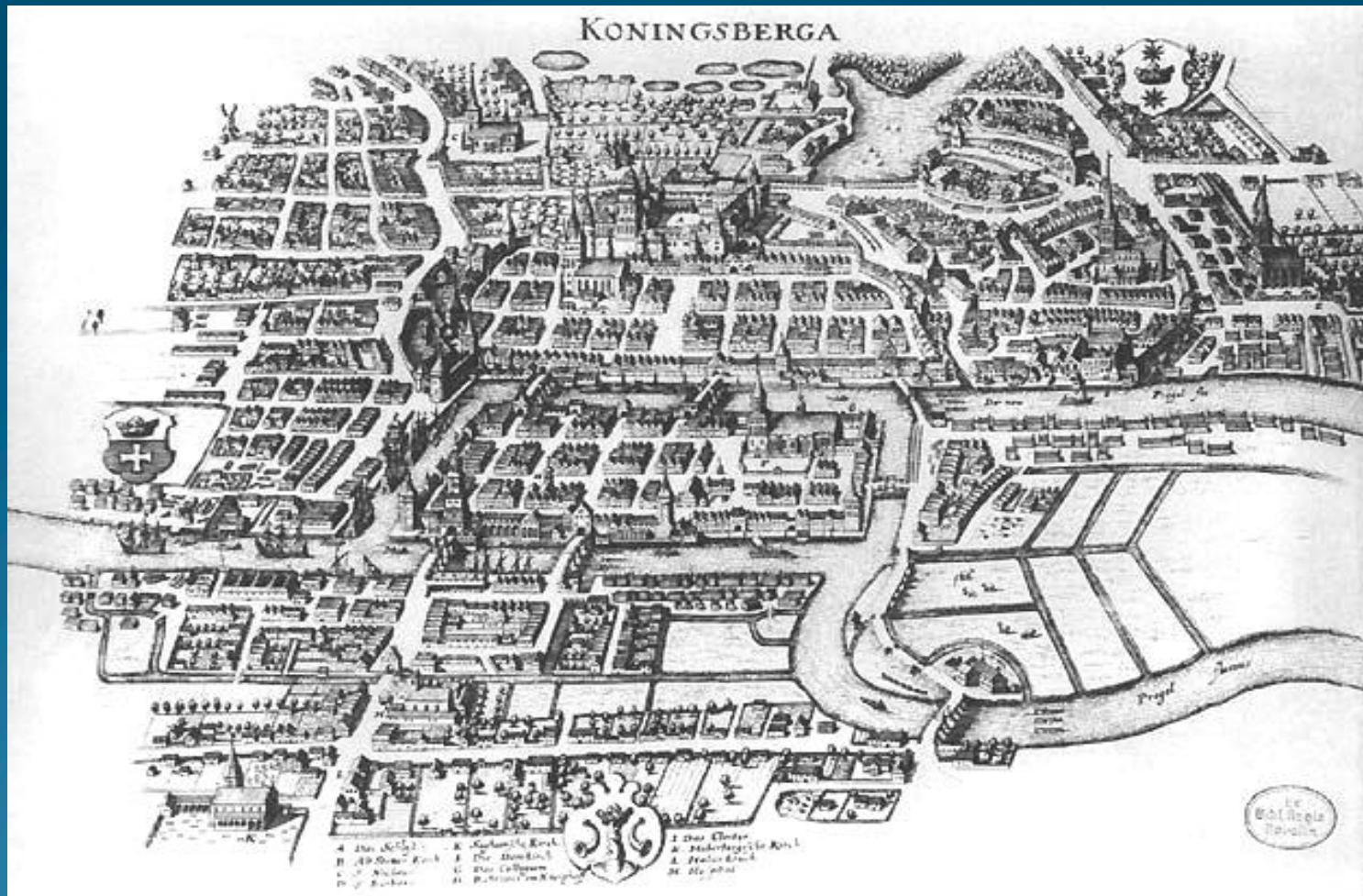


# Graphs, Trees, and Networks

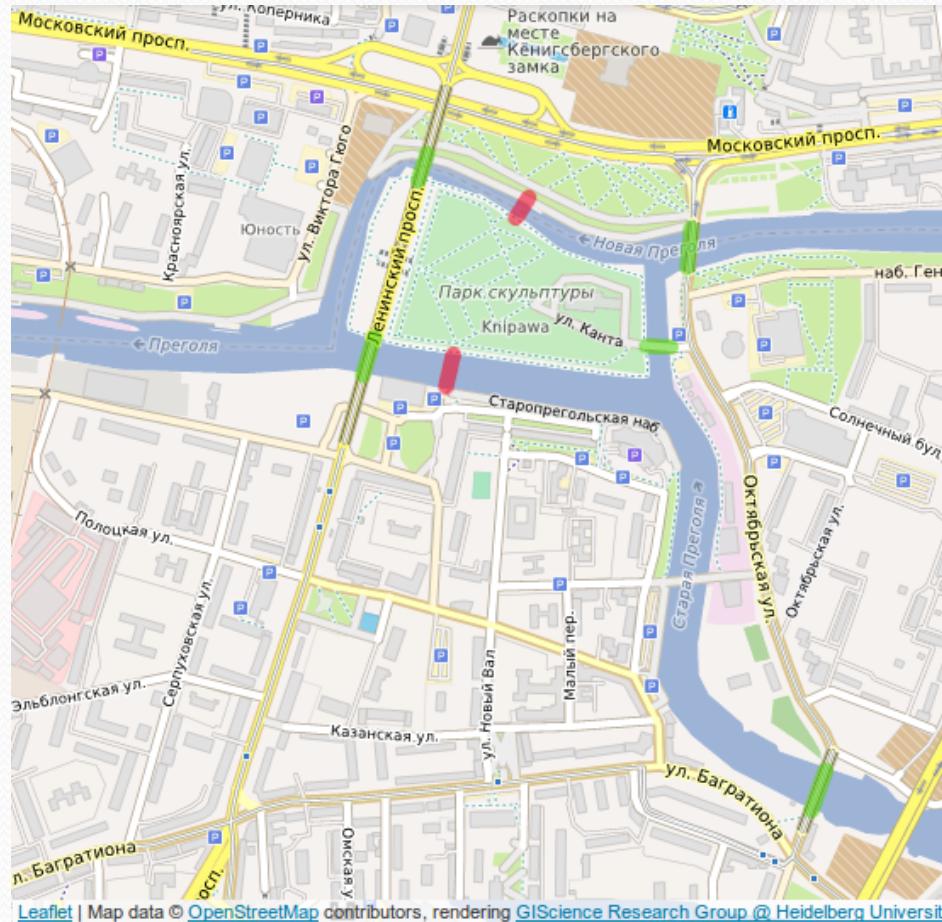


# 1735: Bridges of Königsberg

can you cross  
all 5 or 7 bridges  
exactly once?  
(no taking a boat!)

