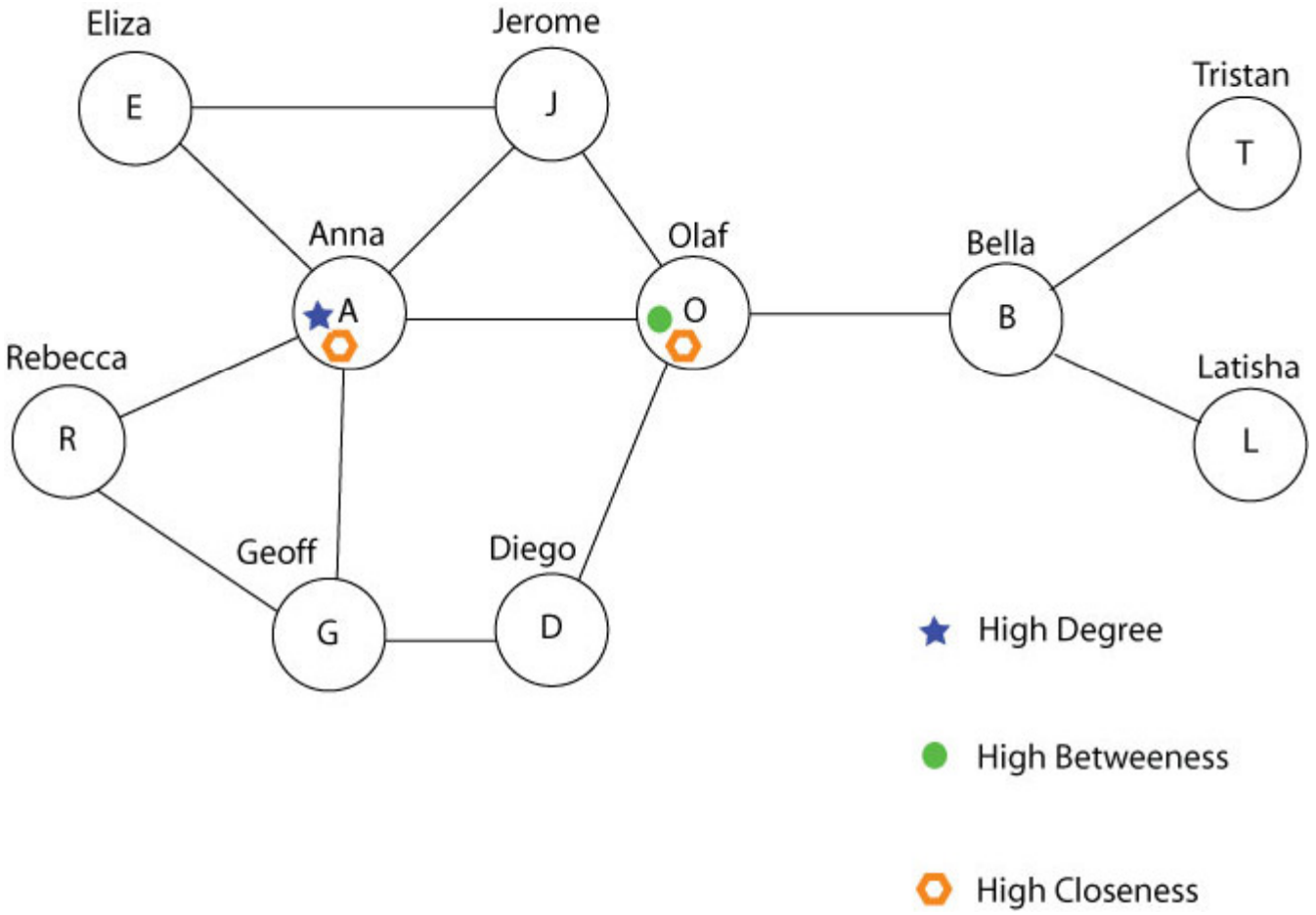
Fighting Terrorism with Social Network Analysis (SNA)

- Goals
  - Define Social Network Analysis (SNA)
  - Explain why SNA is important today
  - Explain how SNA experts use graph theory to analyze social networks
  - Explain the three methods that experts use to determine the leaders of a social network

Fighting Terrorism with Social Network Analysis (SNA)



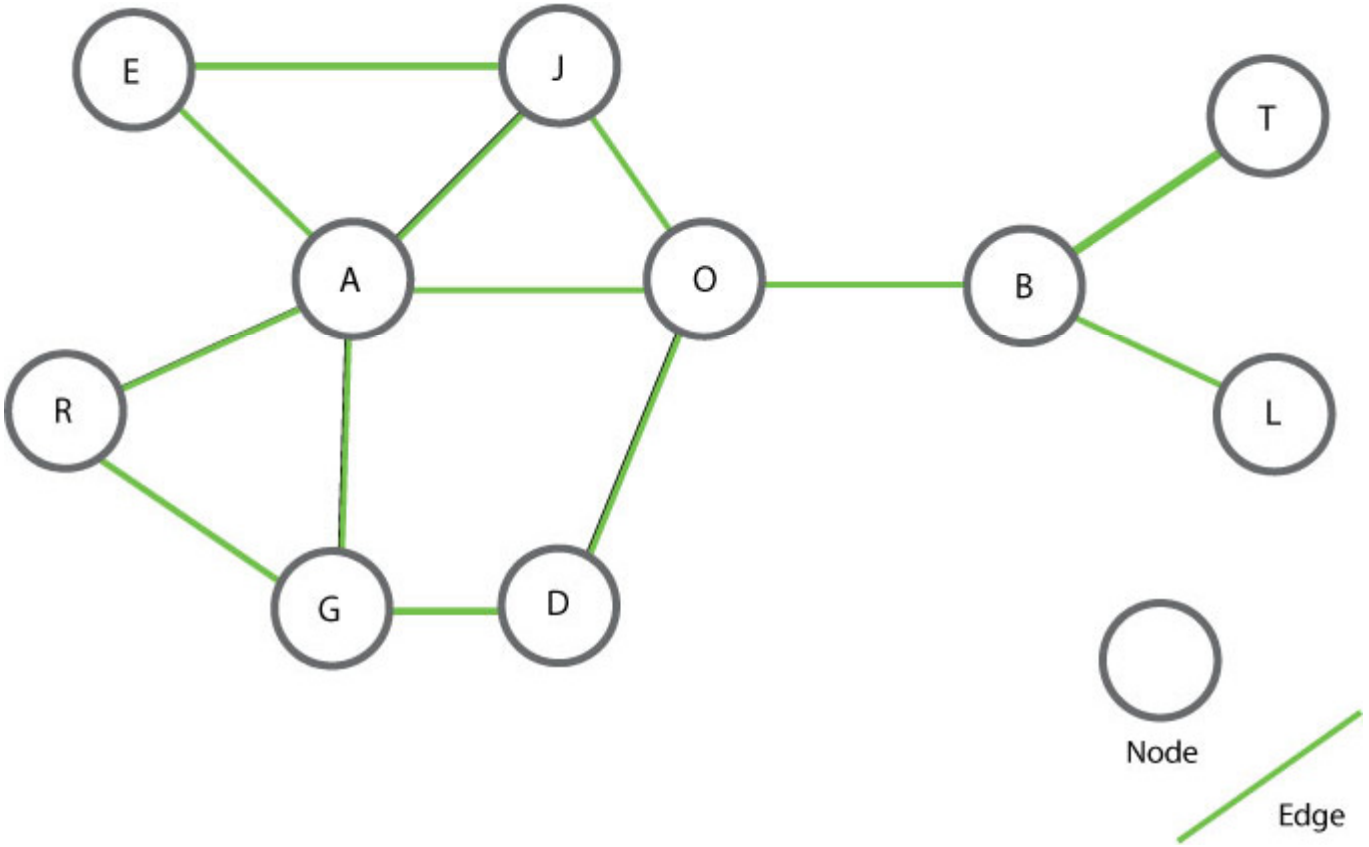
Connecting the Dots

- Voice of America report
- http://www1.voanews.com/english/news/usa/Christmas-Day-Attack-Highlights-US-Intelligence-Gaps-80730167.html (PDF)

