

# Introduction to Network Analysis of the Global Wildlife Trade

University of Rhode Island

13th April 2020

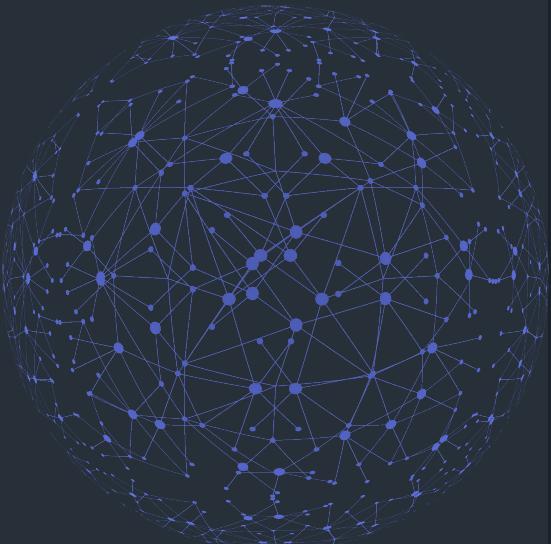
A. Devan-Song

C.K. Glidden, E. Knorr, B.K. Lynn and L.S. Tirrell

# ANATOMY OF THIS WORKSHOP

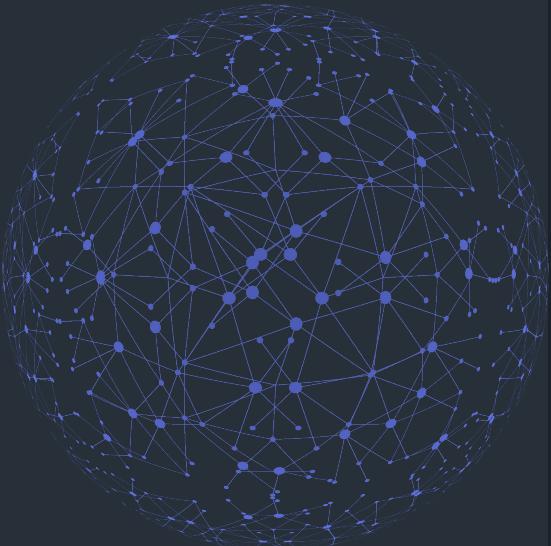
- Introduction to Networks
- Activities
  1. Examining CITES data
  2. Convert CITES data to a network
  3. Visually compare networks
  4. Basic network metrics
  5. Choose two networks to compare; repeat steps (3) and (4) on your own networks

*All of my code and this powerpoint are available on my GitHub!!*



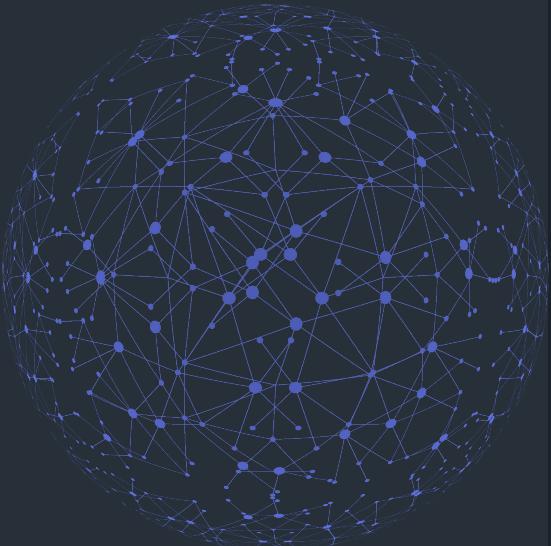
# GROUND RULES OF THIS WORKSHOP

- I will share my screen with you, and move back and forth between powerpoint and google colab
- Try to look at the WebEx when I'm presenting with the powerpoint and running through the examples. You can take notes, but try not to code when I'm talking or you might miss things!



# LEARNING OUTCOMES

- **Define** a network and **describe** basic elements of a network
- **Describe** CITES data and its scope
- **Understand** how to run R code in CoLab
- **Understand** the basics of the package *igraph* in R
- **Create** a testable hypothesis for comparing networks
- **Understand** basic network metrics

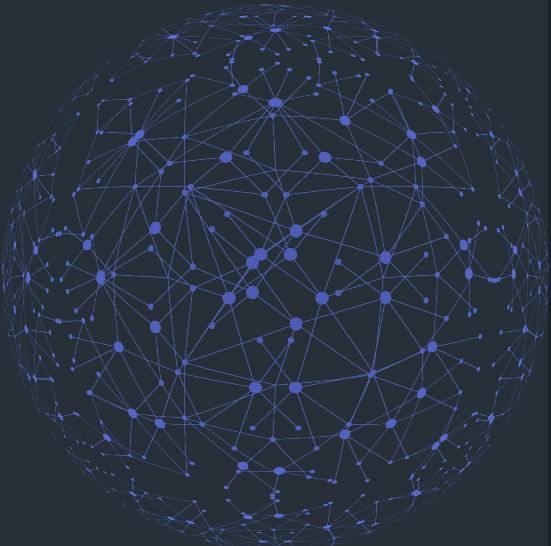


# Pre-lab logistics

- Go to my GitHub Link

[https://github.com/devansong/network\\_workshop](https://github.com/devansong/network_workshop)

- Click on the last link that says “R\_Wildlife\_Trade\_Network\_Analysis.ipynb”
- Open the R code in Google CoLab
- Go to File- click “**Save a copy in Drive**” and open in a new tab
- Run the first cell by clicking the play button (will take ~10mins) as we do introduction to networks

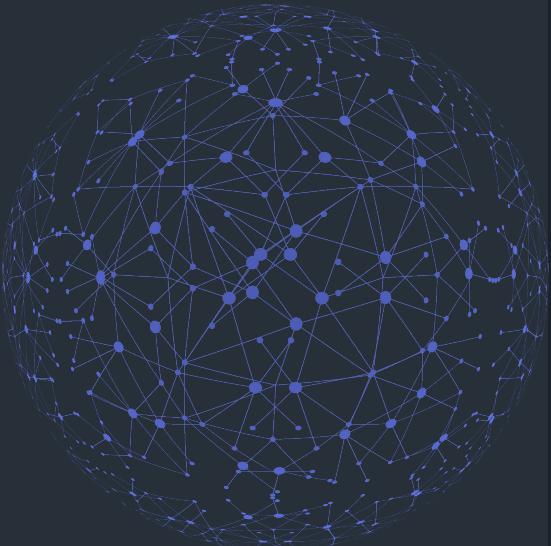


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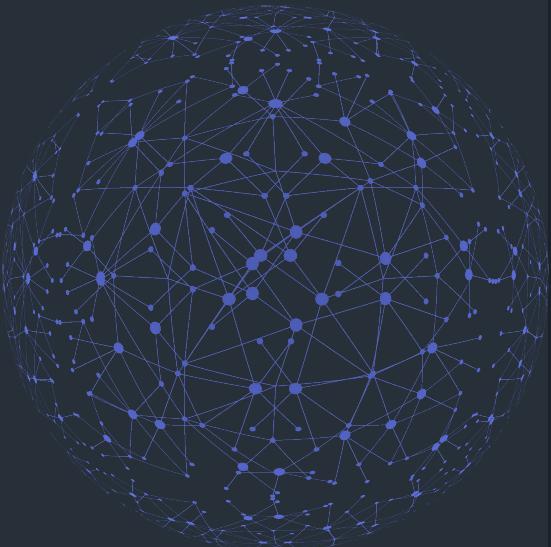
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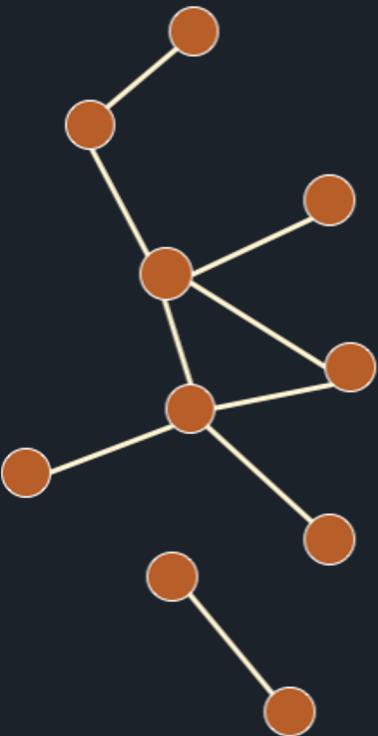
# WHAT IS A NETWORK?

