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FASS 210: Assignment 2
A phonological network, paths and connectedness

May 27th 2021

After loading the adjacency list *vitevitch.adjlist*. Using the networkx and matplotlib.pyplot python libraries we further analyzed the propeties of the network. Appendix 1 shows all of the code that was written to help analyze our network.

The network itself is connected, as there is a path between any vertex a and any vertex b. As well using the is_connected function in Appendix 1 returns a boolean value of True. The average shortest path in our network is 3.124338624338624. The degree of assortativity of the Vitevitch network is -0.19929528588970138, since our degree of assortativity is negative our network can be classified as diassortative (Menczer, 38).
Currently, our density has a value 0.17195767195767195. Table 1 shows nodes that if removed will make the graph disconnected. It also contains the new density of the graph and the respective components of the new networks.

Node	New Density	List of Components
bog	0.170940170	[{’log’, ’dig’, ’dawn’, ’dog’, ’hog’, ’fog’, ’dug’}, {’cut’, ’catch’, ’gnat’, ’coat’, ’that’, ’cad’, ’bag’, ’fat’, ’calf’, ’kit’, ’can’, ’chat’, ’hat’, ’kite’, ’rat’, ’cab’, ’cot’, ’cat’, ’cattle’, ’bat’}]
dog	0.165242165	[{’cut’, ’catch’, ’bog’, ’gnat’, ’coat’, ’that’, ’cad’, ’fog’, ’bag’, ’fat’, ’calf’, ’kit’, ’log’, ’can’, ’chat’, ’hog’, ’hat’, ’kite’, ’rat’, ’cab’, ’cot’, ’bat’, ’cattle’, ’cat’}, {’dig’, ’dug’}, {’dawn’}]
bag	0.179487179	[{’log’, ’bog’, ’dig’, ’dawn’, ’dog’, ’hog’, ’fog’, ’dug’}, {’cut’, ’catch’, ’gnat’, ’coat’, ’that’, ’cad’, ’fat’, ’calf’, ’kit’, ’can’, ’chat’, ’hat’, ’kite’, ’rat’, ’cab’, ’cot’, ’cat’, ’cattle’, ’bat’}]
bat	0.179487179	[{’bag’, ’log’, ’bog’, ’dig’, ’dawn’, ’dog’, ’hog’, ’fog’, ’dug’}, {’cut’, ’rat’, ’gnat’, ’coat’, ’cab’, ’cot’, ’calf’, ’catch’, ’that’, ’fat’, ’kit’, ’can’, ’chat’, ’cad’, ’cattle’, ’hat’, ’cat’, ’kite’}]
cat	0.133903134	[{’bag’, ’log’, ’bog’, ’dig’, ’dawn’, ’dog’, ’hog’, ’fog’, ’dug’, ’bat’}, {’cattle’}, {’cut’, ’coat’, ’cot’, ’kit’, ’kite’}, {’calf’, ’cad’, ’cab’, ’can’}, {’catch’}, {’rat’, ’gnat’, ’fat’, ’that’, ’chat’, ’hat’}]

Table 1: Removed Nodes That Make a Disconnected Network

Removing the nodes ”bog”, ”dog”, ”bag”, ”bat”, ”cat” will result in our network becoming disconnected, Appendix 2 through 6 show the network once each node have been removed. The density decreases the most when the cat node is moved, followed by dog. When bog is removed our density decreases the least, however our density **increases** if bag or bat are removed. Therefore, our density decreases the least if bag or bat are removed due to the increase in density, however, if looking for the minimum decrease excluding increases, then we would require node ”bog” to be removed. The corresponding list of components can also be found for each graph once a specific node is removed.
Removing the nodes ”bog”