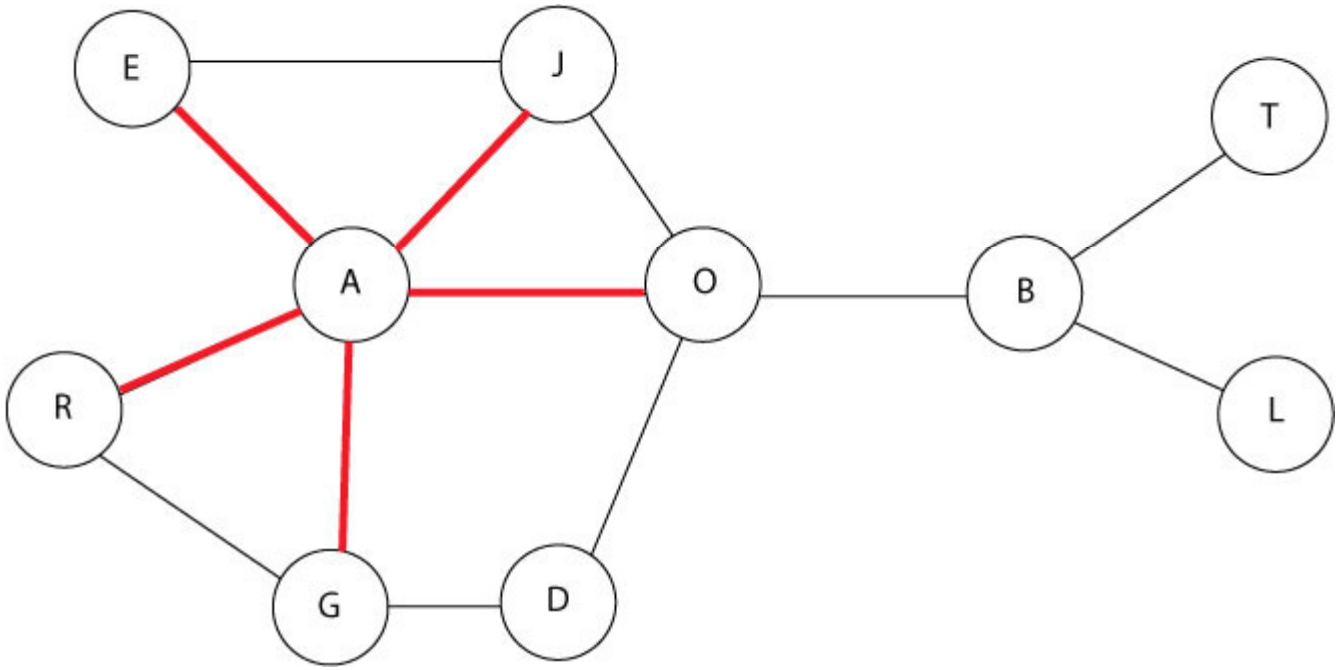
A New Terrain

- Terrorism is not limited by geography
- A new kind of war with a new “terrain”