● Node (or Vertex)

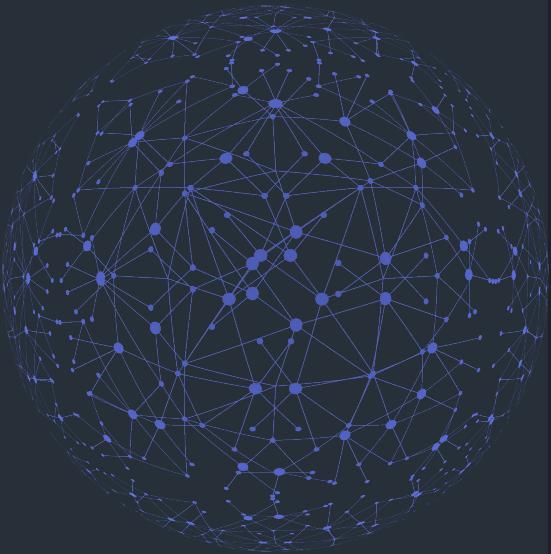
~ Edge



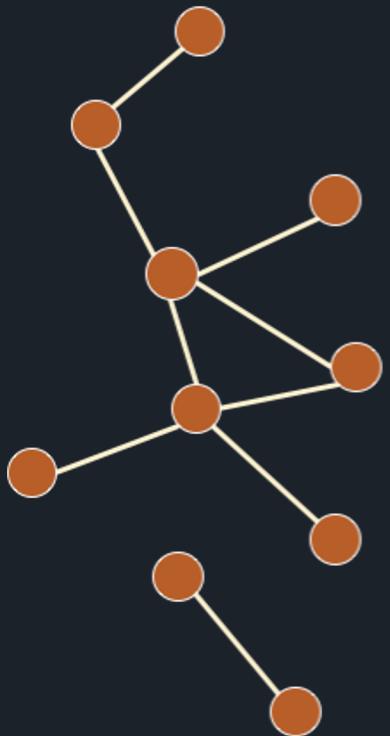
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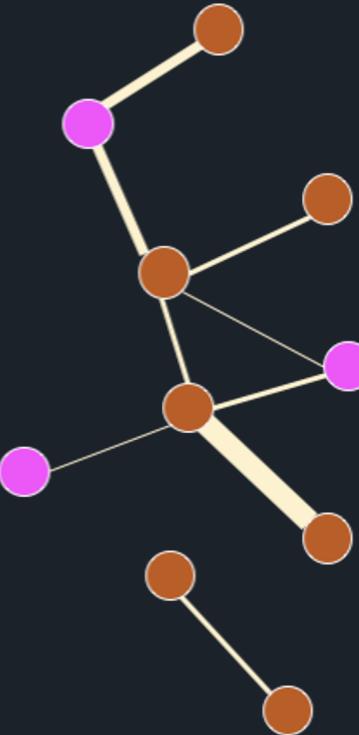
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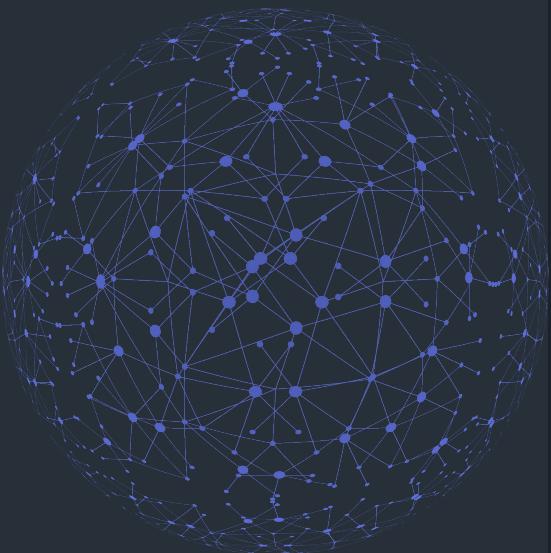
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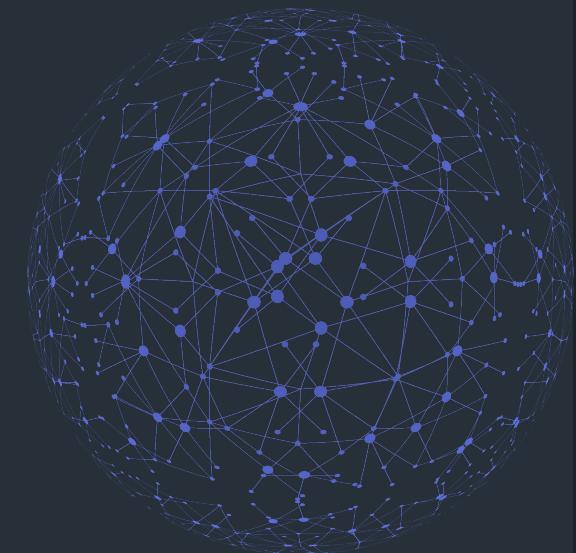
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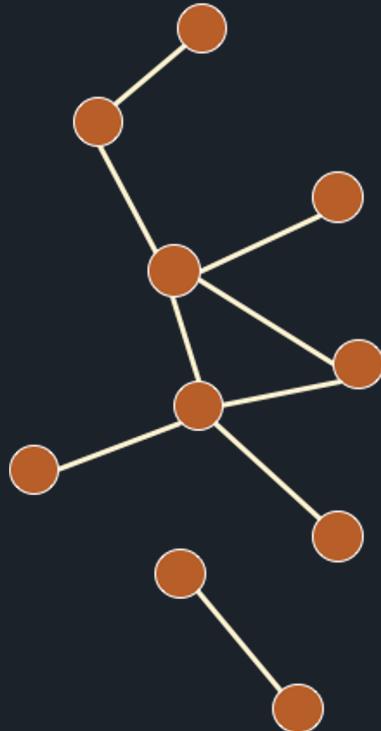
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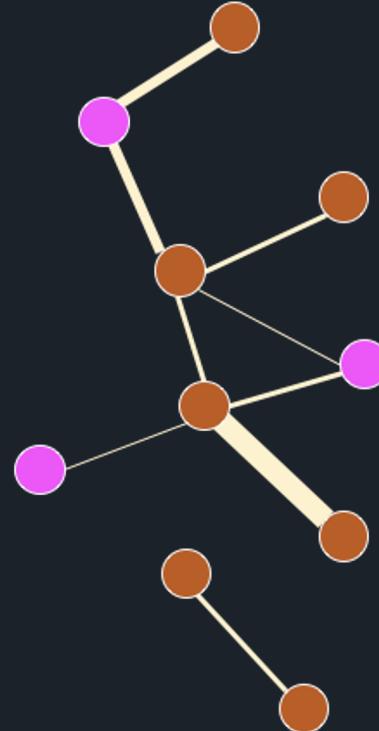
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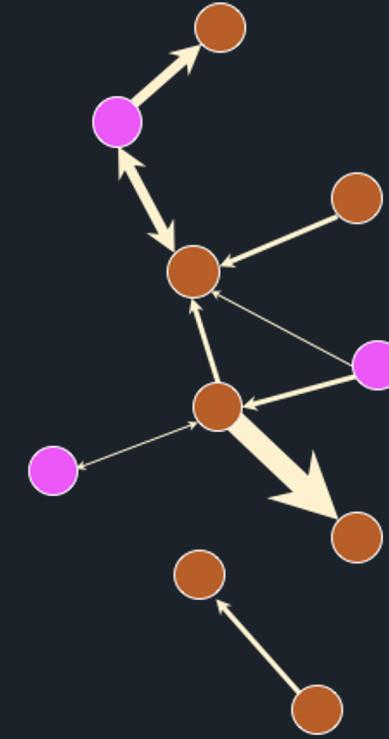
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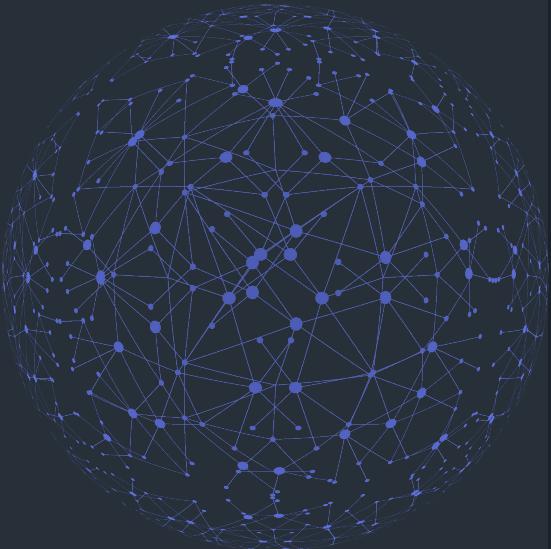
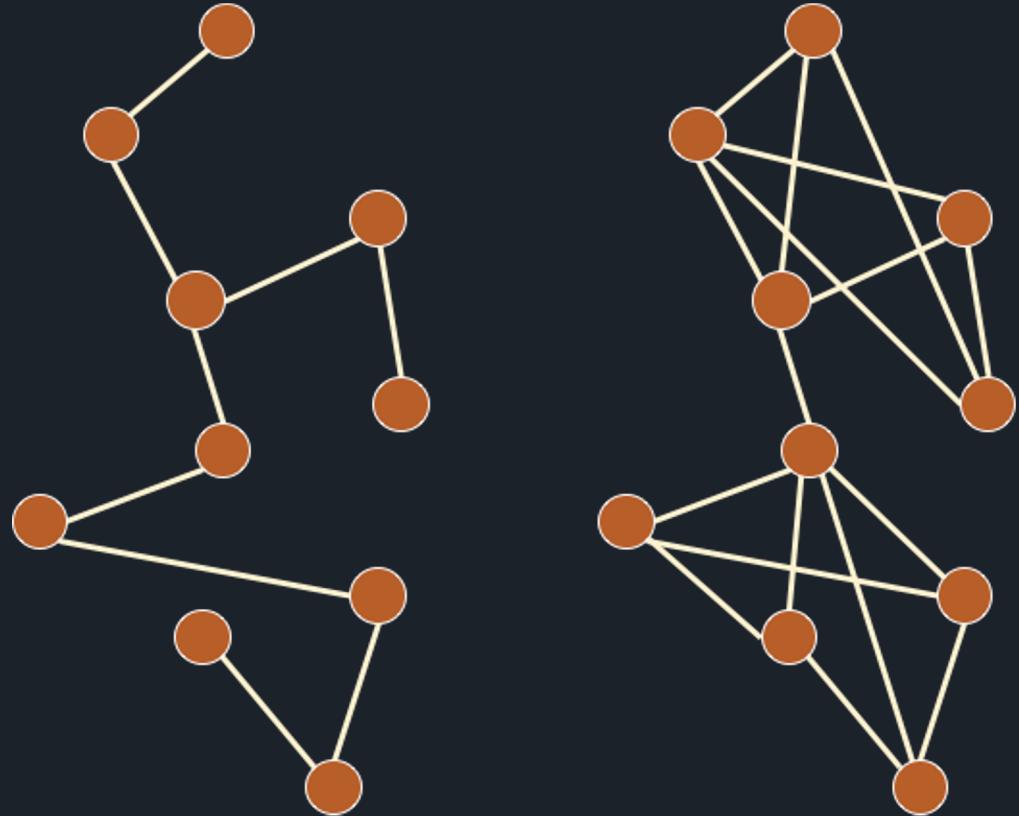


