how well a node connects other nodes (or is between other nodes)
- ***Closeness Centrality***– measures how close (or far) a node is from other nodes

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Today's Computer technology allows you to study real-world networks.

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STUDENT PROJECTS

- Students selected their own projects to present to the class.
- Two groups chose network problems.

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STUDENT PROJECTS

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NETWORK LITERACY: ESSENTIAL CONCEPTS AND CORE IDEAS

1. **Networks are everywhere.**
2. **Networks describe how things connect and interact.**
3. **Networks can help reveal patterns.**
4. **Visualizations can help provide an understanding of networks.**
5. **Today's Computer technology allows you to study real-world networks.**
6. Networks help you to compare a wide variety of systems.
7. The structure of a network can influence its state and vice versa.

https://sites.google.com/a/binghamton.edu/netscied/teaching-learning/network-concepts

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THANK YOU!

Amanda Beecher

abeecher@ramapo.edu

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