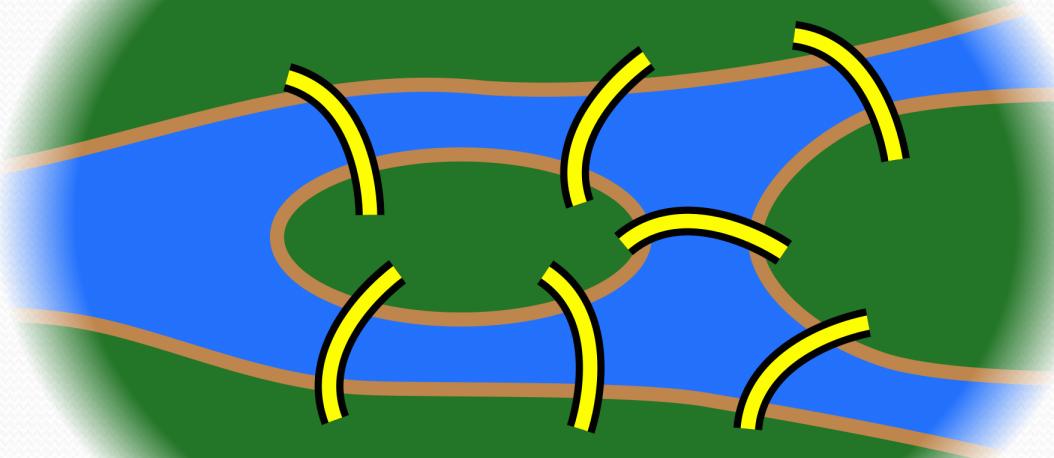
if so, where do  
you have to start  
to do so?

does the order  
you cross the  
bridges matter?