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# WHAT CAN NETWORKS TELL US ABOUT THE GLOBAL WILDLIFE TRADE?

## Properties of networks



# INTRODUCTION TO THE GLOBAL WILDLIFE TRADE NETWORK

Any aspect of the wildlife trade you want:

Number of shipments a year

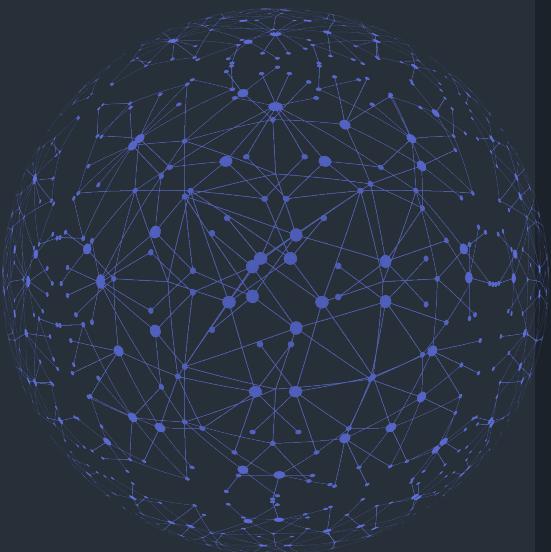
Number of species traded

Volume of live animals



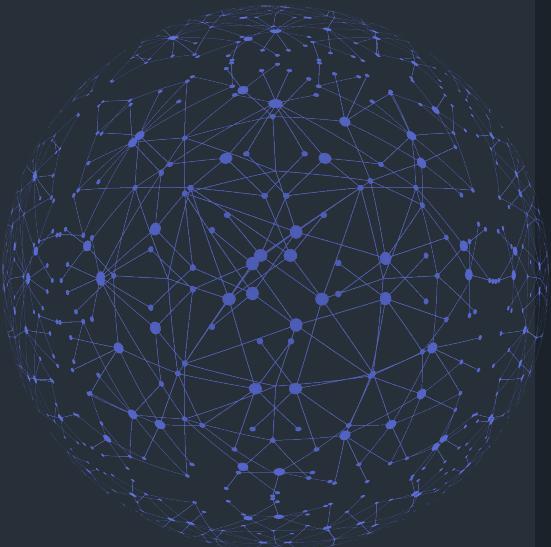
Country  
(E.g. Singapore)

Country  
(E.g. France)



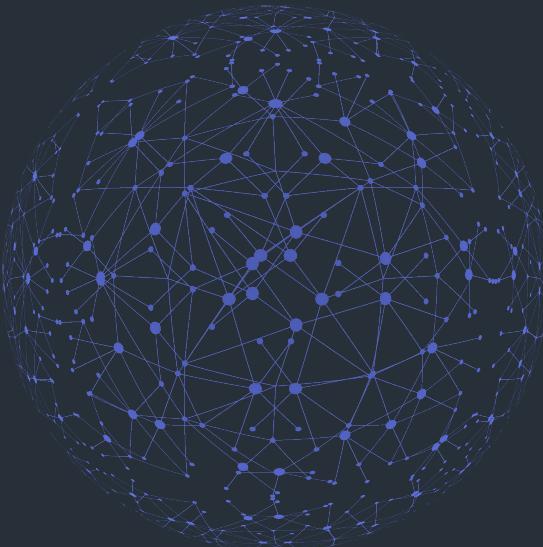
# GLOBAL WILDLIFE TRADE: CITES DATABASE

- CITES: Convention on International Trade of Endangered Species of Flora and Fauna
  - Rife with errors; as is expected of any database
  - To circumvent this for this workshop, we will ONLY look at shipments, not quantities, country of origin, etc
  - Analysis for research should clean up dataset first, which we will not cover in this class



# GLOBAL WILDLIFE TRADE: CITES DATABASE

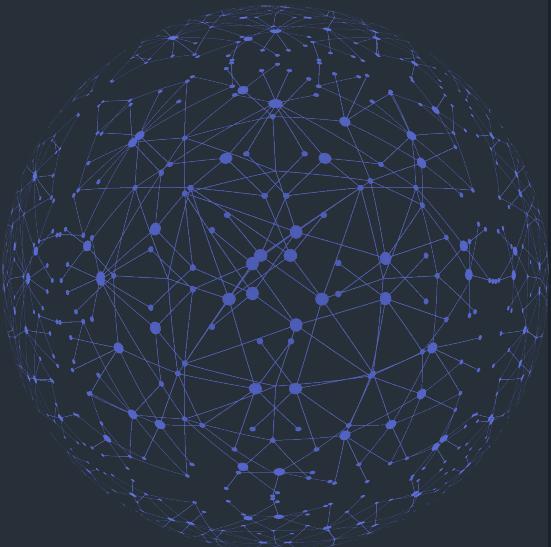
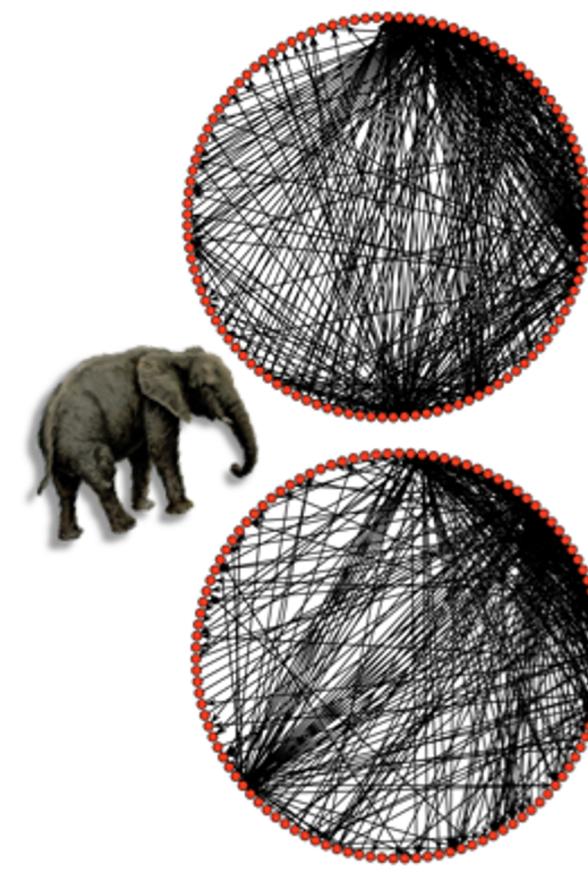
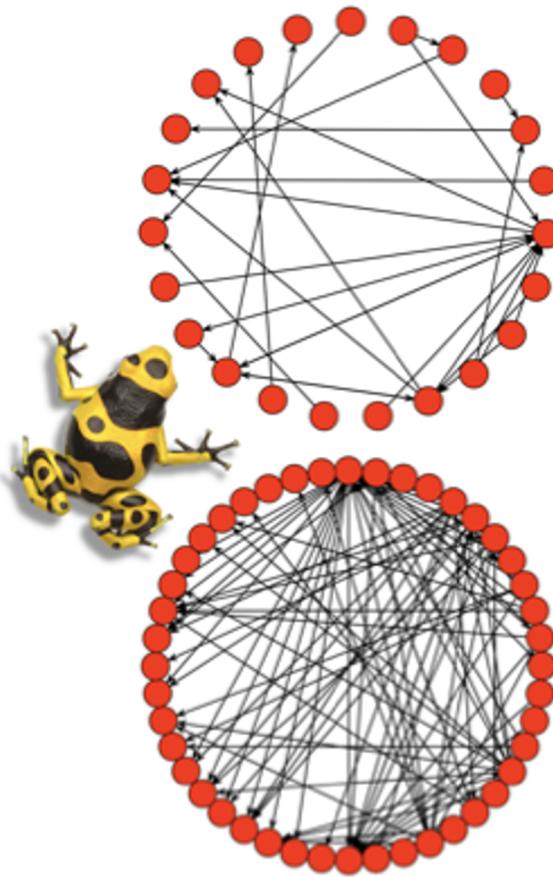
Year	App.	TAXON	Class	Order	Family	Genus	Importer	Exporter	Origin	Importer reported.	Exporter reported.	Term	Unit	Purpose	Source
										quantity	quantity				
2013	I	<i>Haliaeetus albicilla</i>	Aves	Falconiformes	Accipitridae	<i>Haliaeetus</i>	LV	UA		1	NA	live	Z	C	
2013	I	<i>Ailurus fulgens</i>	Mammalia	Carnivora	Ailuridae	<i>Ailurus</i>	US	NZ		1	1	live	Z	C	
2013	I	<i>Saguinus oedipus</i>	Mammalia	Primates	Cebidae	<i>Saguinus</i>	HU	CH		NA	3	live	P	C	