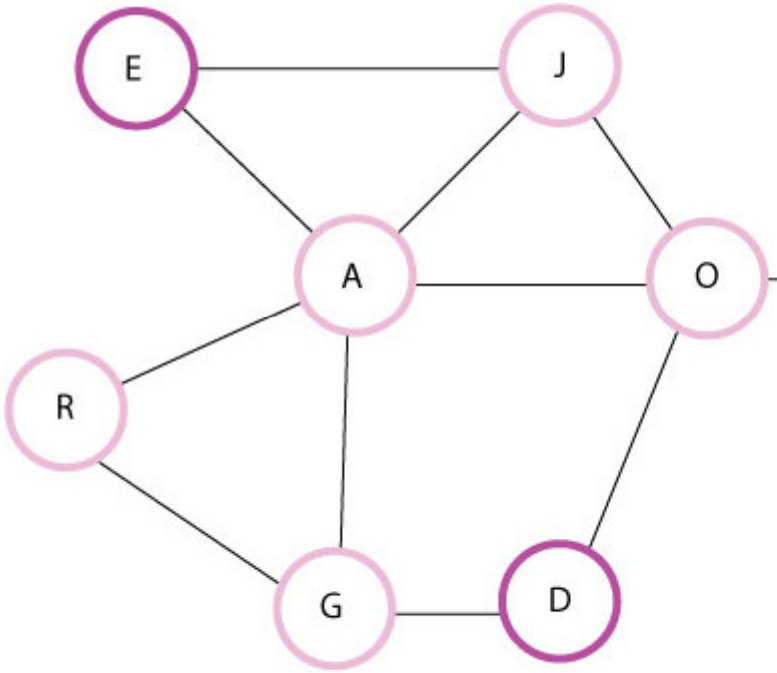
Graph Theory: Nodes and Edges

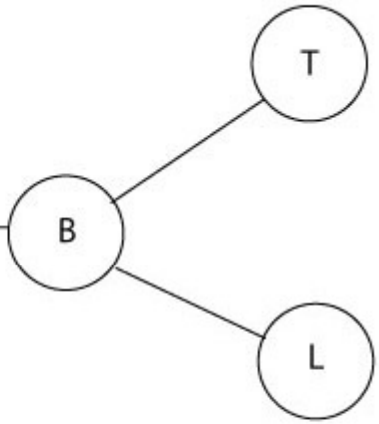


Graph Theory: Degree



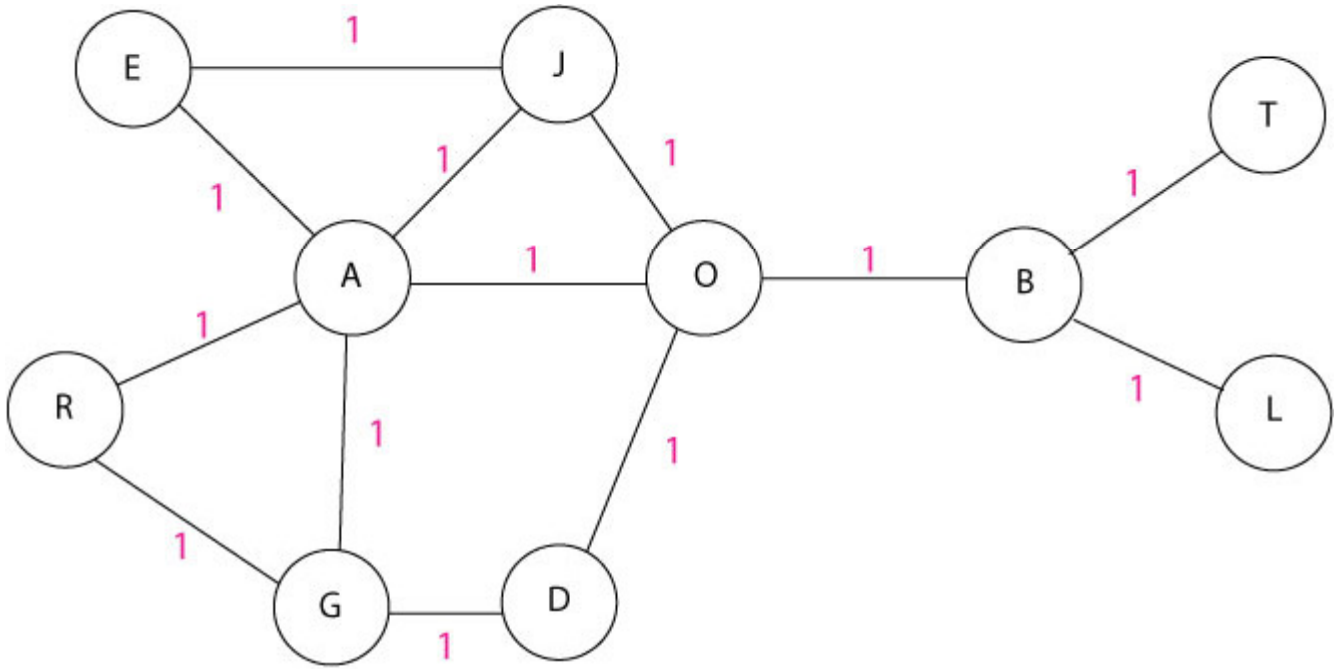
Graph Theory: Walks and Paths



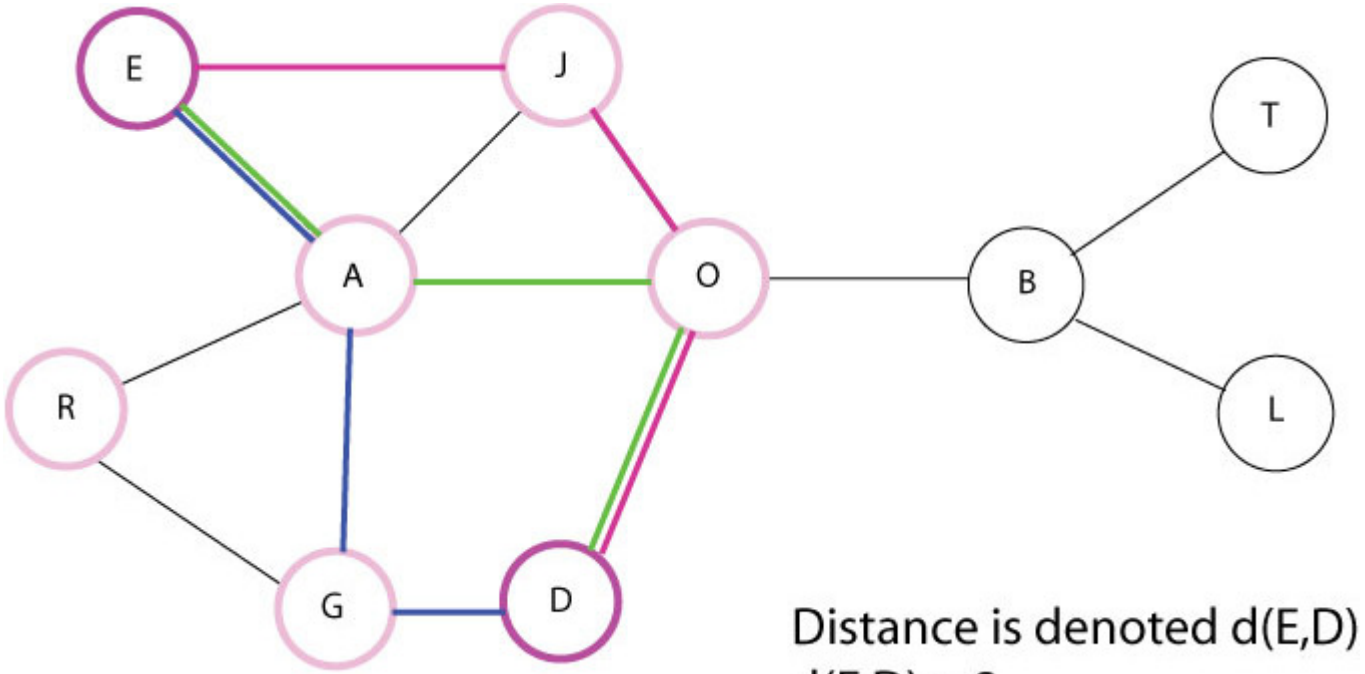


Paths from E to D, indicated with ○, involve some or all intermediate nodes, indicated with ○.

Graph Theory: Distance



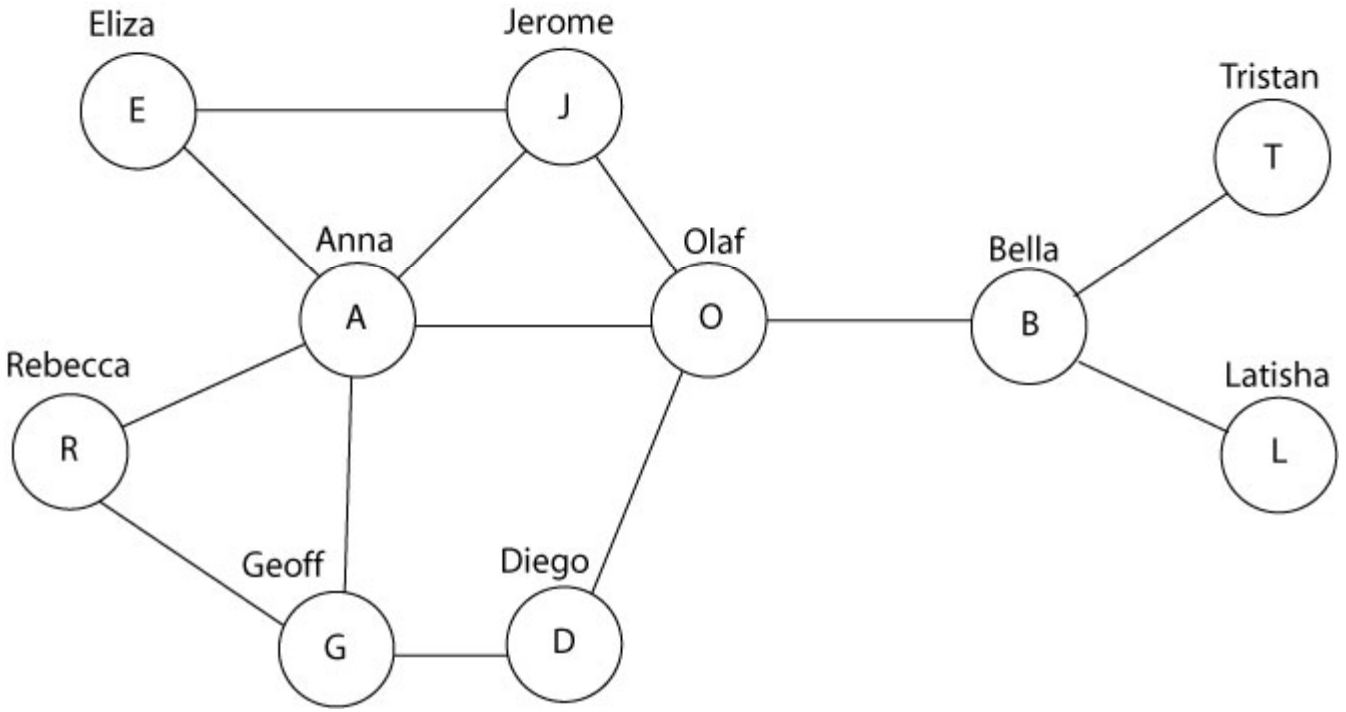
Graph Theory: Geodesic Paths



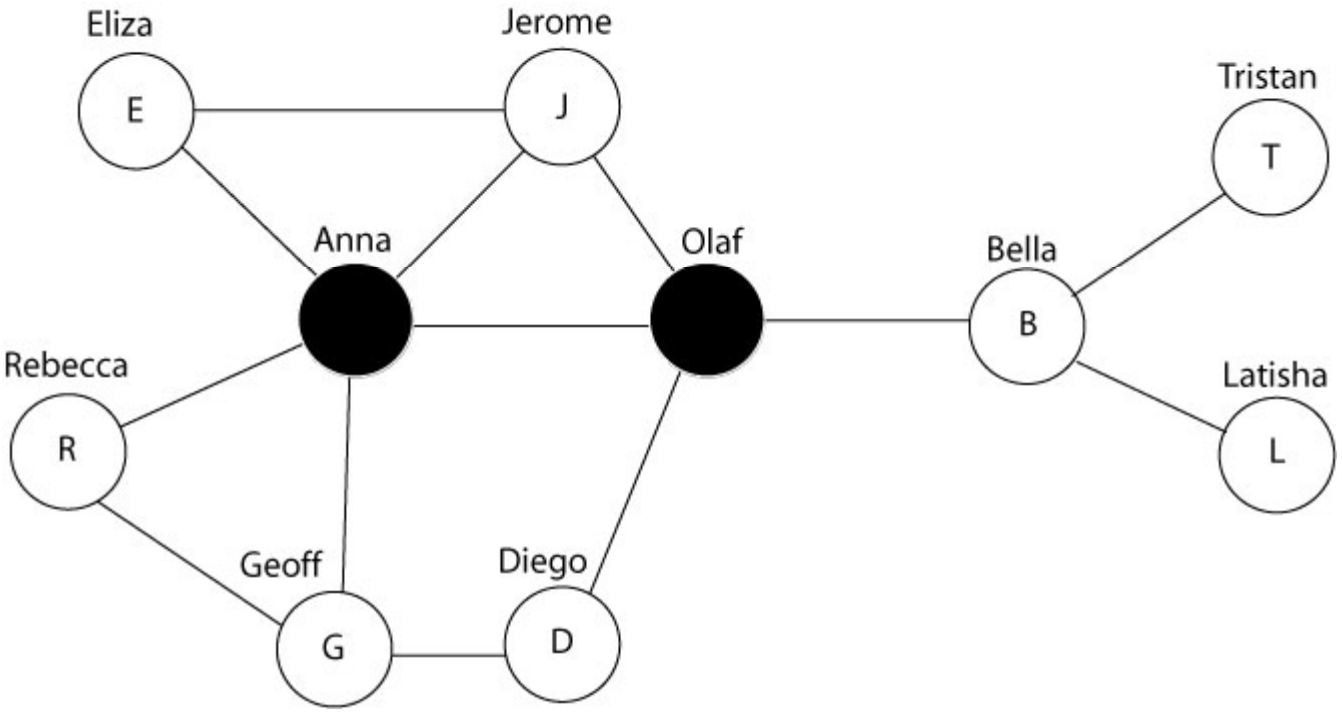
Distance is denoted d(E,D)

