Appendix A

User Study

DataViz: Exploring Pathway Visualization

Welcome to the study!

We are conducting a user study about a software tools for biology research at Iowa State University. There are several types of large-scale data that biologists use to understand their organism. Good visualization methods can help biologists become familiar with those data. Although there are existing tools available to biologists, most of them are hard to manipulate or understand. Our objective is to compare different visualization methods for gene expressions and metabolic networks. Your participation is completely voluntary. All of the information you provide will be kept strictly confidential and reported in summary form only. No individuals will be identified, nor will your name be attached to any data. This research may lead to advances that let users perform biology related tasks more efficiently in the future.

DataViz: Exploring Pathway Visualization

Consent form

This form describes a research project. It has information to help you decide whether or not you wish to participate. Research studies include only people who choose to take part—your participation is completely voluntary. Please discuss any questions you have about the study or about this form with the project staff before deciding to participate.

Who is conducting this study?

This study is being conducted by Ike Anyanetu, Megan Wilson, and Nereida Aguilar, who are conducting research in the SPIRE-REU program at Iowa State University, with graduate mentors Preeti Bais, Erin Boggess, and Jesse Walsh, and principal investigator Dr. Julie Dickerson.

Why am I invited to participate in this study?
You are being asked to take part in this study because you are a student, post-Doc or Faculty in the department of Biology or Computer Science, or majored in Bioinformatics and Computational Biology. You should not enter the study if you are under the age of 18.

What is the purpose of this study?

The purpose of this study is to compare different representations of flux data in biological pathways. Flux describes the rate of enzymatic conversions between molecules in metabolic pathways. The metabolic networks in this study are represented as graphs in which the nodes symbolize molecules and the edges show the reactions between these molecules. Reaction directions and magnitudes are indicated by five different visualization techniques.

What will I be asked to do?
If you agree to participate, you will be asked to perform tasks specified by the researcher. The tasks include graph interpretation and usability testing. You will also be asked to complete an exit survey. The expected time to complete the study is 30 minutes.

What are the possible risks and benefits of my participation?
Risks – There are no known risks to participation other than that which is normally associated with typical computer usage. Benefits – There is no direct benefit to participants. However, this research may lead to software and methods that let user perform biology related tasks easier in the future.

How will the information I provide be used?
The information you provide will be used for the following purpose:
-Identify a preferred representation for flux direction and magnitude.

What measures will be taken to ensure the confidentiality of the data or to protect my privacy?
Records identifying participants will be kept confidential to the extent allowed by applicable laws and regulations. Records will not be made publicly available. However, federal government regulatory agencies, auditing departments of Iowa State University, and the ISU Institutional Review Board (a committee that reviews and approves research studies with human subjects) may inspect

and/or copy your records for quality assurance and analysis. These records may contain private information. To ensure confidentiality to the extent allowed by law, the following measures will be taken. You will be assigned a unique identifier code. Anyone outside of the research team will be unable to use the codes to determine a participant's name or other information. If the results are published, your identity will remain confidential. All records will be stripped of any personal identification information and kept in a restricted access lab within a locked office. The record linking the name and the code will be kept in a restricted access computer, and only the research team can access it.

Will I incur any costs from participating or will I be compensated?
There will be no costs for participating in this study, and no compensation be provided.

What are my rights as a human research participant?

Participating in this study is completely voluntary. You may choose not to take part in the study or to stop participating at any time, for any reason, without penalty or negative consequences.

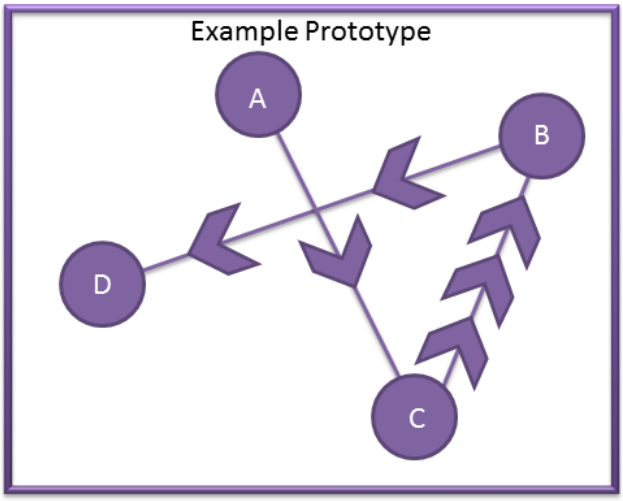
Who can I contact if I have questions or problems?
You are encouraged to ask questions at any time during this study.
• For further information about the study, contact
Ike Anyanetu, ianyanet@iastate.edu
Megan Wilson, mwilson@iastate.edu
Nereida Aguilar, naguilar@iastate.edu or
Dr. Julie Dickerson, julied@iastate.edu

• If you have any questions about the rights of research subjects or research-related injury, please contact the IRB Administrator,
(515) 294-4566, IRB@iastate.edu, or
Director, (515) 294-3115, Office for Responsible Research, 1138 Pearson Hall, Iowa State University, Ames, Iowa 50011.