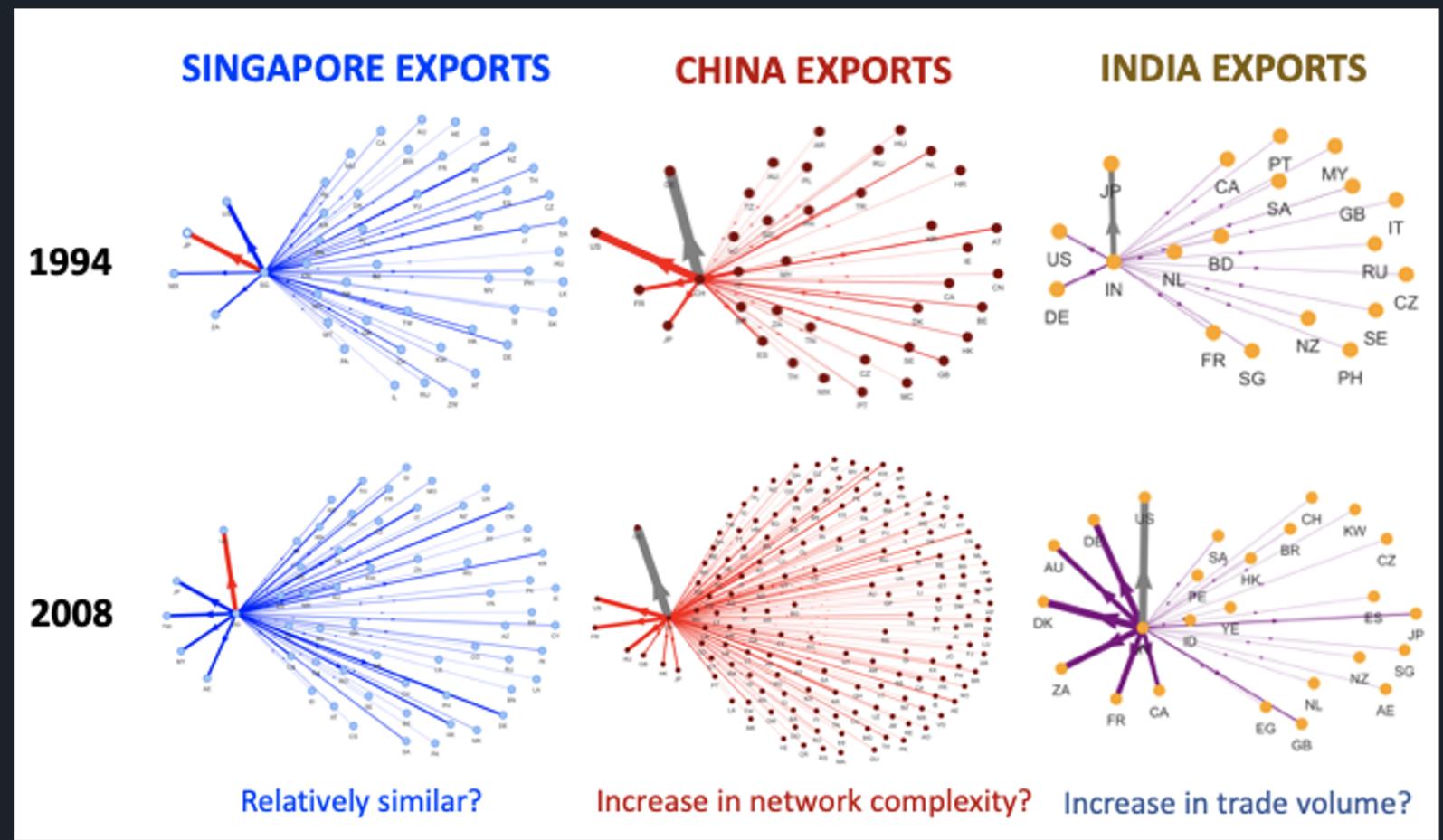
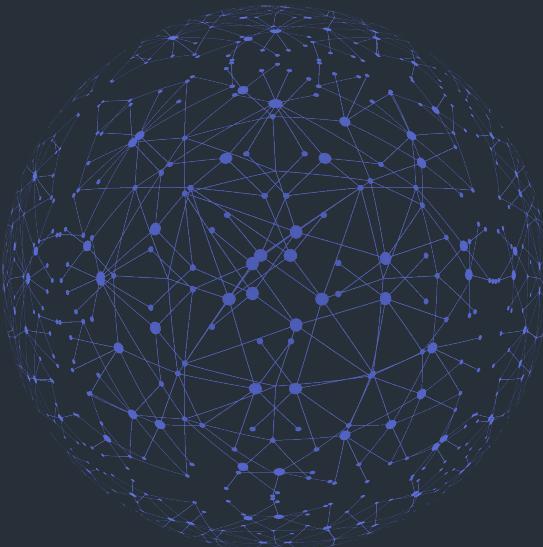
# REAL-LIFE NETWORKS: WILDLIFE TRADE

1990

2016



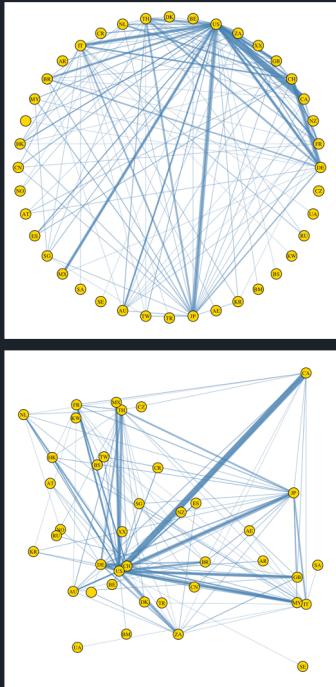
# REAL-LIFE NETWORKS: WILDLIFE TRADE



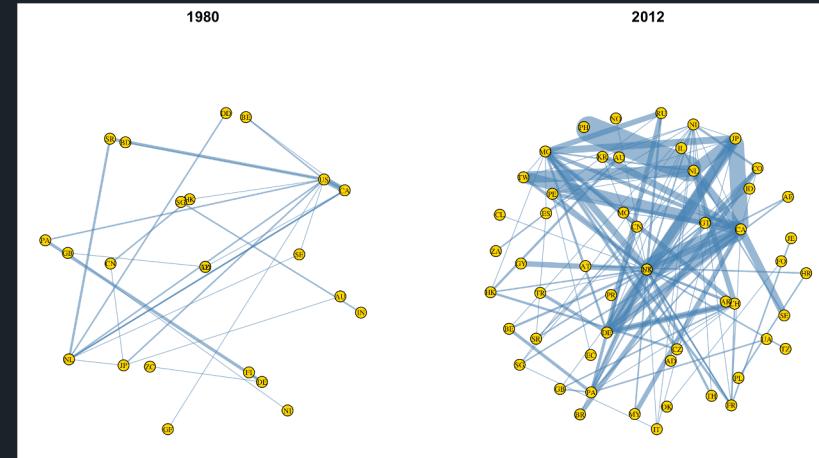
## 1. Examine CSV data

	Year	App.	Taxon	Class	Order	Family	Genus	Importer	Exporter	Origin	Importer reported.	Exporter reported.	Term	Unit	Purpose	Source
											.quantity	.quantity				
											1 NA	1 NA	live	live	Z	C
2022605	2013 I		Haliaeetus albicilla	Aves	Falconiformes	Accipitridae	Haliaeetus	LV	UA							
2022623	2013 I		Ailurus fulgens	Mammalia	Carnivora	Ailuridae	Ailurus	US	NZ		1	1	live	live	Z	C
2023089	2013 I		Saguinus oedipus	Mammalia	Primates	Cebidae	Saguinus	HU	CH		NA	NA	3 live	3 live	P	C