d(E,D) = 3

Social Network Graph



Breaking Down the Network



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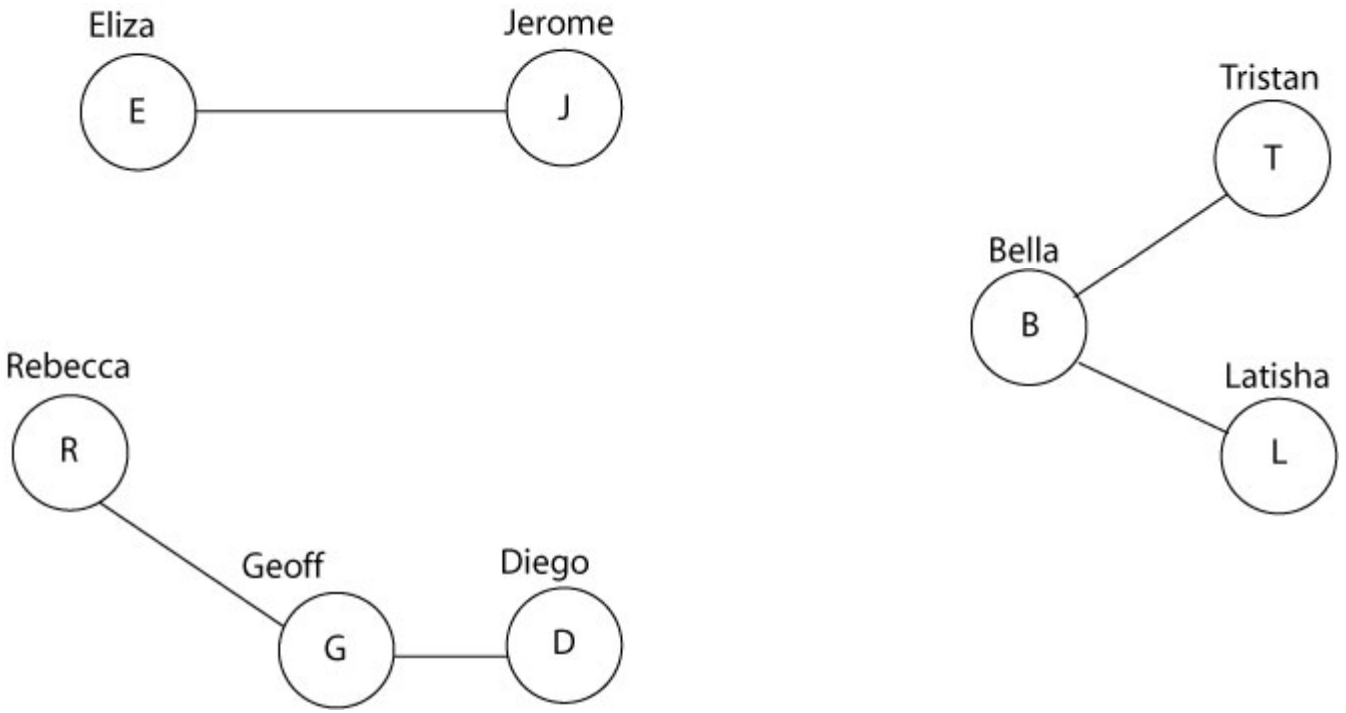
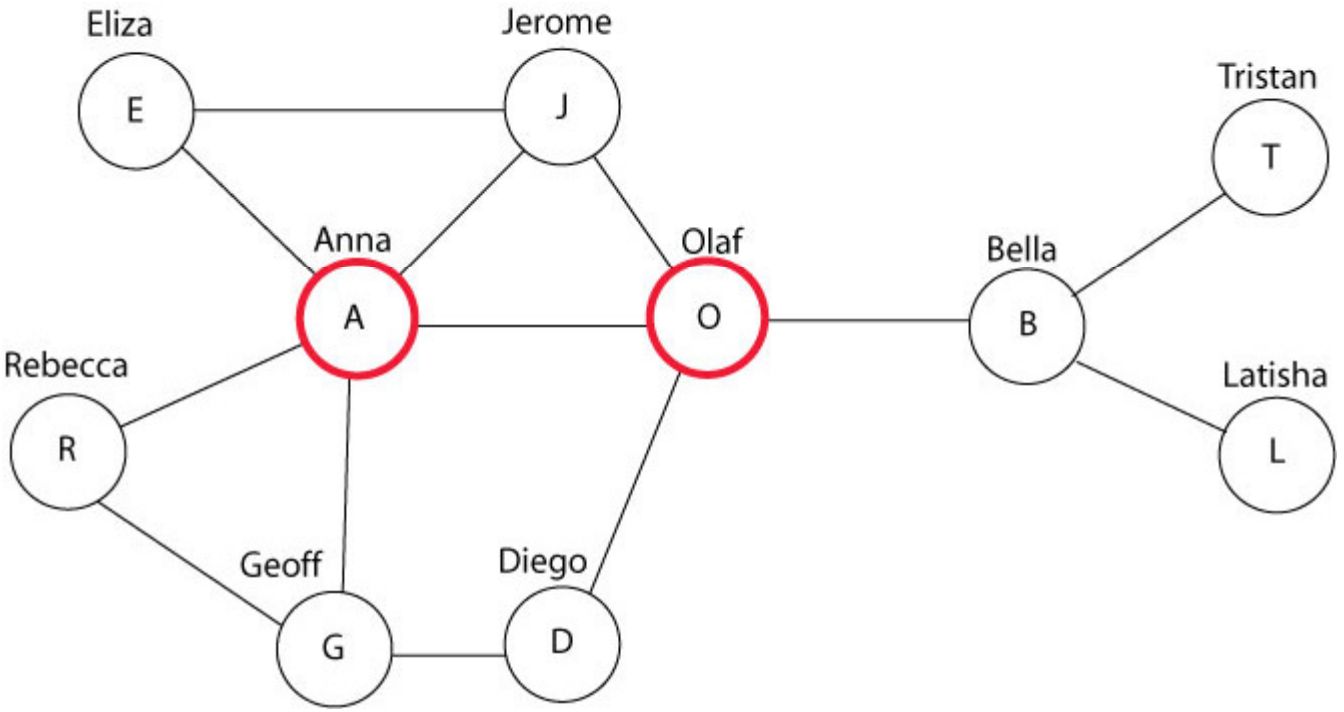