Consent and Authorization Provisions
Clicking the box below indicates that you voluntarily agree to participate in this study, that the study has been explained to you, that you have been given the time to read the document and that your questions have been satisfactorily answered.

☐**I have read the consent form and agree to willingly participate in this study.**

The following is an example of the type of questions you are going to be answering



In this example the arrows are pointing in the direction of the reaction while the number of arrows is indicative of the flux magnitude.

Each of the graphs in the survey will use a different method to display direction and flux magnitude

*Note this graph format will not be used in the actual survey

i. Between Which two nodes is the edge magnitude greatest?

a. Between nodes A and C
b. Between nodes B and C
c. Between nodes B and D

ii. To which magnitude is this difference between the edge value of A/C and C/B

a. They are about the same
b. 2x
c. 3x
d. 4x

iii. Between edges D-B and C-A which has the greater value?

a. D-B
b. C-A
c. Unable to determine
d. They are about the same

In each of the following examples in which direction are the edges pointing?

iv. B and C

a. From B to C or
b. C to B

v. A and C

a. From A to C or
b. C to A

Instructions

You will be asked a series of questions about five different graphs please go with your first response and answer all questions

Each graph will use a different method to show direction and magnitude, the length of the edge is not a factor in any of the graphs.

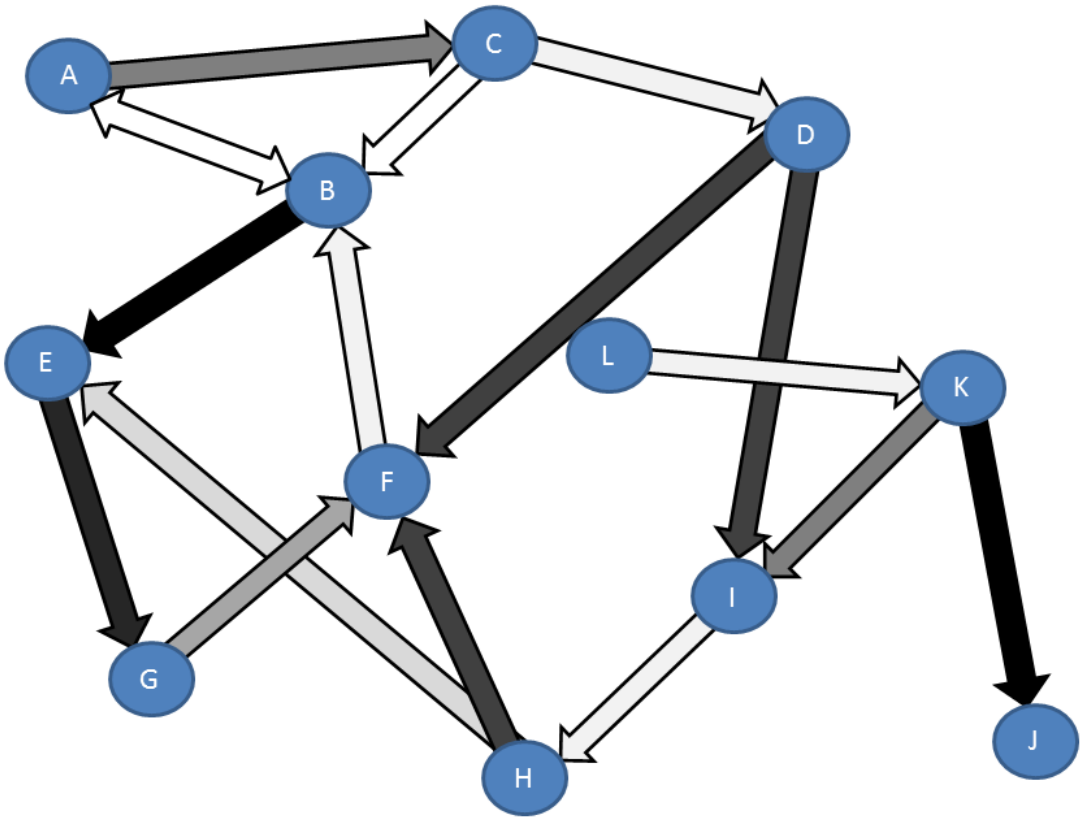
Once you have completed a section you may not return to it.