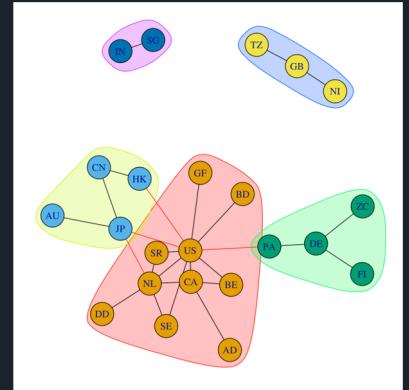
2. Convert the master dataset into graph object and visualize the network. Try different layouts



3. Subset the main CSV data into 2 groups you want to compare (e.g. birds vs mammals; 1980 vs 2015)



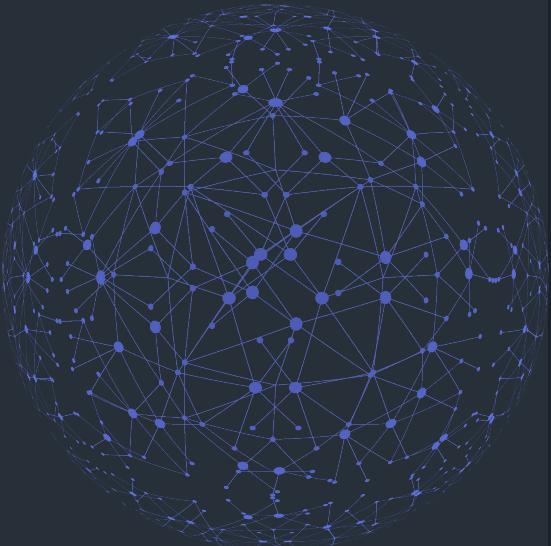
4. Explore a suite of metrics that can be used to describe your network numerically and visually



5. Repeat steps 3-4 with your own hypothesis!

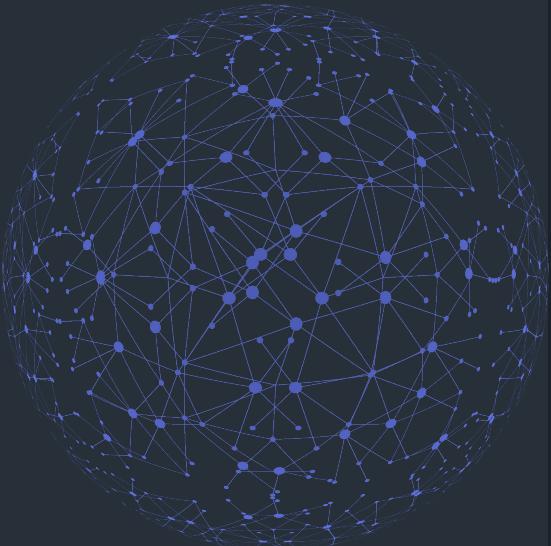
# ACTIVITY 0: TESTING COLAB OUT

1. We are going to add kittens and corgis to our colab!
2. Scroll through contents on the left (imagine this is an e-book)
3. Tell the difference between text (instructions) and code
4. Understand #
5. Run code using shift+enter
6. How to undo mistakes



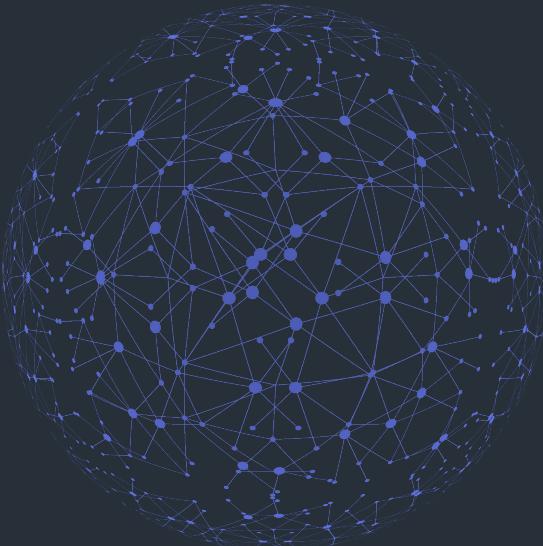
# ACTIVITY 0: TESTING COLAB OUT

1. Take some time to make sure you understand how to run code in Colab, and use the contents section to navigate



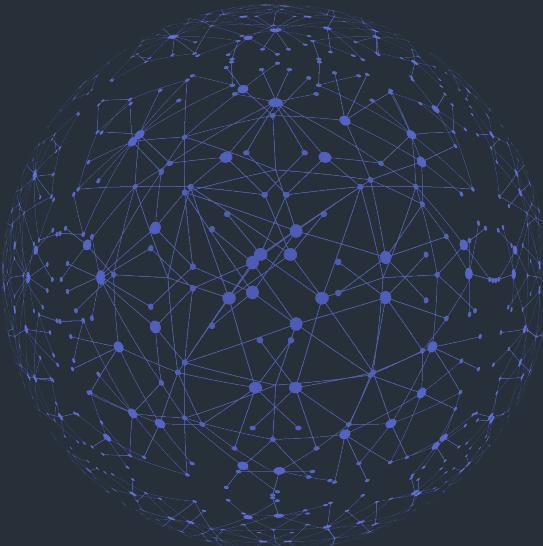
# ACTIVITY 1: EXAMINE CSV DATA

1. Run code to find out
  - a. how many shipments does your data have?
  - b. how many different genera are represented in your dataset?
  - c. what time does your dataset span?
  - d. Plot a frequency histogram of different **classes** in your dataset



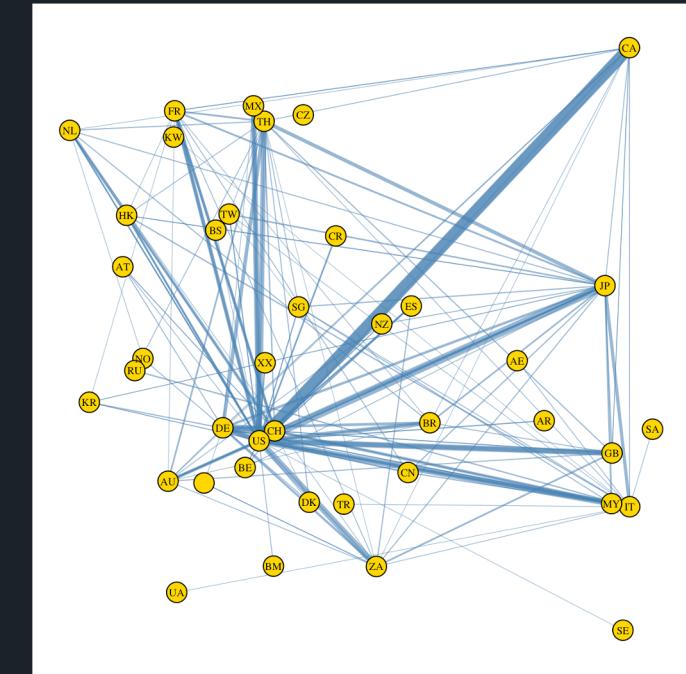
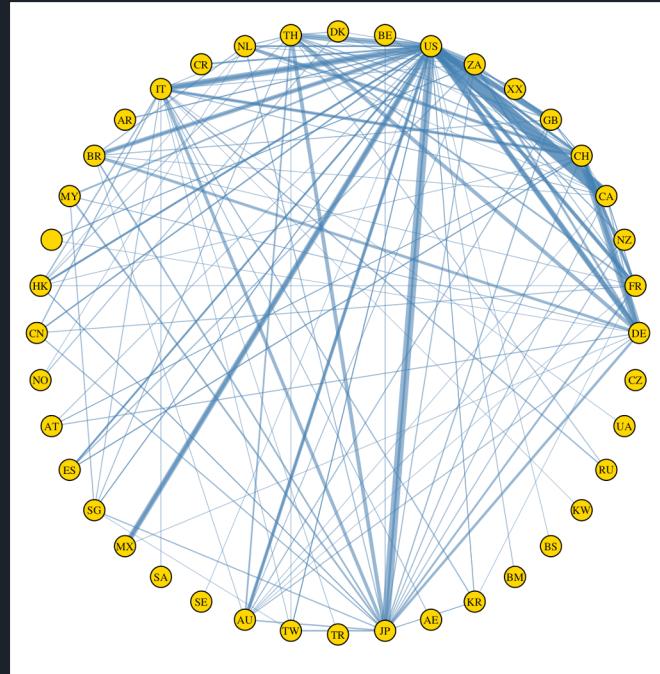
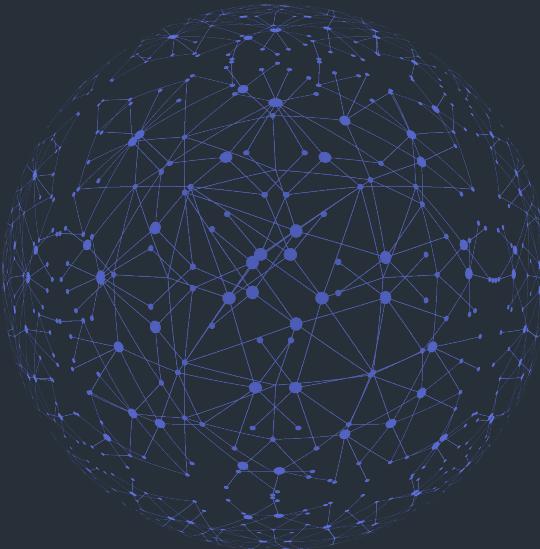
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  - b. how many different genera are represented in your dataset?
  - c. what time does your dataset span?
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# ACTIVITY 2: CONVERT DATASET TO GRAPH OBJECT; VISUALIZE