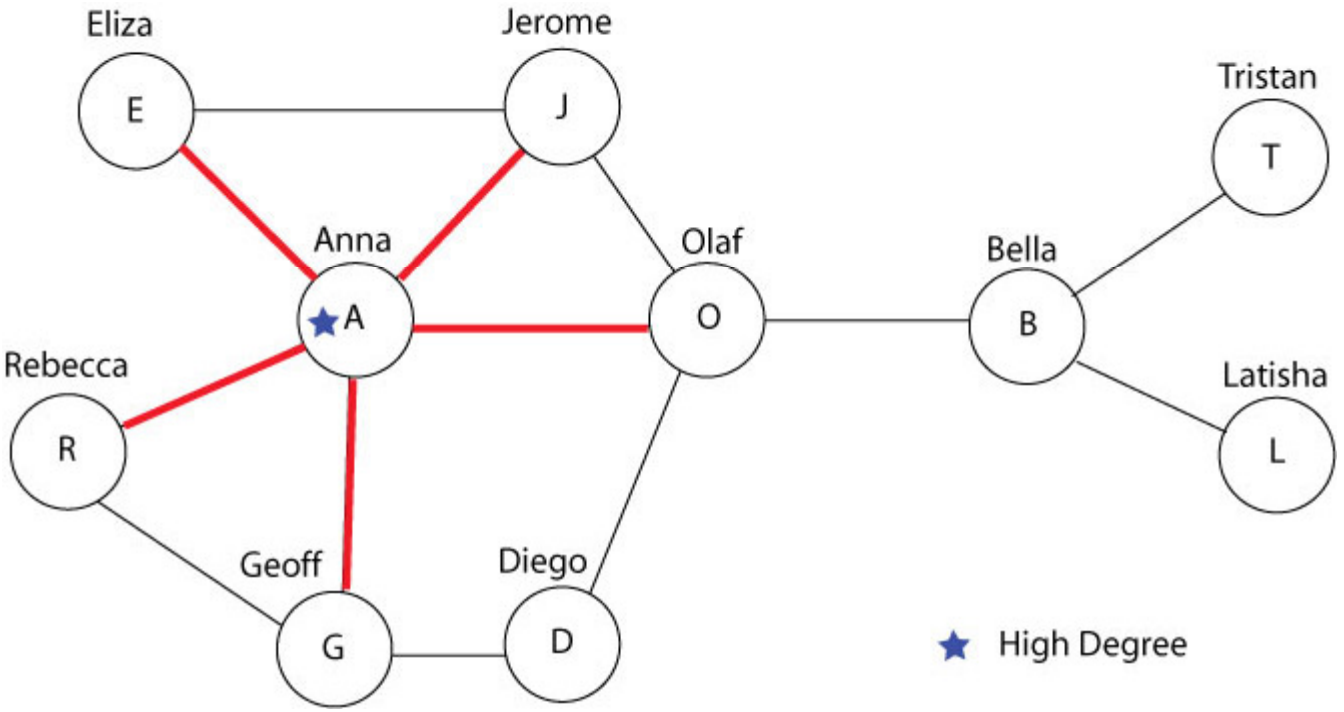
Determining the Leaders



Three Scores of Leadership

- Degree Score
- Betweeness Score
- Closeness Score

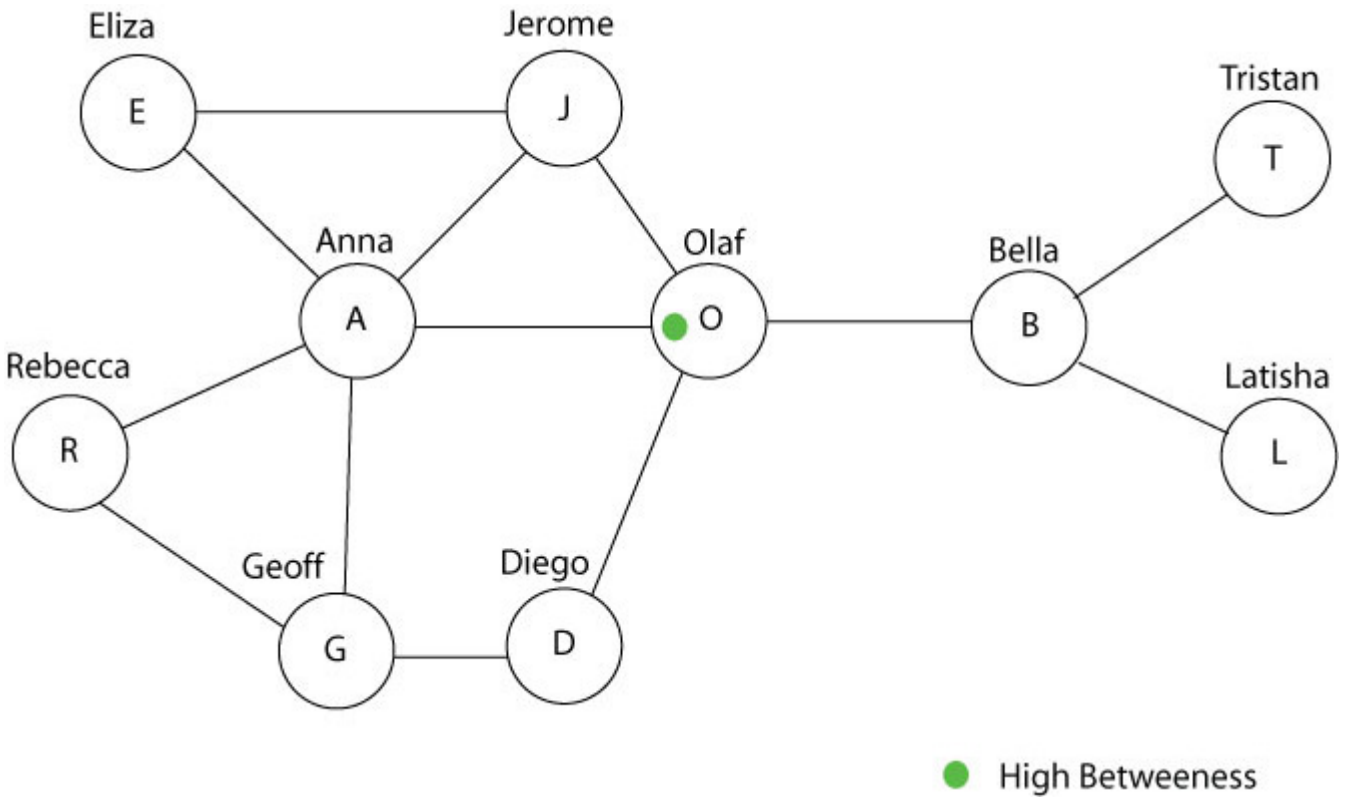
Degree Score



Nodes with High Degree

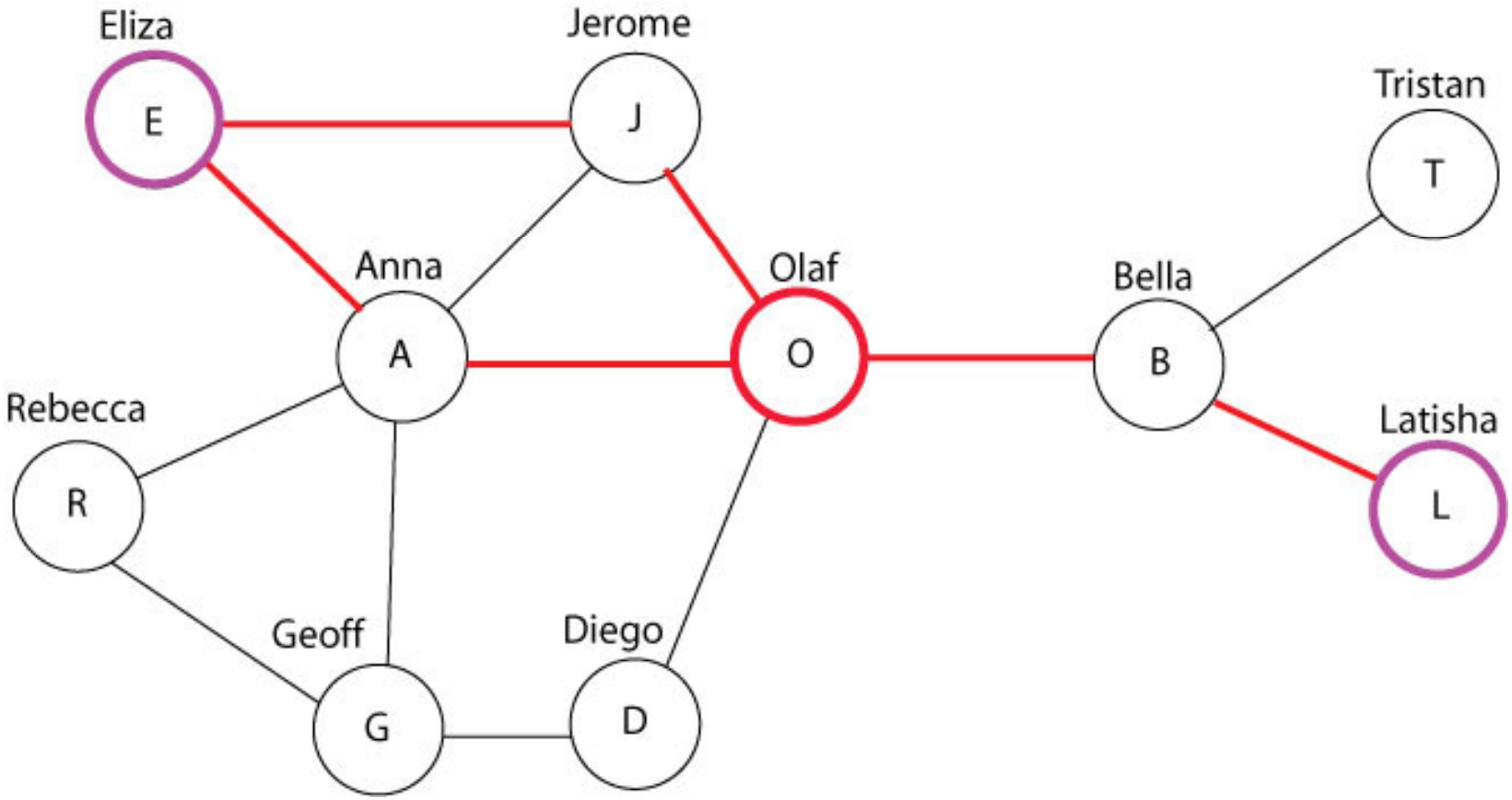
- Well-connected
- Active players in the network
- Often connectors or hubs in the network
- Identified as being deal makers
- Have advantaged positions
- Are not necessarily the most powerful people in the network