The magnitude values are approximate.

The order in which the node are listed in question

DataViz: Exploring Pathway Visualization

Use the following graph to answer questions 1 to 6



1. Which of the following edges has the largest magnitude?

- K-J
- Unable to determine
- C-B.
- G-F

2.Between edges A-C and E-G which has the greater value?

- A-C
- E-G
- Unable to determine
- They are about the same

3. Approximately, what is the difference in magnitudes between edges G-F and K-J?

- 4x
- 3x
- 2x
- They are about the same

4.Between nodes F and H, which direction are the edges pointing?

- From H to F
- From F to H

5.Between nodes E and G, which direction are the edges pointing?

- From G to E
- From E to G

6. Which of the following edges is bidirectional?

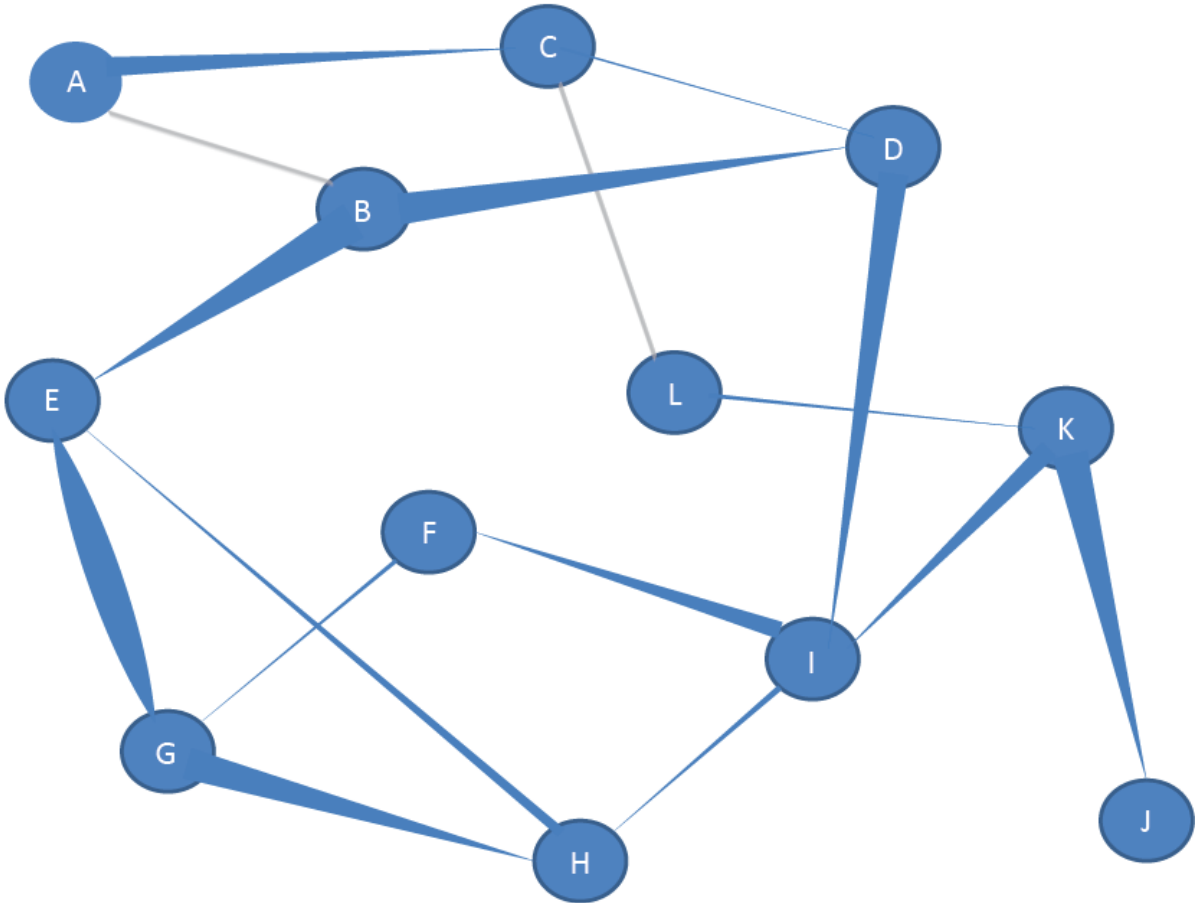
- A-B
- D-F
- B-E
- Cannot be determined

7. Please rank how confident or non-confident you were in distinguishing edge magnitude

1 Not Confident | 2 | 3 | 4 | 5 Very Confident

DataViz: Exploring Pathway Visualization

Please use the following graph to answer questions 1 to 6



1. Between which two nodes is the edge magnitude greatest?

- Between nodes J and K
- Between nodes A and B
- Unable to determine
- Between nodes B and E

2.Between edges G-H and I-F which has a greater value?