- Table of shipments transformed to graph object (network)
- Different layouts to visualize networks



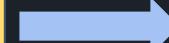
# ACTIVITY 2: WHAT IS A FUNCTION?

Input: CITES data (in the form of a table)

Year	App.	Taxon	Class	Order	Family	Genus	Importer	Exporter	Origin	Importer .quantity	Exporter. .quantity	Term	Unit	Purpose	Source
2022605	2013 I	<i>Haliaeetus albicilla</i>	Aves	Falconiformes	Accipitridae	<i>Haliaeetus</i>	LV	UA		1	NA	live	Z	C	
2022623	2013 I	<i>Ailurus fulgens</i>	Mammalia	Carnivora	Ailuridae	<i>Ailurus</i>	US	NZ		1	1	live	Z	C	
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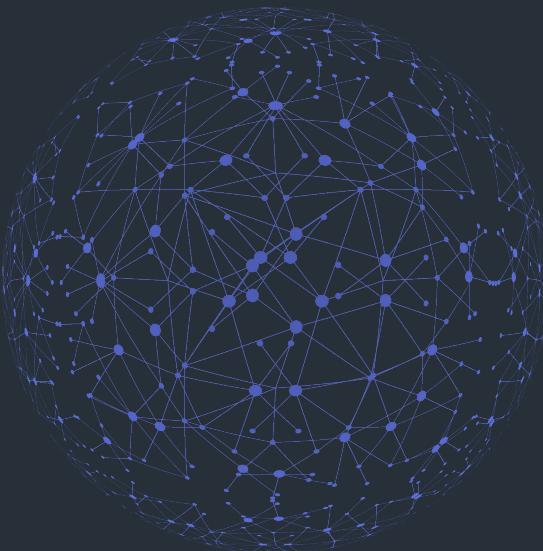
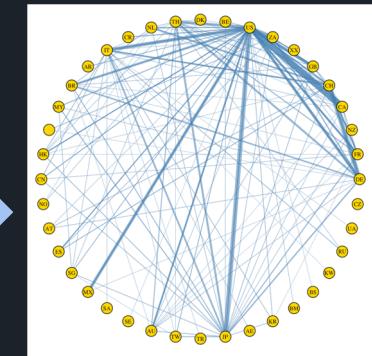


Function  
to create  
network  
from table



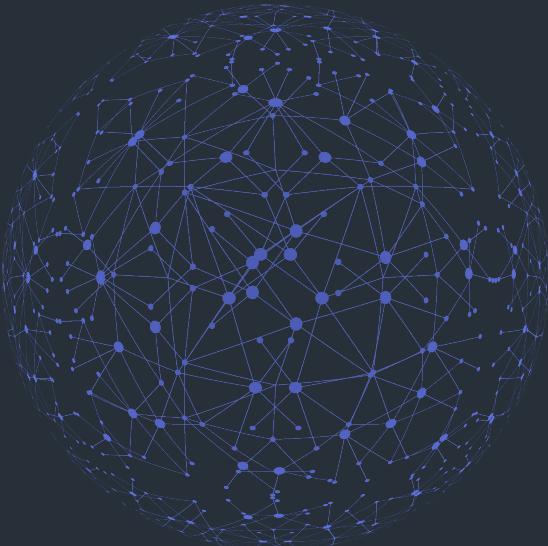
Function  
to plot  
network

Output

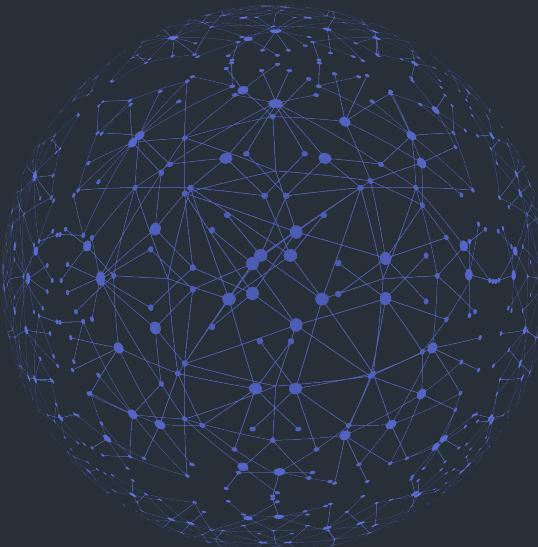
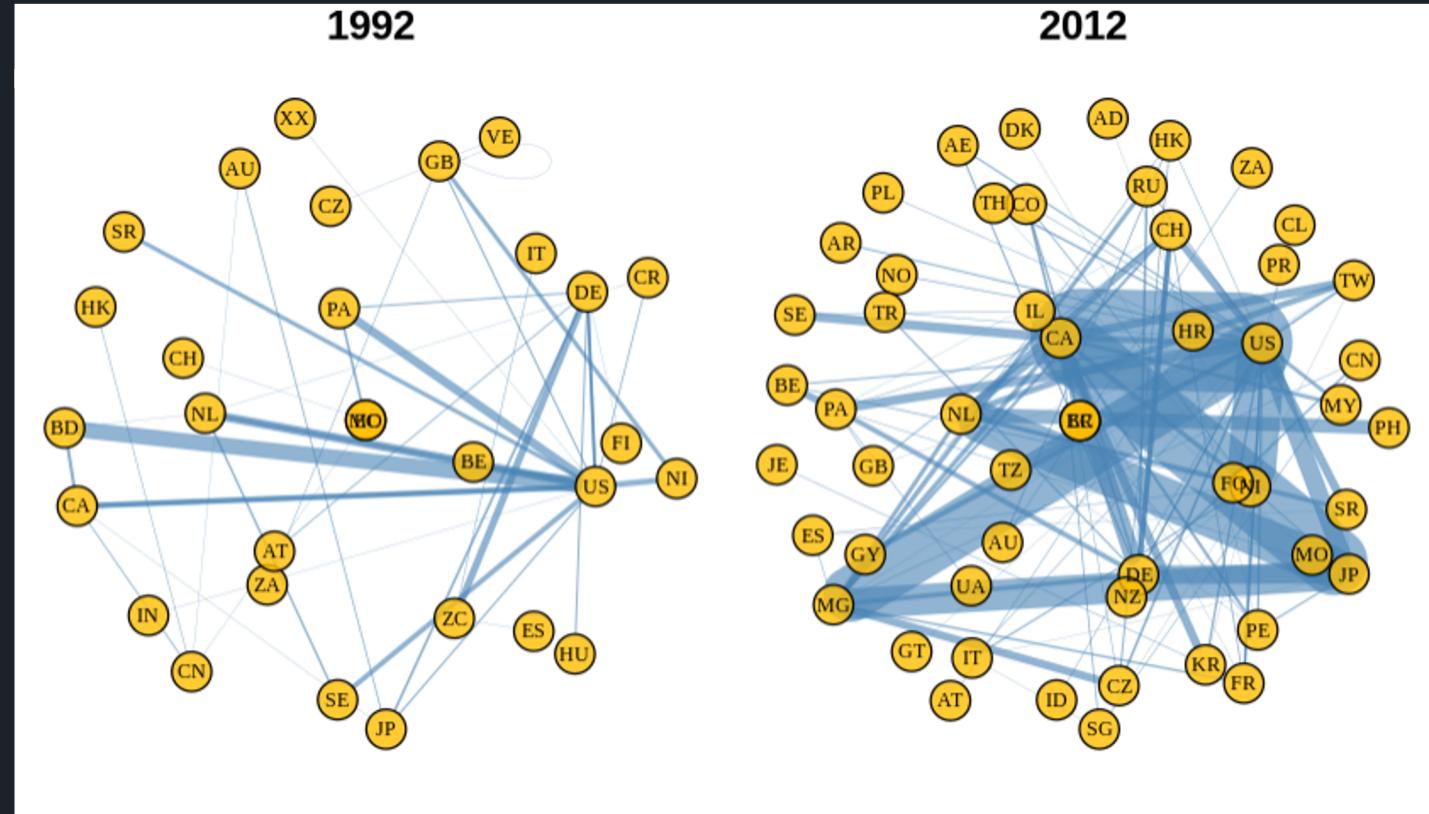