Betweeness Score



Betweeness of Olaf with Respect to Eliza and Latisha

- Geodesic Distance: d(E,L) = 4

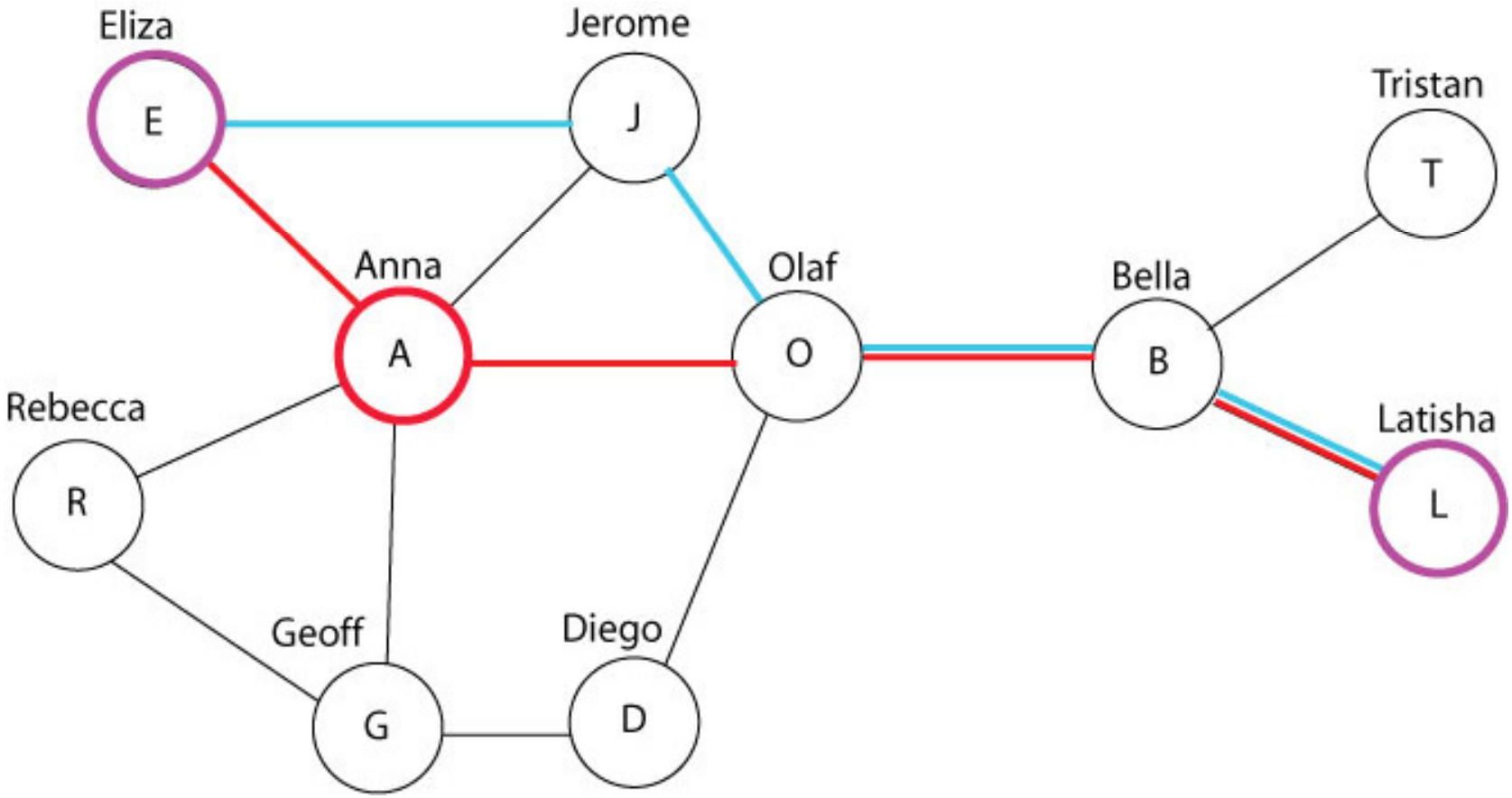


Betweeness of Olaf with Respect to Eliza and Latisha

- Betweeness = #geodesic paths through node/total #geodesic paths
  - Geodesic paths from Eliza to Latisha: EJOBL and EAOBL
  - Geodesic paths from Eliza to Latisha through Olaf: EJOBL and EAOBL
- Olaf's betweeness score with respect to Eliza and Latisha is 1.

Betweeness of Anna with Respect to Eliza and Latisha

- Geodesic Distance: d(E,L) = 4



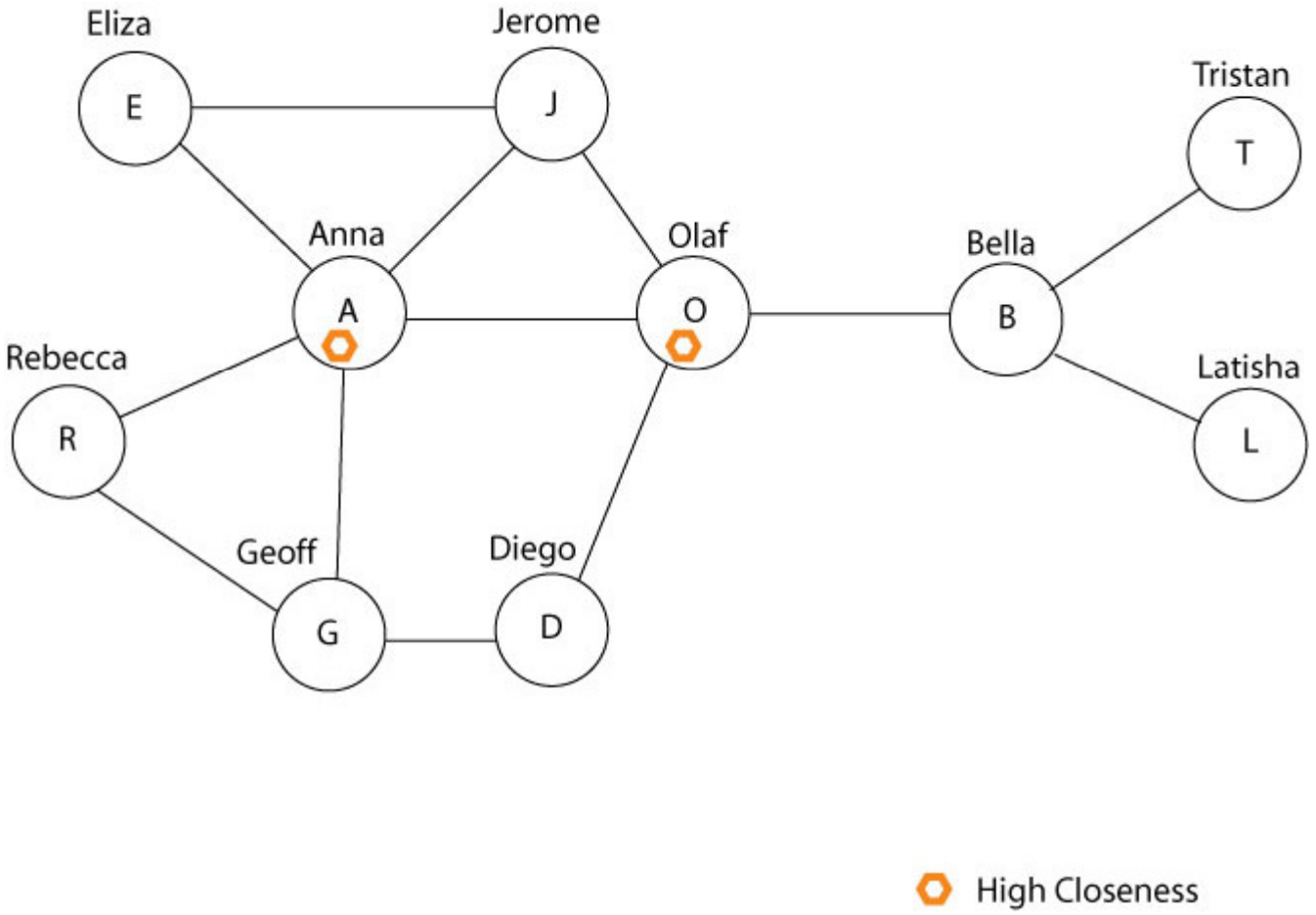
Betweeness of Anna with Respect to Eliza and Latisha

- Betweeness = #geodesic paths through node/total #geodesic paths
  - Geodesic paths from Eliza to Latisha: EJOBL and EAOBL
  - Geodesic paths from Eliza to Latisha through Anna: EAOBL
- Anna's betweeness score with respect to Eliza and Latisha is 1/2.