- G-H
- I-F
- Unable to determine
- They are about the same

3.What factor is the difference between the magnitudes of edges B-E and K-J?

- 4x
- 2x
- They are about the same
- 3x

4.Between nodes F and I, which direction are the edges pointing?

- From F to I
- From I to F

5.Between nodes G and H, which direction are the edges pointing?

- From H to G
- From G to H

6. Which of the following edges is bidirectional?

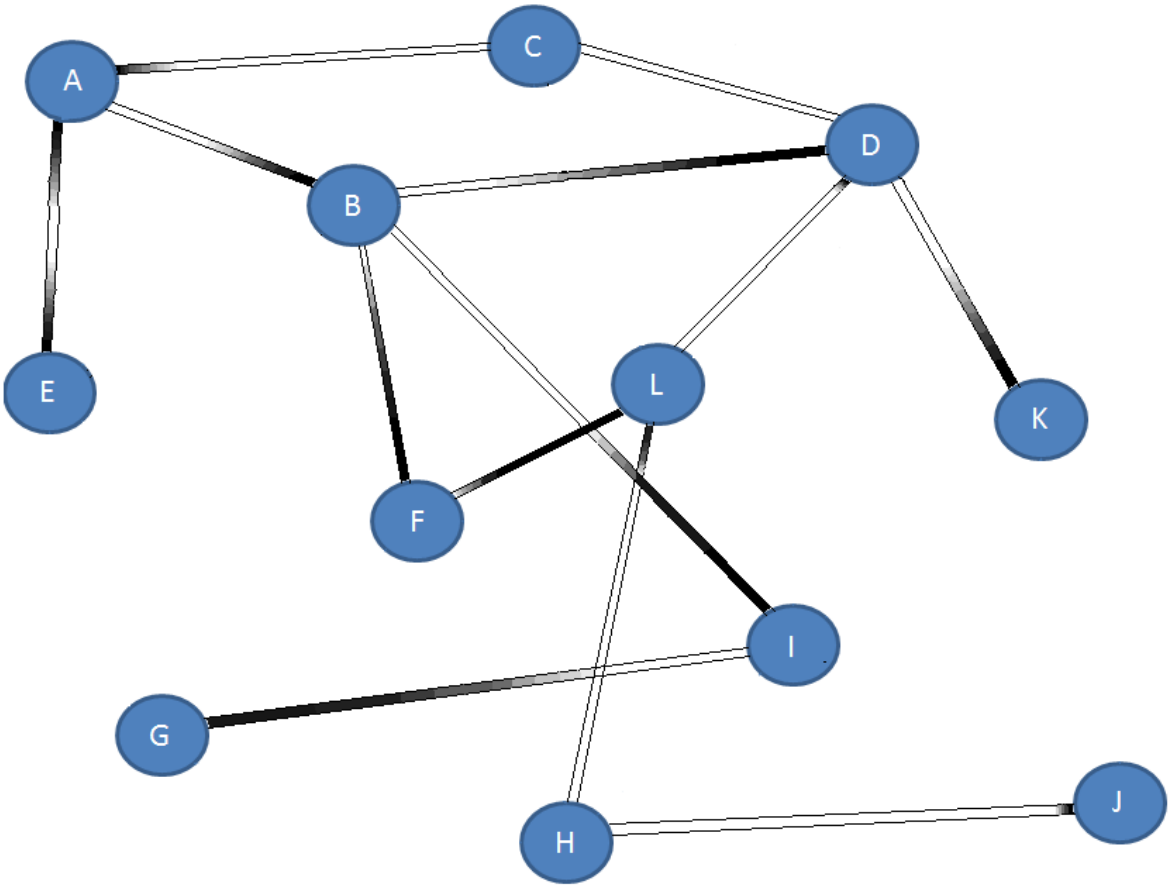
- E-G
- F-G
- C-L
- Cannot be determined

7. Please rank how confident or non-confident you were in distinguishing edge magnitude

- 1 Not Confident
- 2
- 3
- 4
- 5 Very Confident

DataViz: Exploring Pathway Visualization

Please use the following graph to answer question 1 to 6



1. Between which two nodes is the edge magnitude greatest?

- Between nodes H and J
- Unable to determine
- Between nodes A and E
- Between nodes D and B

2.Between edges L-F and G-I which has a greater value?