## ACTIVITY 2: CONVERT AND VISUALIZE DATA

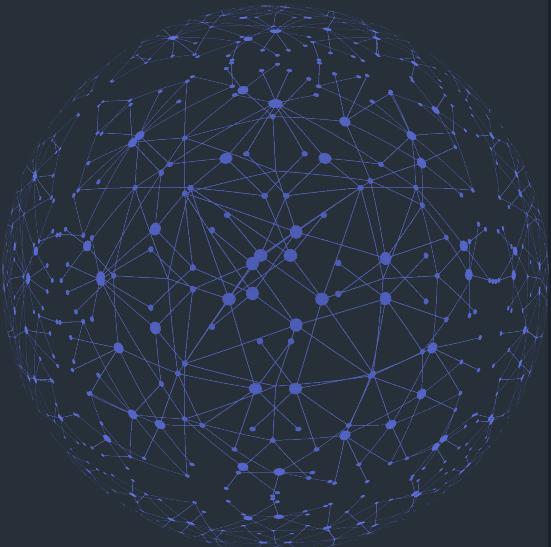
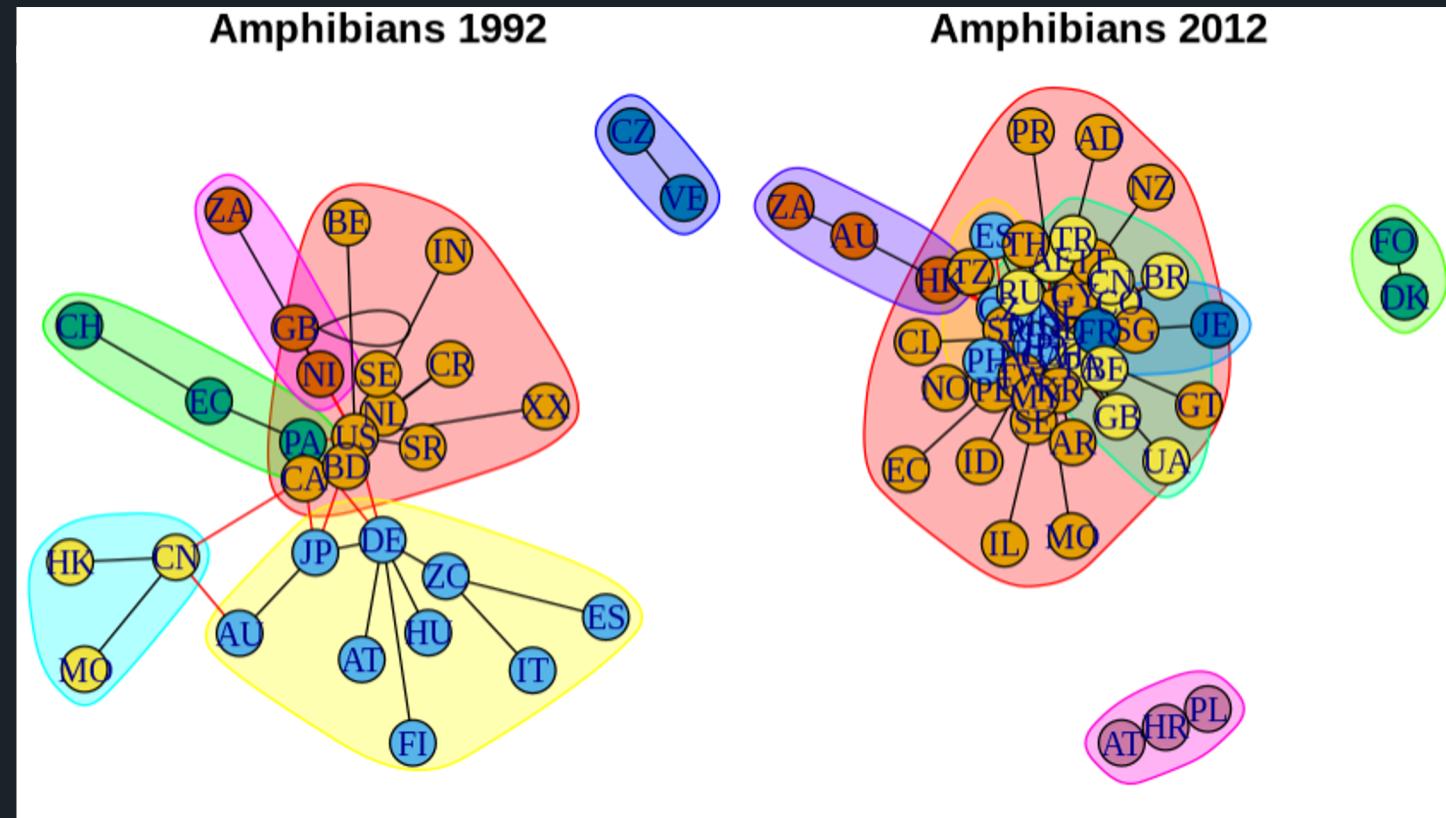
Complete activity 2 on your own, and take your time to look at the networks and answer the questions on your own at the end of activity 2



# ACTIVITY 3: CONVERT 2 AMPHIBIAN DATASETS (1992, 2012) TO NETWORKS

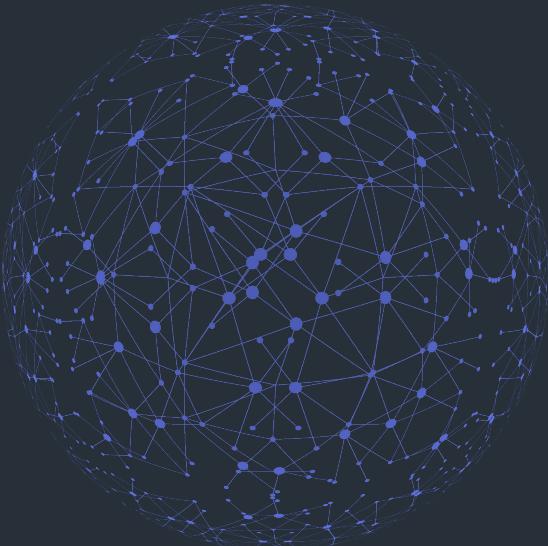


# ACTIVITY 3: VISUALLY COMPARE CLUSTERING IF YOUR 2 AMPHIBIAN DATASETS



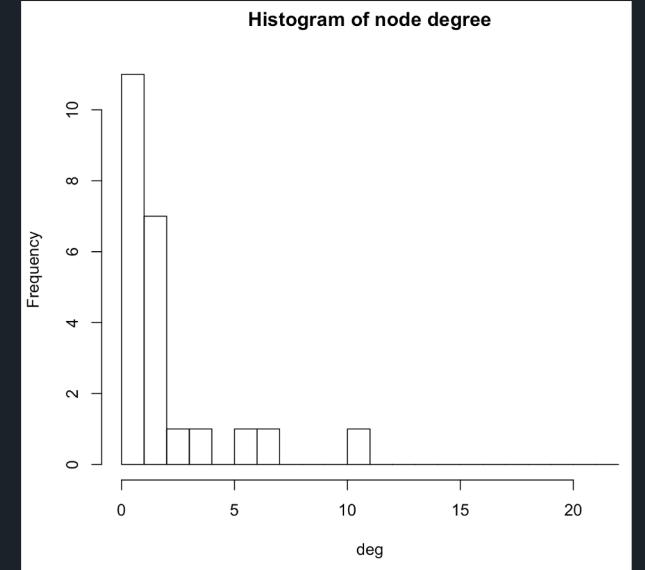
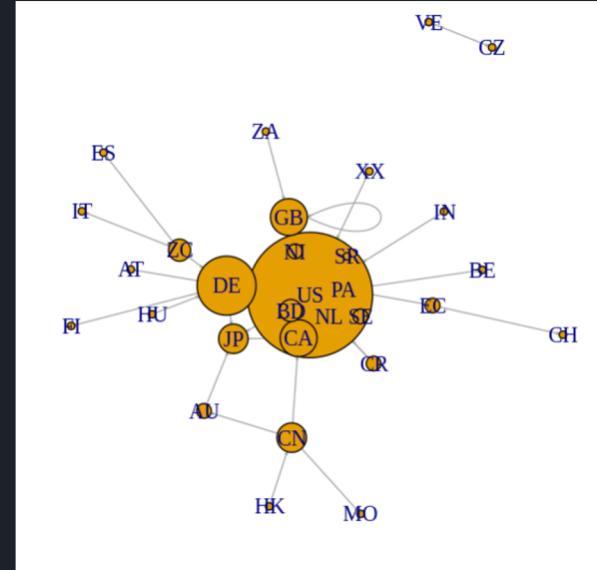
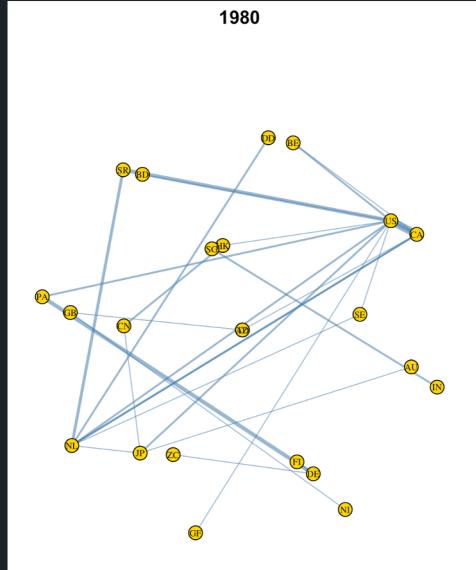
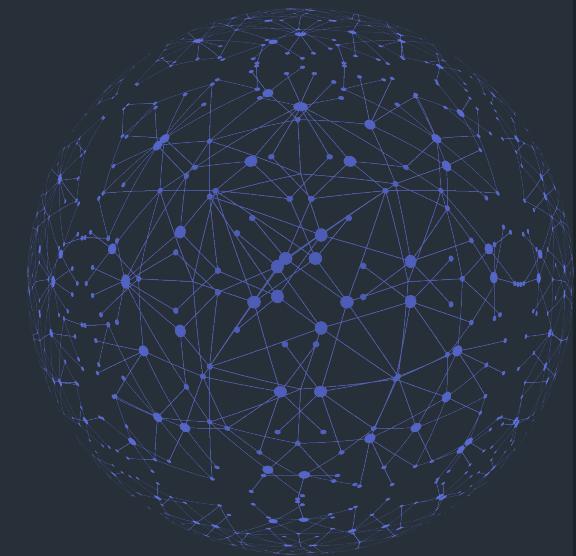
## ACTIVITY 3: COMPARE 2 NETWORKS