@jotis13

# Bridges of Königsberg



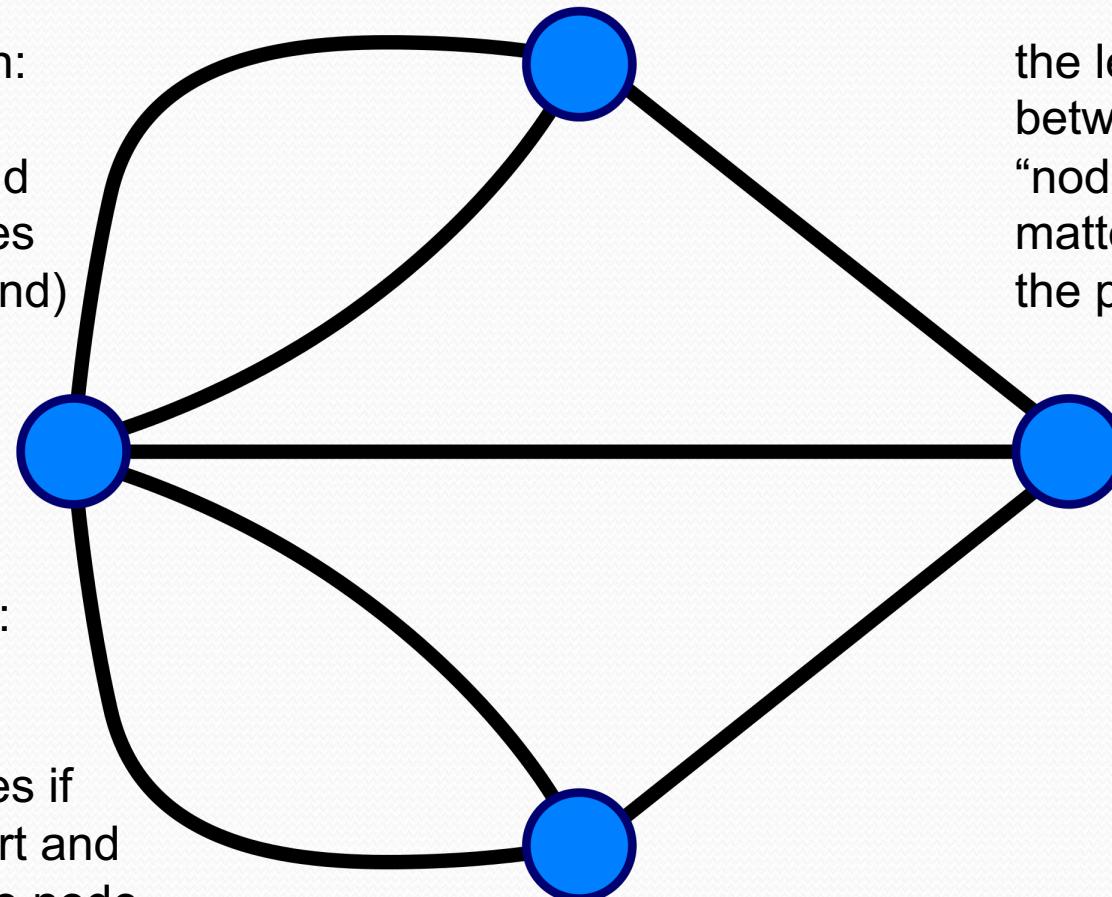
@jotis13

# Bridges of Königsberg

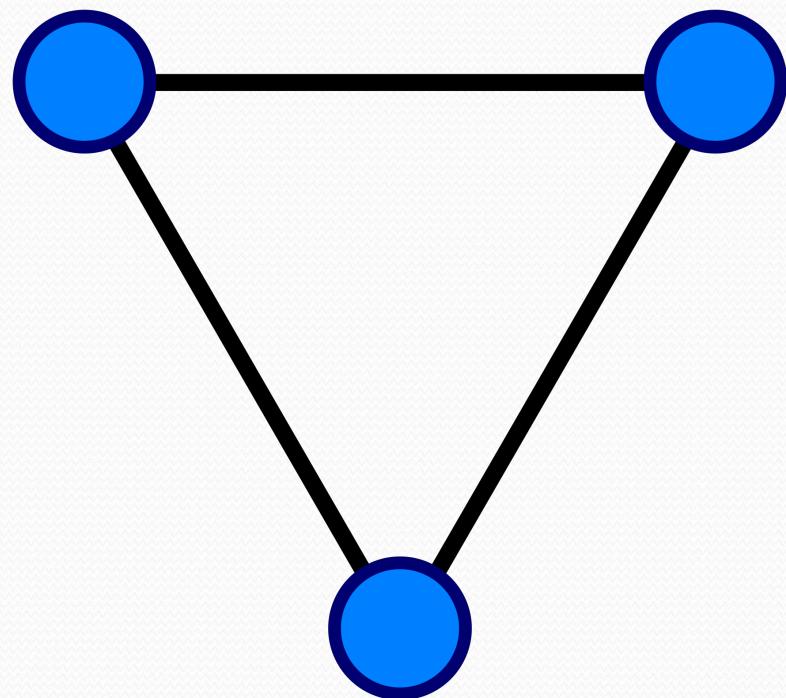
general solution:  
only two nodes  
can have an odd  
number of edges  
(the start and end)

the length of the lines  
between these  
“nodes” doesn’t  
matter for solving  
the problem

variant solution:  
all nodes must  
have an even  
number of edges if  
you want to start and  
end at the same node



# Graphs and Networks



- graph: an ordered pair  $G = (V, E)$  with
  - $V$  a set of nodes (also called vertices, points)
  - $E$  a set of edges which are pairs of nodes (also called relationships)
- network: a graph with real-world meaning