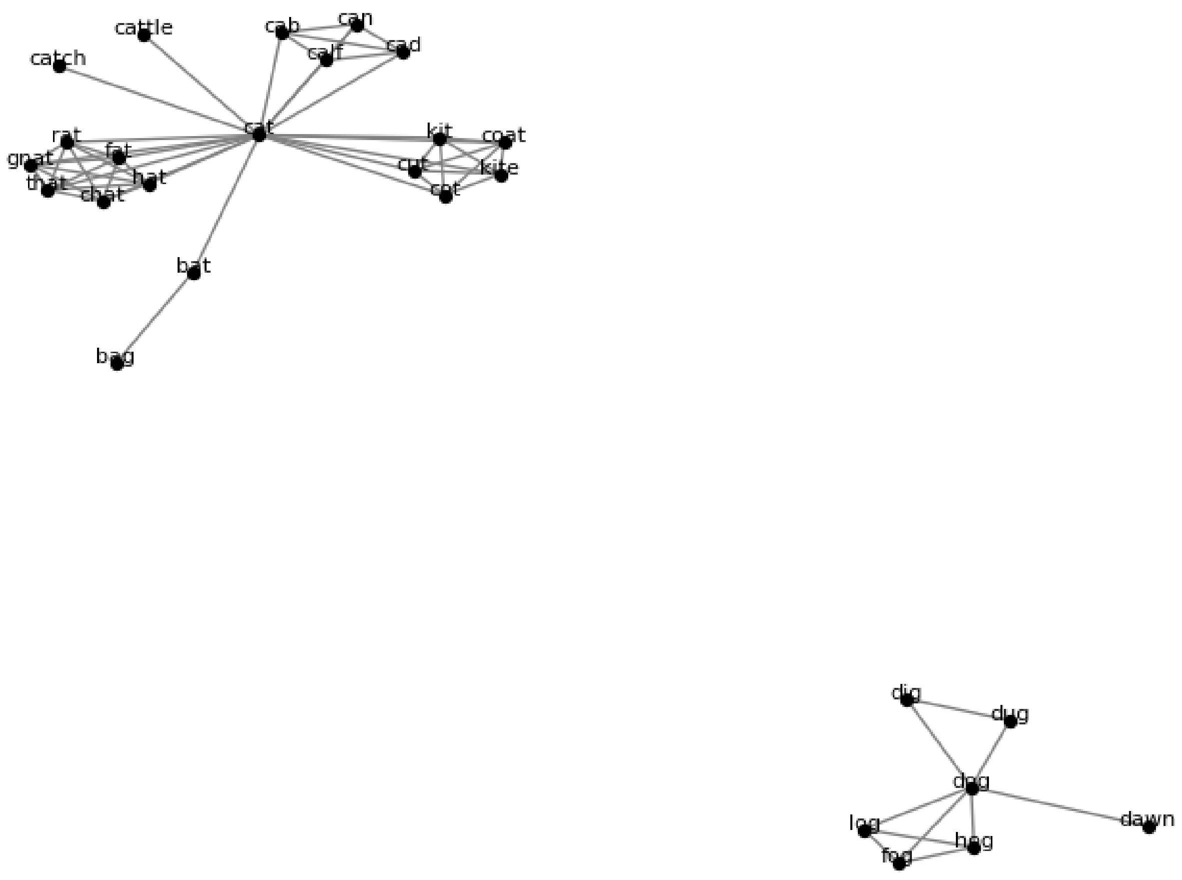
References

"2. Small Worlds." *A First Course in Network Science*, by Filippo Menczer et al., Cambridge University Press, 2020, pp. 37–38.