Complete activity 3 on your own, and take your time to look at the networks and answer the questions on your own



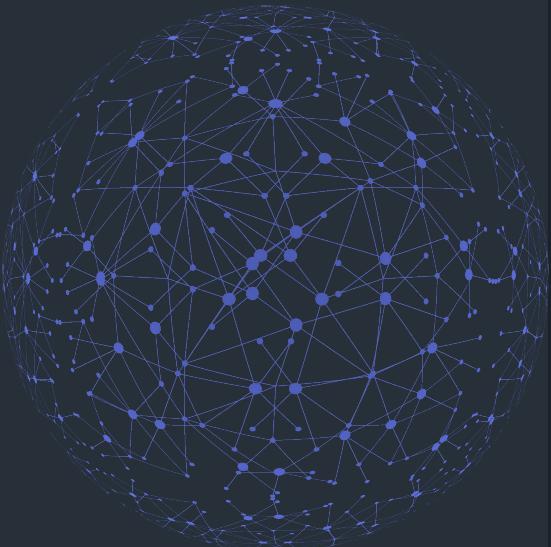
# ACTIVITY 4: CALCULATE NETWORK METRICS

Network metrics summarize properties of a network



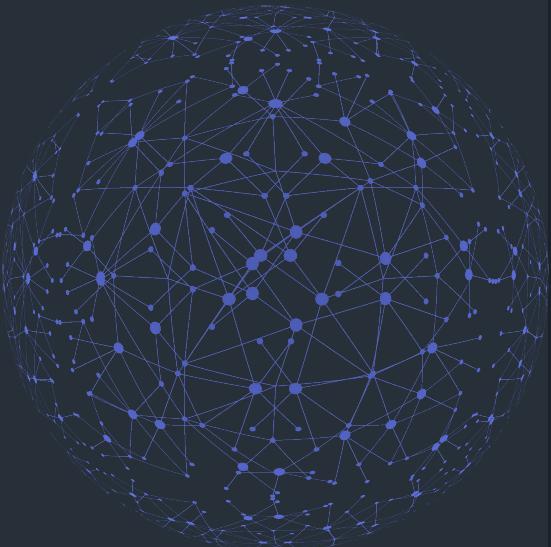
## ACTIVITY 4: CALCULATE NETWORK METRICS

Run through Activity 4 on your own



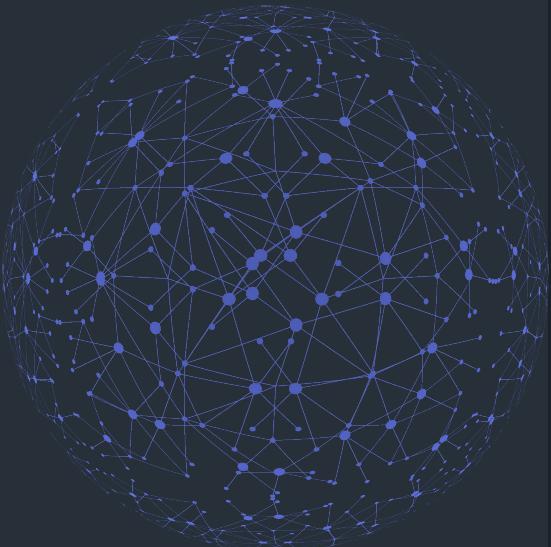
# ACTIVITY 5: CHOOSE 2 GROUPS YOU WANT TO COMPARE!

- Choose **2 subsets** of trade data to compare
  - Examples in the code; or create your own
- How do you think these two subsets will differ? Why?
- Copy, paste, and modify my code from part 3 to visualize your two networks
- Copy, paste, and modify my code from part 4 to calculate metrics for your two networks



## ACTIVITY 5: TROUBLESHOOTING

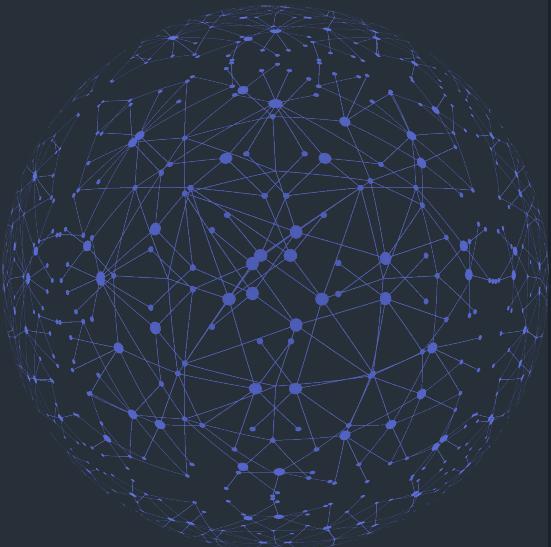
- Double check your spelling
  - Capitals
  - Quotation marks, brackets
- If your plot has no edges and is mostly blue, reduce the weight factor
- Check if you have subsetted your data correctly



# DISCUSSION

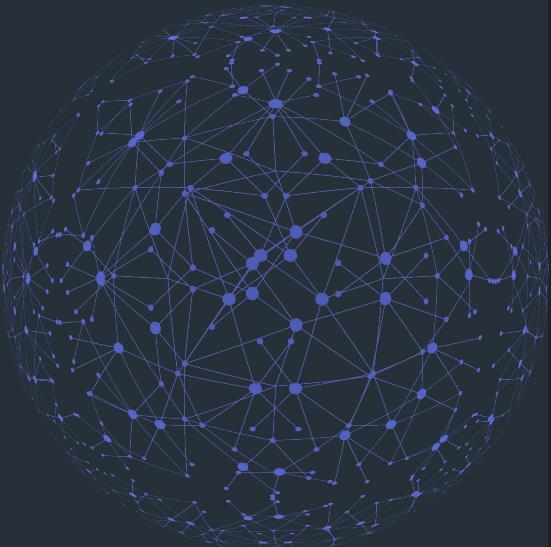
Now that you are familiar with some analyses that R can do with networks:

- (1) How would you refine your research question?
- (2) How can network analysis in R assist you with answering this question?



# WRAP UP

- Network analysis is a powerful tool to ask questions about dyadic data
- Myriad of network tools online to help achieve your coding goals
- Likely that someone else has done it, and put code online



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# Acknowledgements/references

- Csardi G, Nepusz T: The igraph software package for complex network research, InterJournal, Complex Systems 1695. 2006. <http://igraph.sf.net>
- Kolaczyk, E.D. and Csárdi, G., 2014. Statistical analysis of network data with R (Vol. 65). New York, NY: Springer.
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- Ognyanova, K. (2019) Network visualization with R. Retrieved from [www.kateto.net/network-visualization](http://www.kateto.net/network-visualization).
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- UNEP-WCMC (Comps.) 2019. Full CITES Trade Database Download. Version 2019.2. CITES Secretariat, Geneva, Switzerland. Compiled by UNEP-WCMC, Cambridge, UK. Available at: <https://trade.cites.org>.