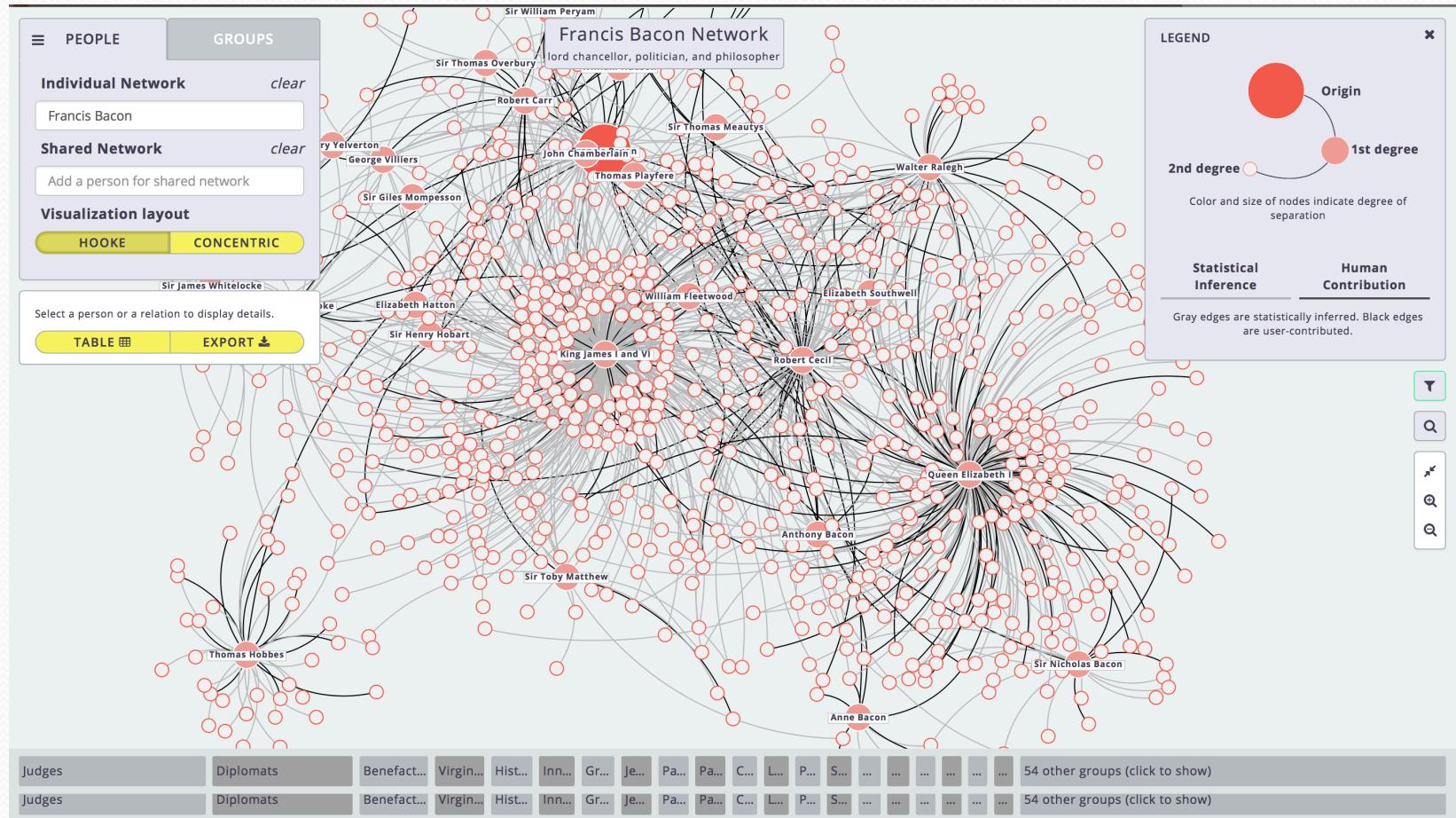
# Social Network: Facebook



# Social Network: Stanley Milgram

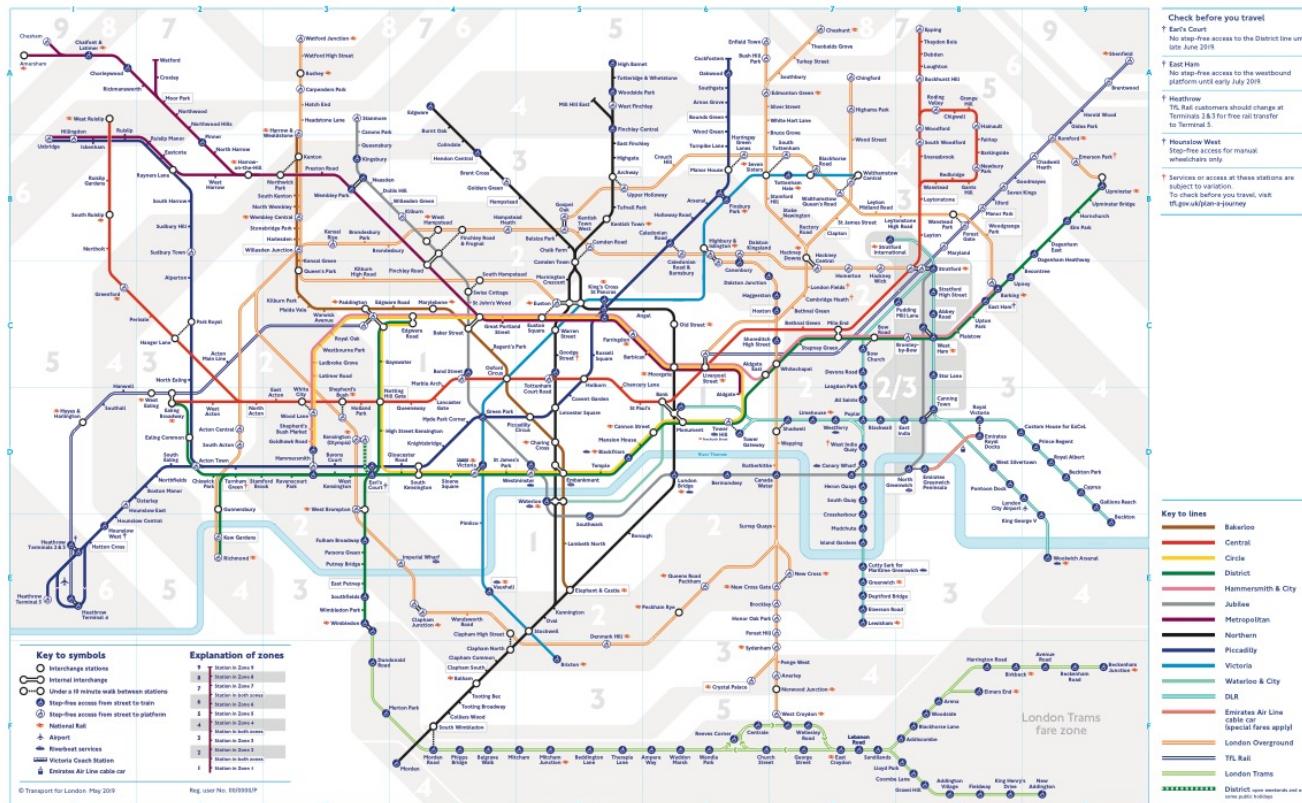


# Social Network: Six Degrees of Francis Bacon



# Transportation Network: London

## Tube map



MAYOR OF LONDON