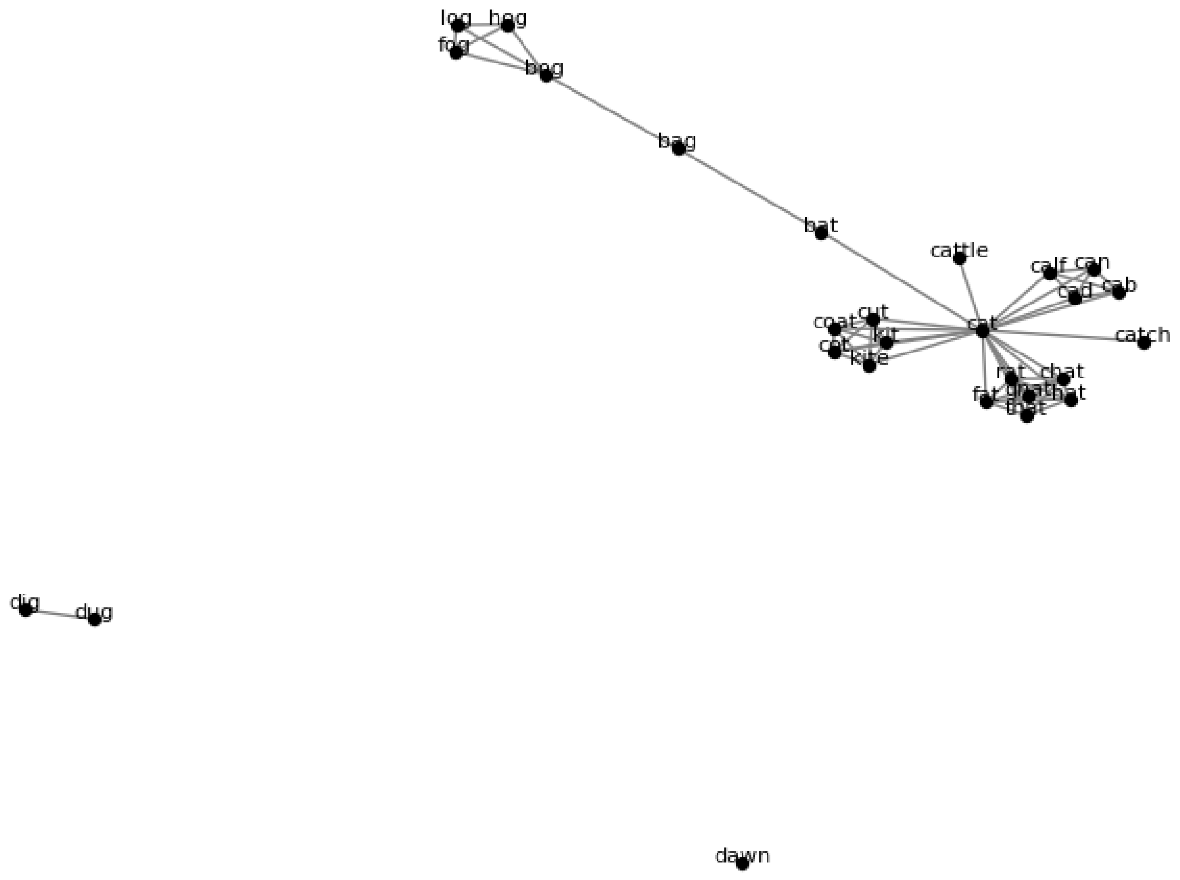
Appendix 1 - Code Used

```python
import networkx as nx
import matplotlib.pyplot as plt  # Since we are not using a notebook we will import like this


def main():
    graph = nx.read_adjlist('../Datasets/vitevitch.adjlist')
    connected = is_connected(graph)
    avg_short_path = shortest_path(graph)
    deg_asrt = assortativity(graph)
    removed_nodes = disconnected(graph)
    density = network_density(graph.number_of_nodes(), graph.number_of_edges())
    reduce_density = reduce_least_density(removed_nodes)
    removed_components = components(removed_nodes)
    print(f"The truth value of connectedness is {connected} \n"
          f"The average shortest path in our network is {avg_short_path} \n"
          f"The degree of assortativity is {deg_asrt} \n"
          f"If we remove the nodes {removed_nodes} our graph will become disconnected \n"
          f"The Current density of our network is {density} \n"
          f"Removing the nodes {removed_nodes} resuls in densitys of {reduce_density} respectively
              \n"
          f"The list of components are as followed:  \n "
          f"\t - {removed_components[0]} \n"
          f"\t - {removed_components[1]} \n"
          f"\t - {removed_components[2]} \n"
          f"\t - {removed_components[3]} \n"
          f"\t - {removed_components[4]} \n")
    print(len(removed_components))

def components(nodes_list):
    return_components = []
    for nodes in nodes_list:
        graph_r = nx.read_adjlist('../Datasets/vitevitch.adjlist')
        graph_r.remove_node(nodes)
        return_components.append(list(nx.connected_components(graph_r)))
    return return_components

def reduce_least_density(nodes_list):
    difference = 0
    min_node = []
    for nodes in nodes_list:
        graph_r = nx.read_adjlist('../Datasets/vitevitch.adjlist')
        graph_r.remove_node(nodes)
        density = nx.density(graph_r)
        min_node.append(density)
    return min_node


def network_density(N, L):
    numerator = 2 * L
    denominator = N * (N - 1)
    return numerator / denominator


def disconnected(graph):
    return_nodes = []
    for node in list(graph.nodes()):
        graph_r = nx.read_adjlist('../Datasets/vitevitch.adjlist')
        graph_r.remove_node(node)
        if not nx.is_connected(graph_r):
            return_nodes.append(node)
            nx.draw(graph_r,
                    with_labels=True,
                    node_color='black',
                    node_size=18,
                    font_size=8,
                    verticalalignment='baseline',
                    edge_color='grey')
            plt.title(f"Removed node {node}")
            plt.savefig(f'{node}.png')
            plt.show()

    return return_nodes


def shortest_path(G):
    return nx.average_shortest_path_length(G)


def is_connected(G):
    return nx.is_connected(G)


def assortativity(G):
    return nx.degree_assortativity_coefficient(G)


if __name__ == '__main__':
    main()
```