Nodes with High Betweeness

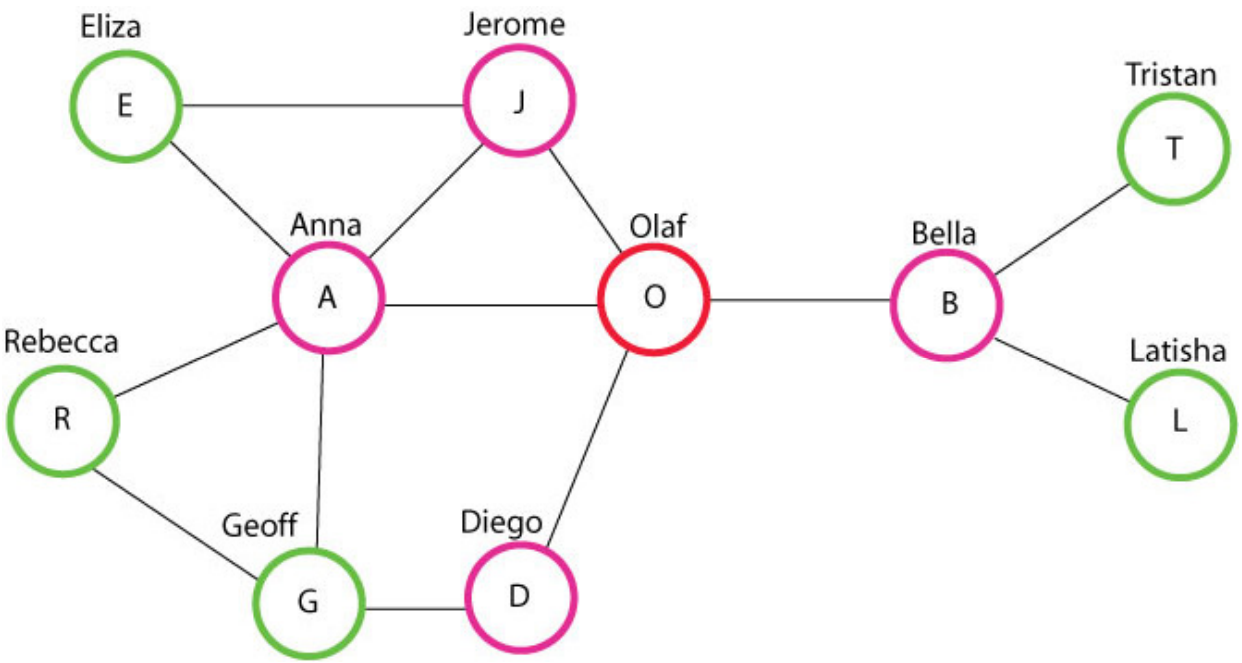
- Hold a favored or powerful position within the network
- Represent a single point of failure (take this person out of the network and the ties between cliques are severed)
- Have a greater amount of influence over what happens in a network

Closeness Score



Closeness of Olaf

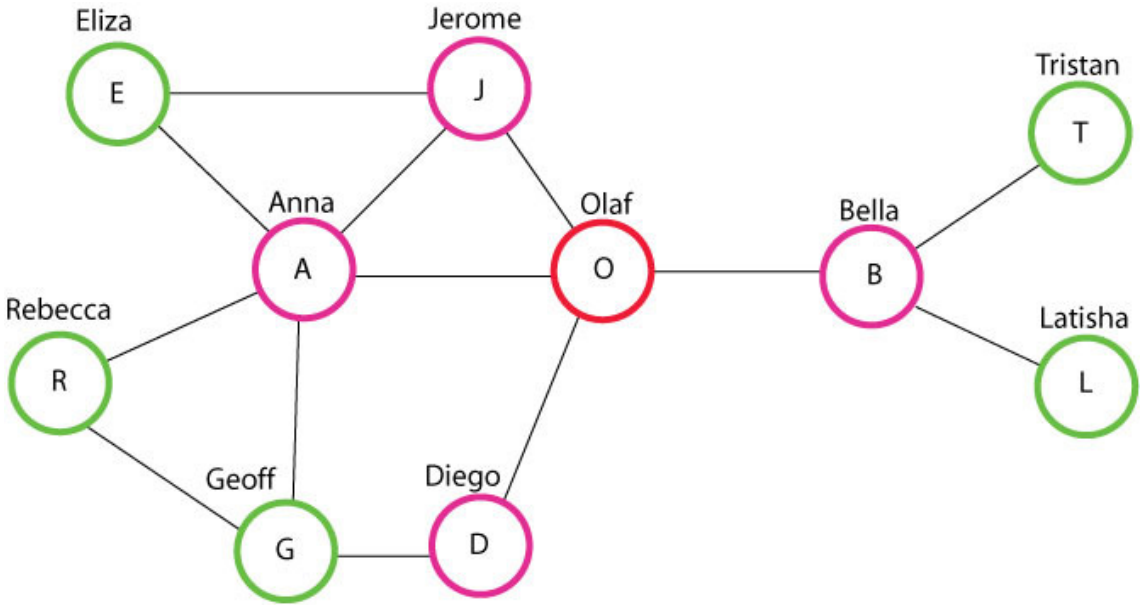
- d(O,B) = 1
- d(O,T) = 2
- d(O,L) = 2
- d(O,A) = 1
- d(O,J) = 1
- d(O,D) = 1
- d(O,G) = 2
- d(O,E) = 2
- d(O,R) = 2



Closeness of Olaf

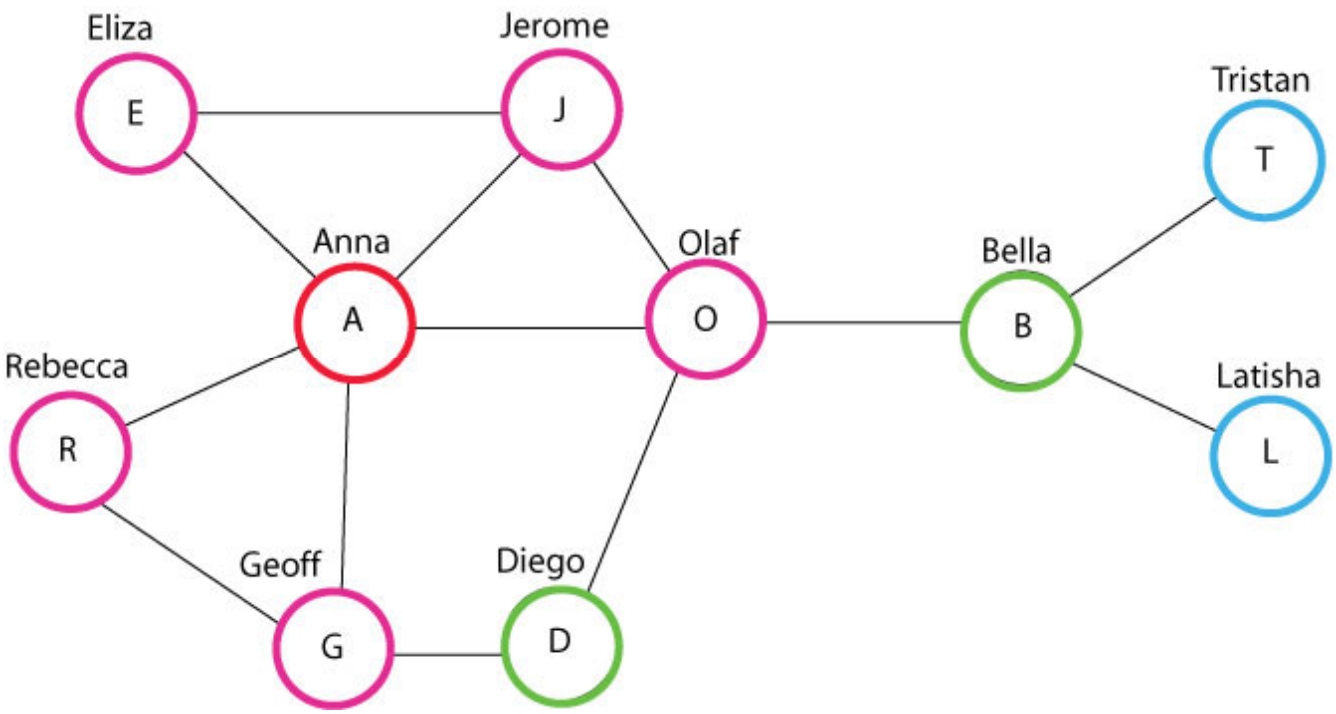
- d(O,B) = 1
- d(O,T) = 2
- d(O,L) = 2
- d(O,A) = 1
- d(O,J) = 1
- d(O,D) = 1
- d(O,G) = 2
- d(O,E) = 2
- d(O,R) = 2