tfl.gov.uk

i 24-hour travel information

0343 222 1234\*

\*Service and network changes may apply. See TfL.gov.uk for details.

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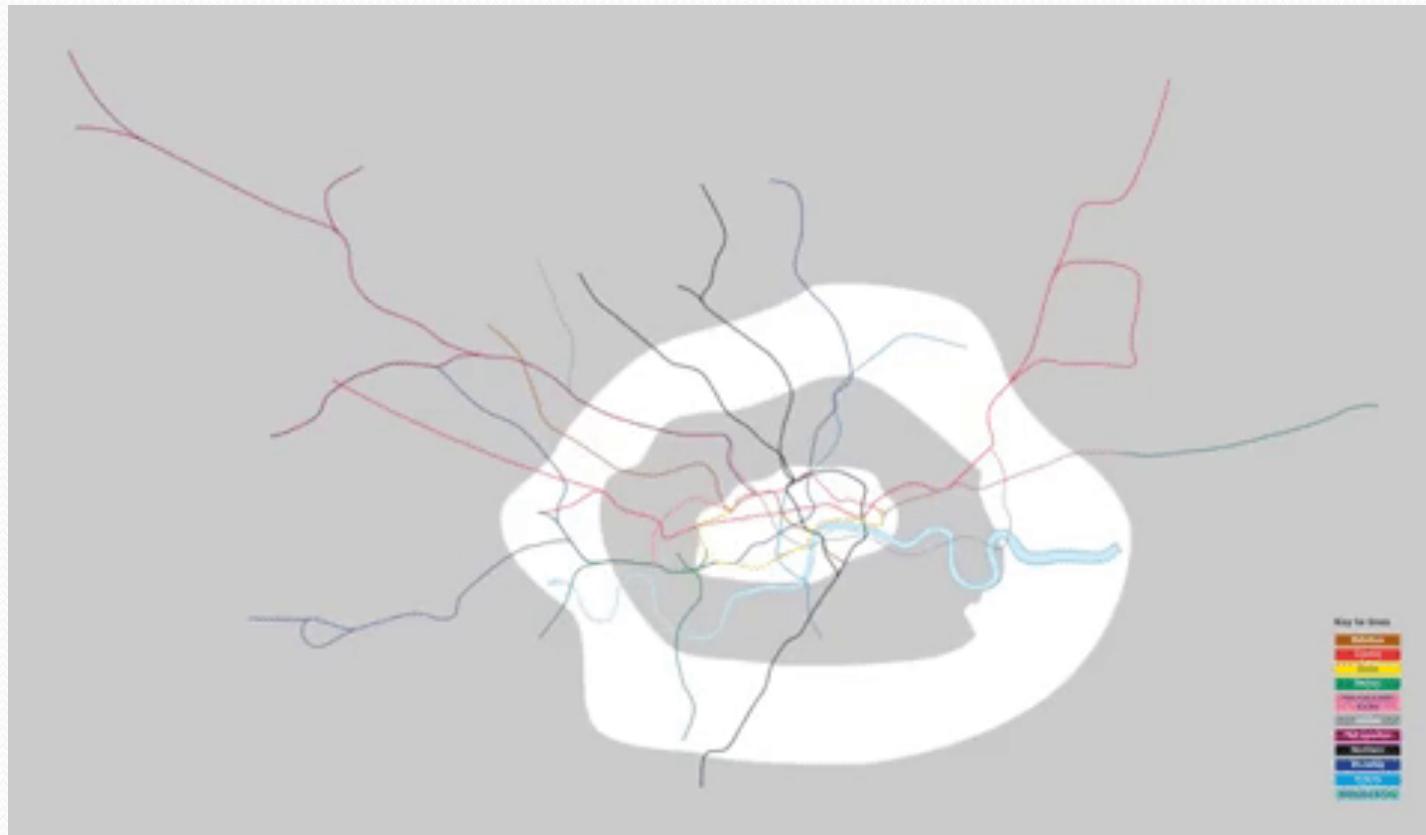
@TfLTravelAlerts