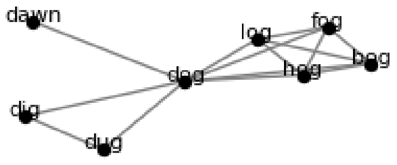
Appendix 2 - Bog Removal

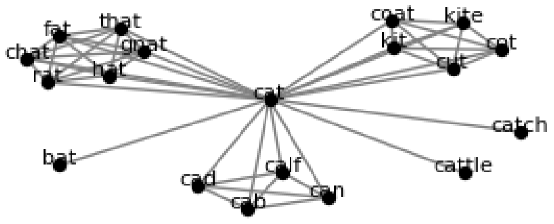


Appendix 3 - Dog Removal

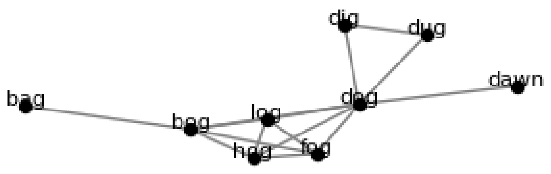


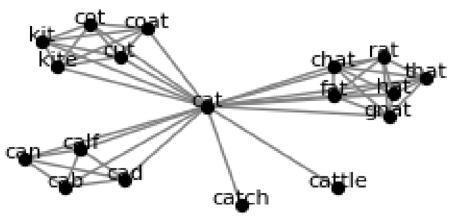
Appendix 4 - Bag Removal



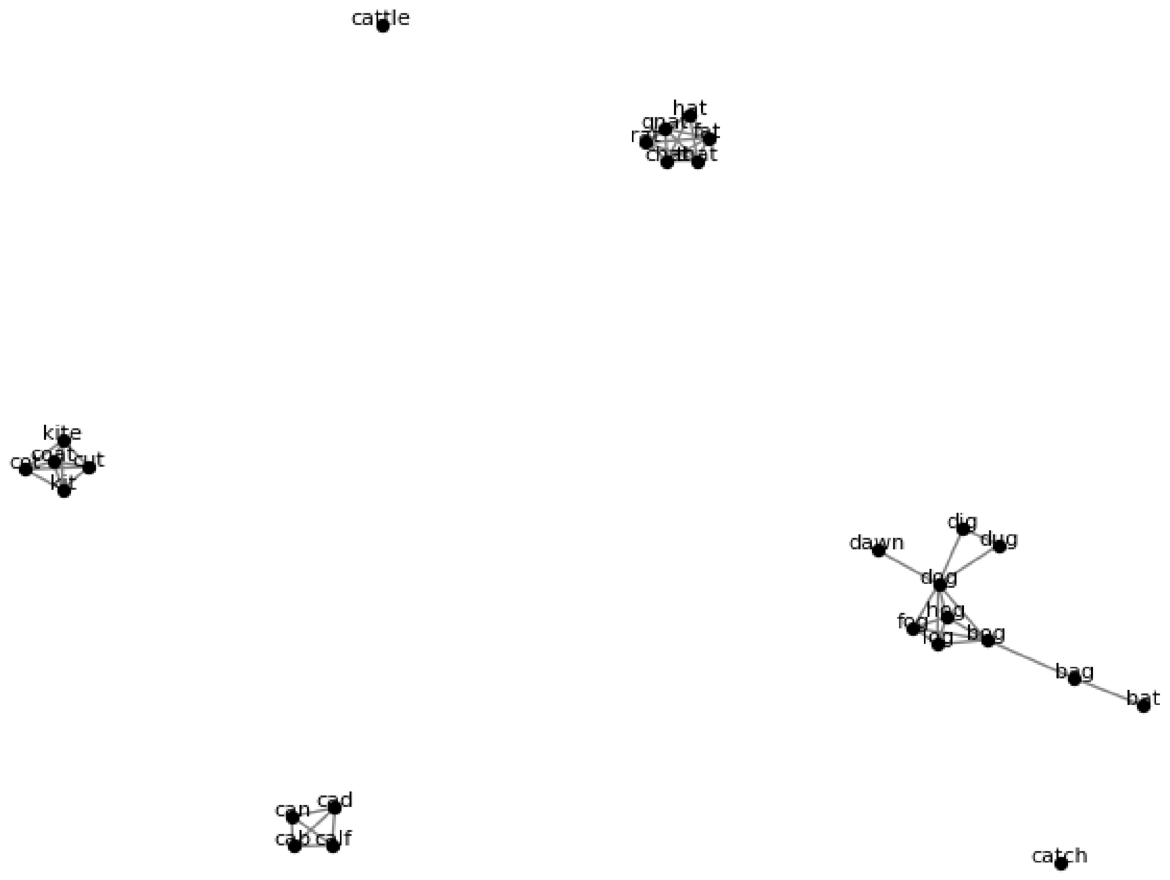


Appendix 5 - Bat Removal





Appendix 6 - Cat Removal



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