- Sum the reciprocals:
  - 1/1 + 1/2 + 1/2 + 1/1 + 1/1 + 1/1 + 1/2 + 1/2 + 1/2
  - Olaf's closeness score is 6.5.
- 4(1/1) + 5(1/2)



Closeness of Anna

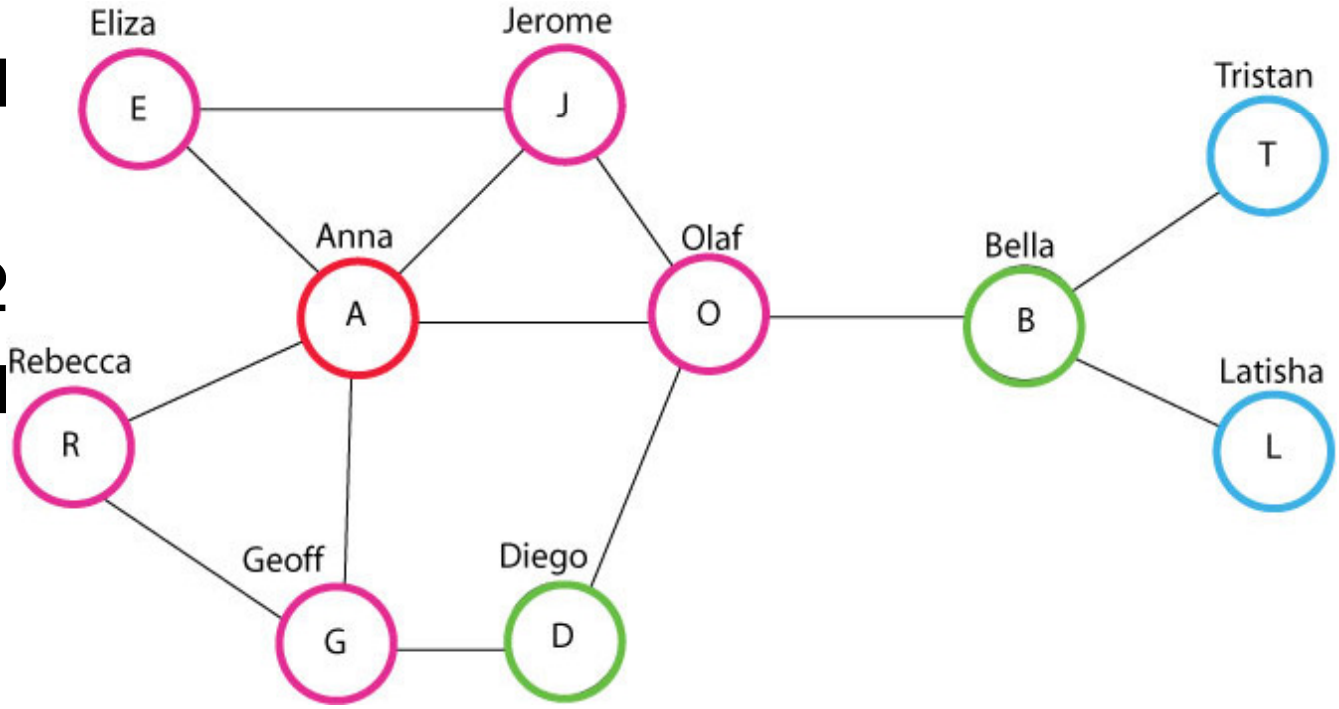
- d(A,B) = 2
- d(A,T) = 3
- d(A,L) = 3
- d(A,O) = 1
- d(A,J) = 1
- d(A,D) = 2
- d(A,G) = 1
- d(A,E) = 1
- d(A,R) = 1



Closeness of Anna

- d(A,B) = 2
- d(A,T) = 3
- d(A,L) = 3
- d(A,O) = 1
- d(A,J) = 1
- d(A,D) = 2
- d(A,G) = 1
- d(A,E) = 1
- d(A,R) = 1

- 5(1/1) + 2(1/2) + 2(1/3)
- Anna's closeness score is 6.66.

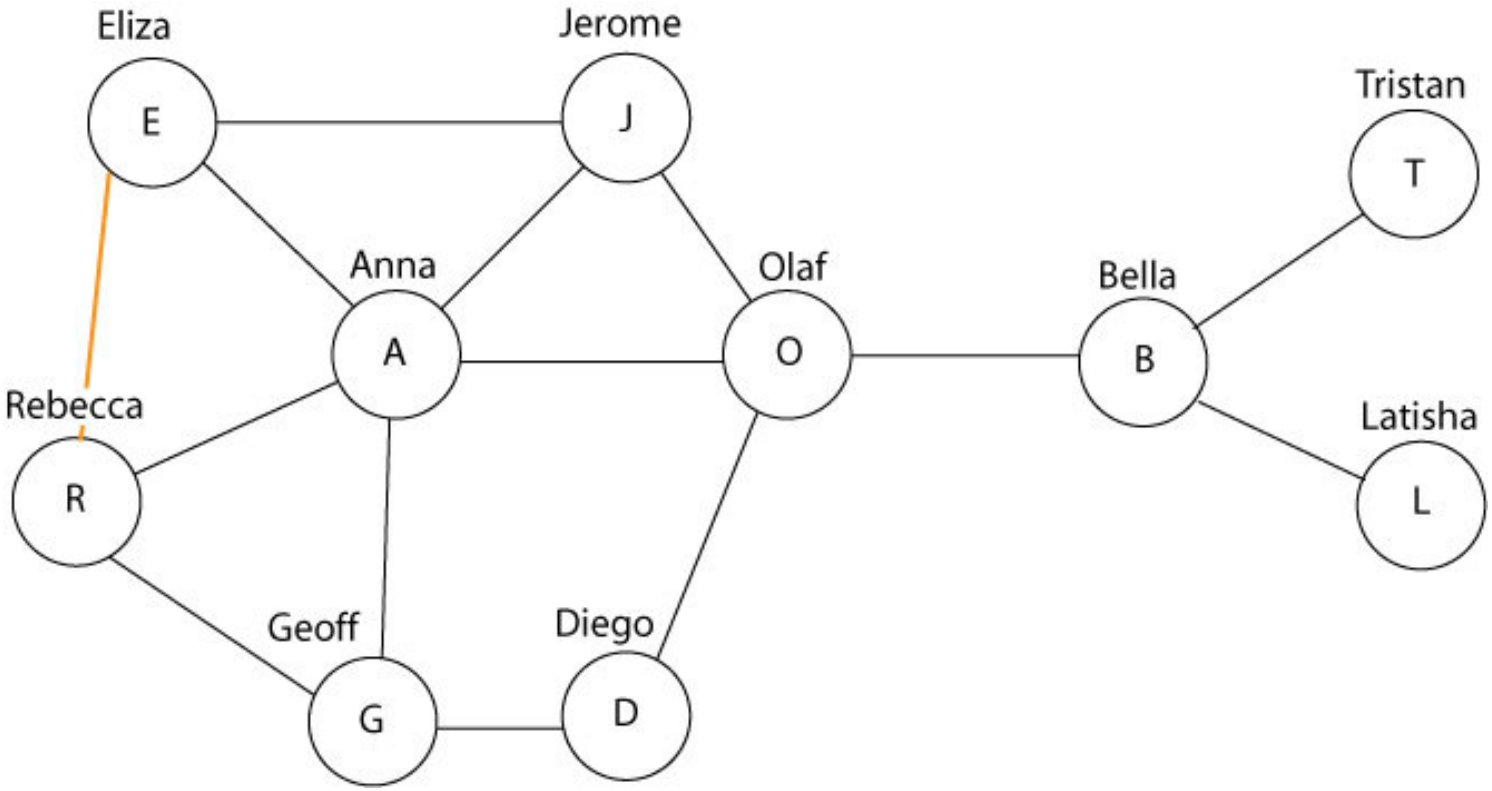


Nodes with High Closeness

- Have quick access to other nodes in the network
- Have a high visibility to what is going on in the network

Connection Probability

- Estimate which edges are missing
- Combine with other information to find key nodes



Successfully Connecting the Dots

- June 7, 2006: Abu Musab al-Zarqawi was killed by bombs dropped by American F-16 fighter jets.
- The key to this mission was identifying and focusing on a node of distance 1 from the most important target.

References

"An Introduction to Social Network Analysis." 3 April 2010. Advanced Systems Group. http://www.fmsasg.com/News/PressRoom/SNA.pdf

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Devlin, Keith, and Gary Lorden. The Numbers Behind NUMB3RS. Penguin Group (USA) Inc., New York, New York, 2007.