TRANSPORT  
FOR LONDON  
EVERY JOURNEY MATTERS

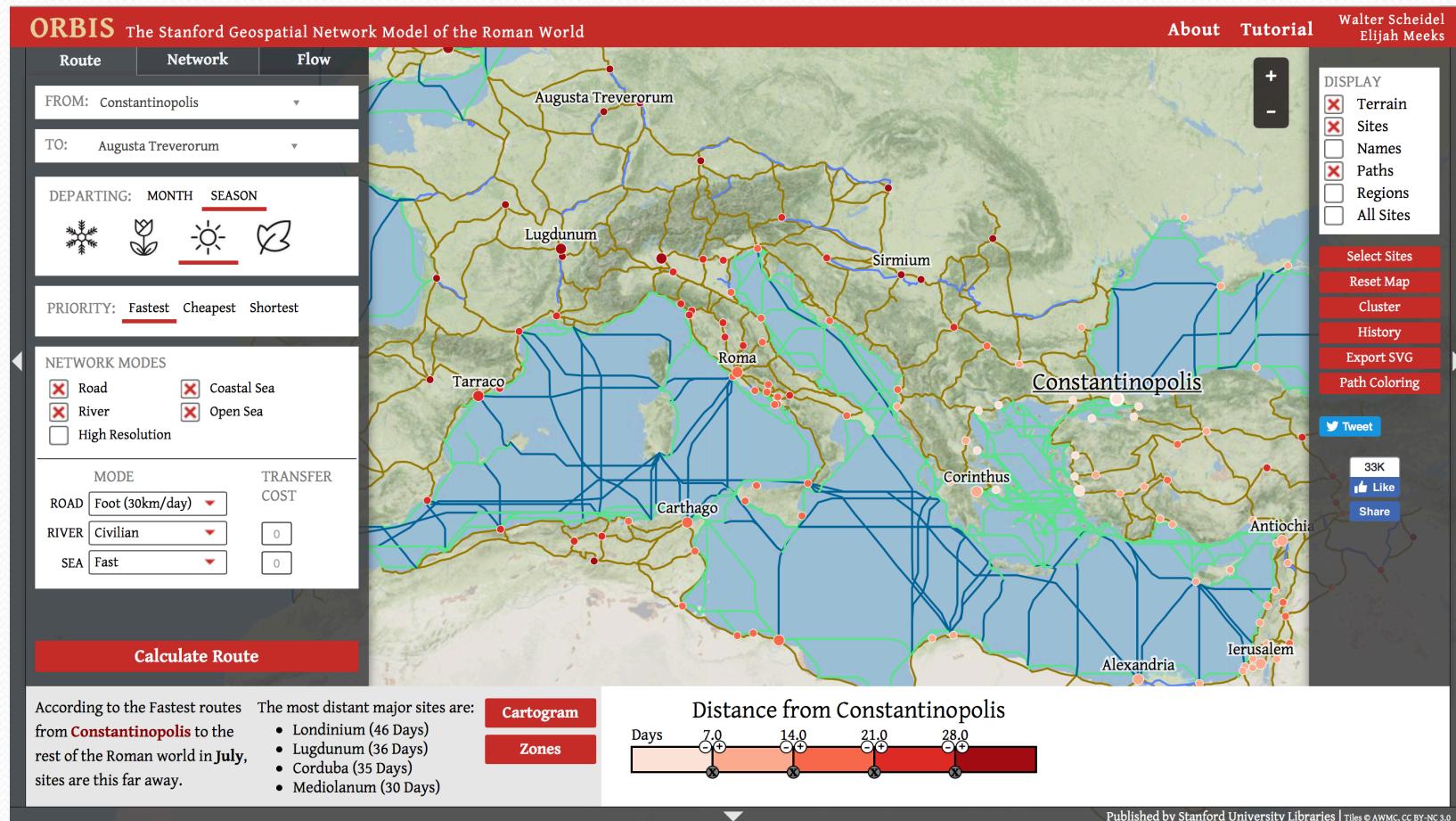
@jotis13

<https://mymodernmet.com/animated-subway-maps/>



@jotis13

# Transportation Network: Orbis

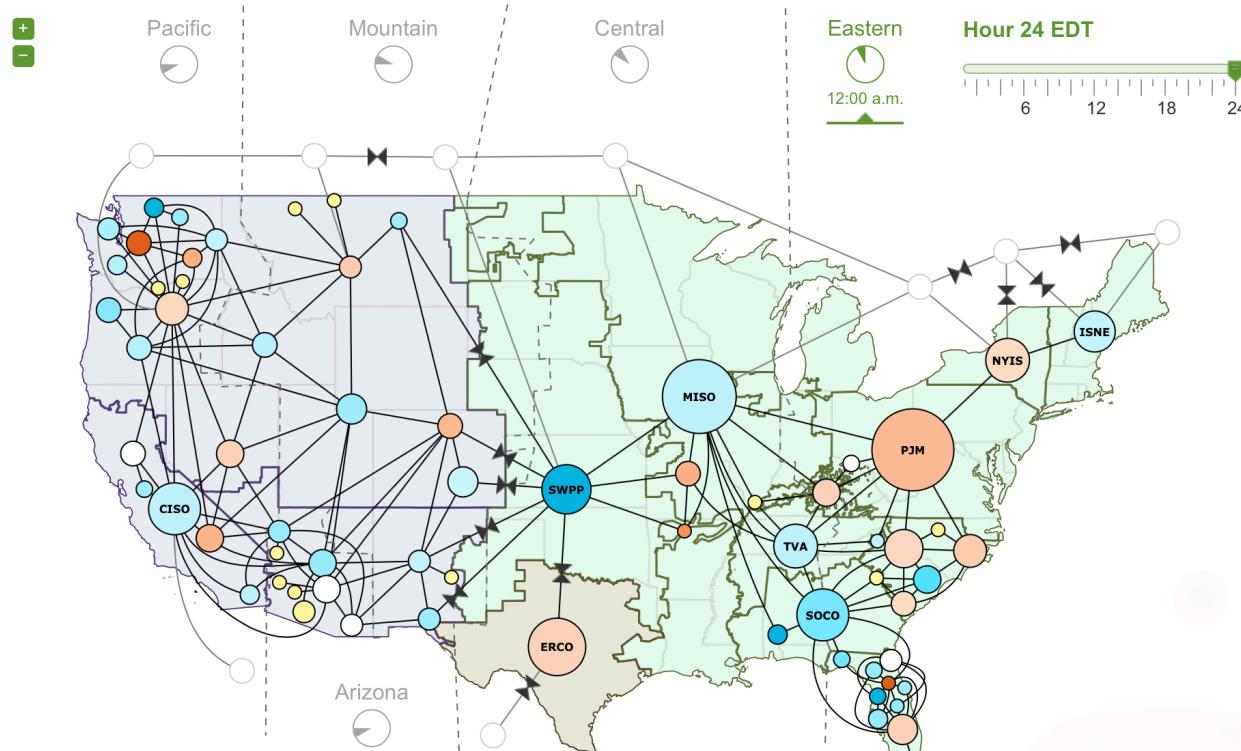


@jotis13

# Electricity Network

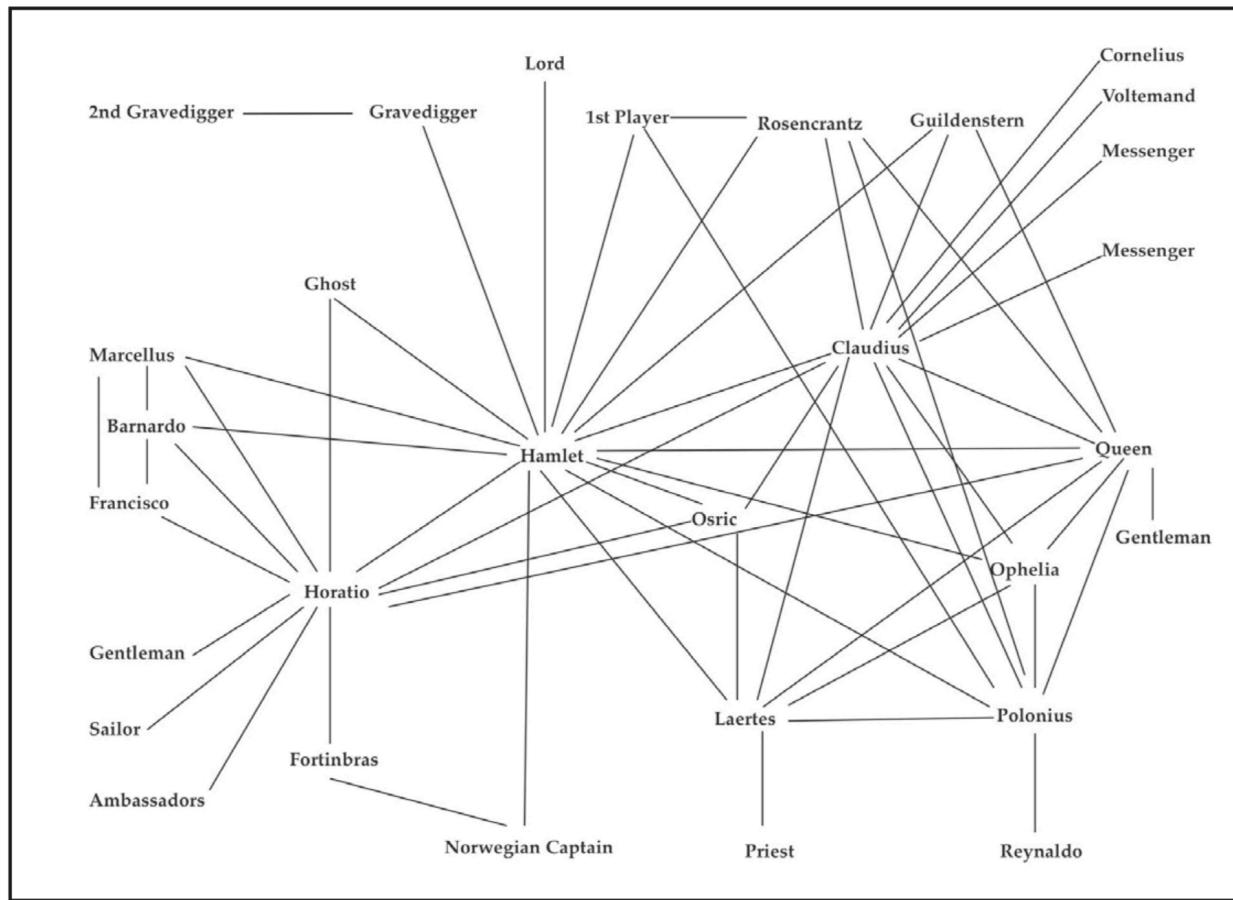
429,789 U.S. electricity demand (Lower 48 states)  
megawatthours

◀ Jun 8, 2019 ▶



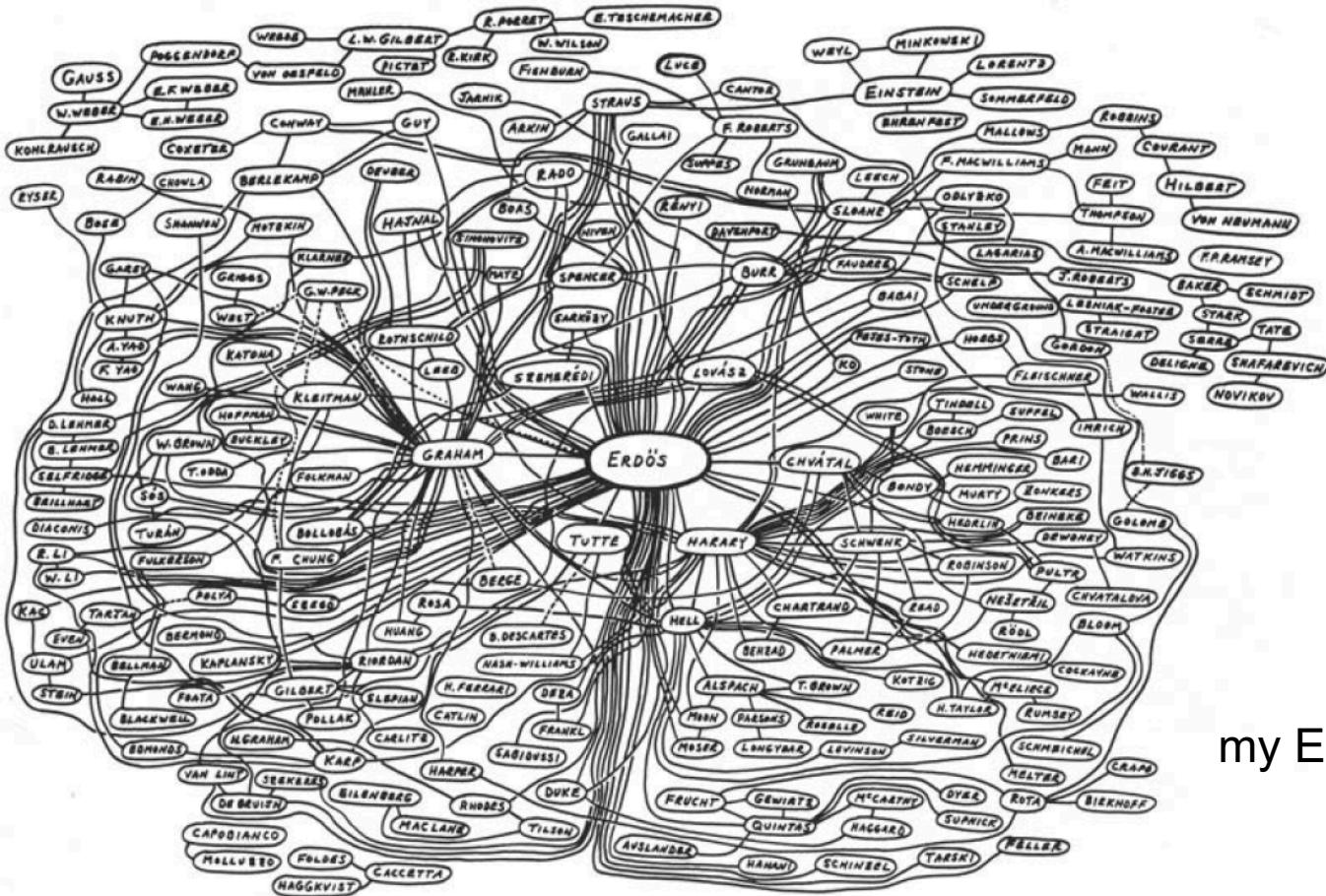
@jotis13

# Hamlet Stage Time Network



@jotis13

# Coauthorship Network

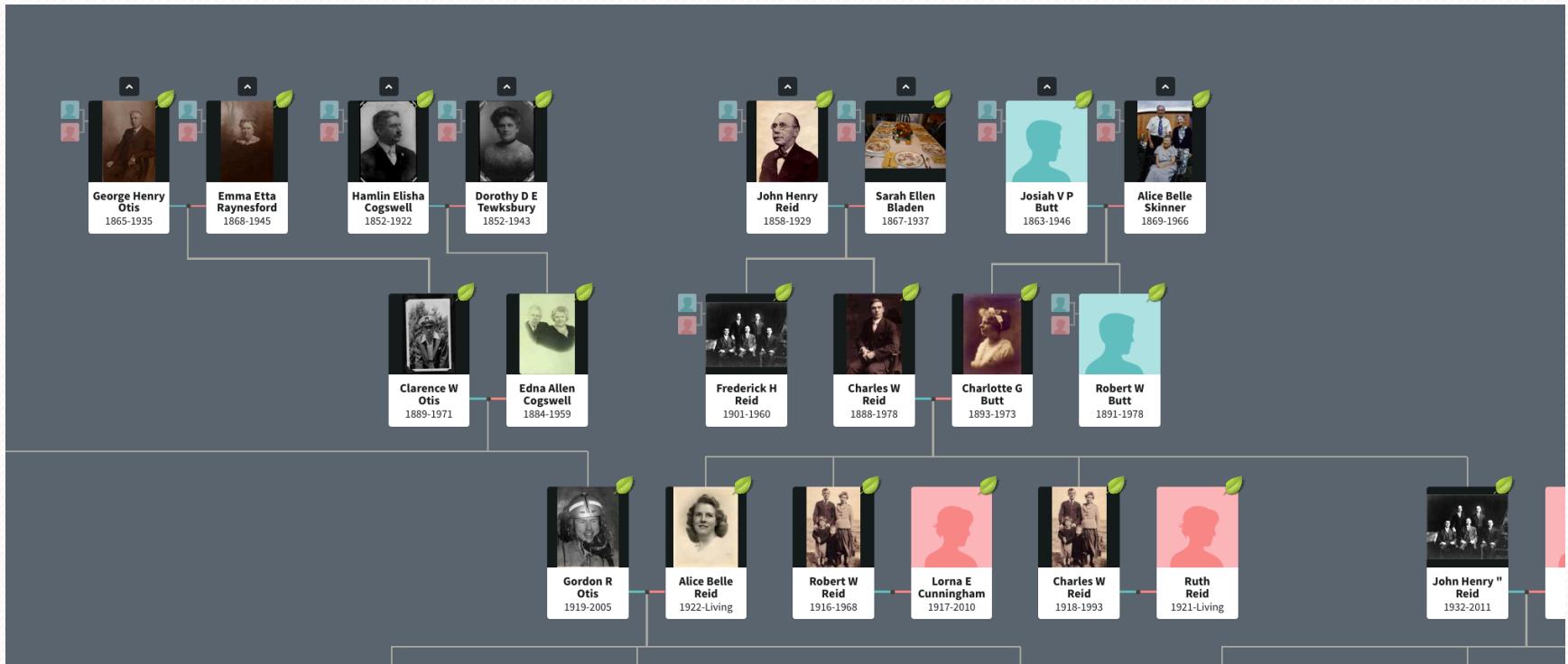


my Erdős # is 4

@jotis13

# (Family) Tree

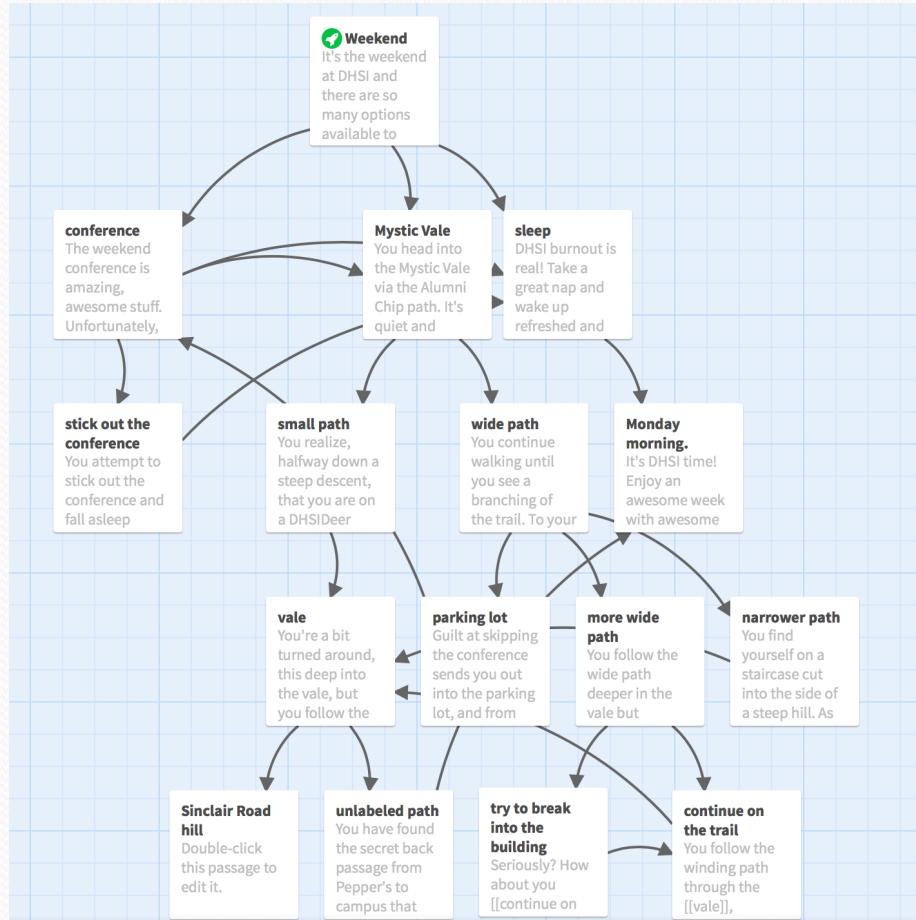
strict line of  
“parent” and  
“child” nodes



@jotis13

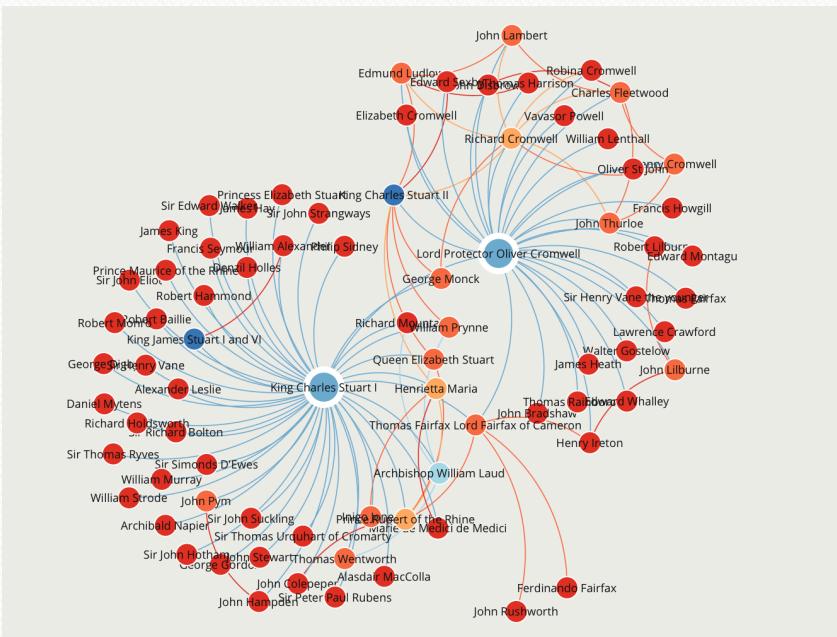
“parent” and “child” nodes but things can also get messy

# Decision Tree



@jotis13

# So What Are Networks?



- nodes/vertices: things that are connected
  - scholars
  - cities
  - disease victims
- edges: things that connect
  - publications
  - roads
  - disease vectors