- L-F
- G-I
- Unable to determine
- They are about the same

3.What factor is the difference between the magnitudes of edges A-B and B-F?

- 4x
- 2x
- 3x
- They are about the same

4.Between nodes B and F, which direction are the edges pointing?

- From B to F
- From F to B

5.Between nodes G and I, which direction are the edges pointing?

- From G to I
- From I to G

6.Which of the following edges is bidirectional?

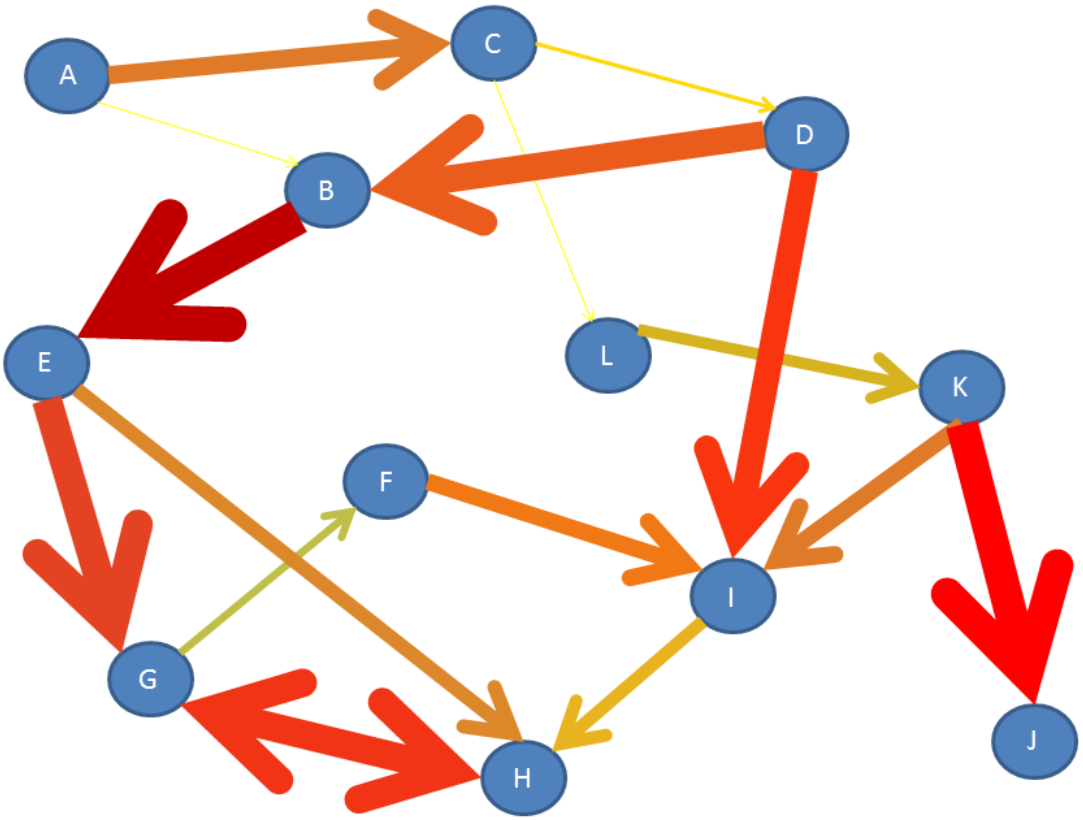
- A-C
- C-D
- A-E
- Cannot be determined

7.Please rank how confident or non-confident you were in distinguishing edge magnitude

- 1 Not Confident
- 2
- 3
- 4
- 5 Very Confident

DataViz: Exploring Pathway Visualization

Please use the following graph to answer question 1 to 6



1. Between which two nodes is the edge magnitude greatest?

- Unable to determine
- Between nodes C and D
- Between nodes D and I
- Between nodes E and B

2.Between edges D-I and D-B which has a greater value?

- D-I
- D-B
- Unable to determine
- They are about the same

3.What factor is the difference between the magnitudes of edges B/E and D/I?

- They are about the same
- 2x
- 3x
- 4x

4.Between nodes E and H, which direction are the edges pointing?

- From H to E
- From E to H

5. Between nodes E and G, which direction are the edges pointing?

- From E to G
- From G to E

6.Which of the following edges is bidirectional?

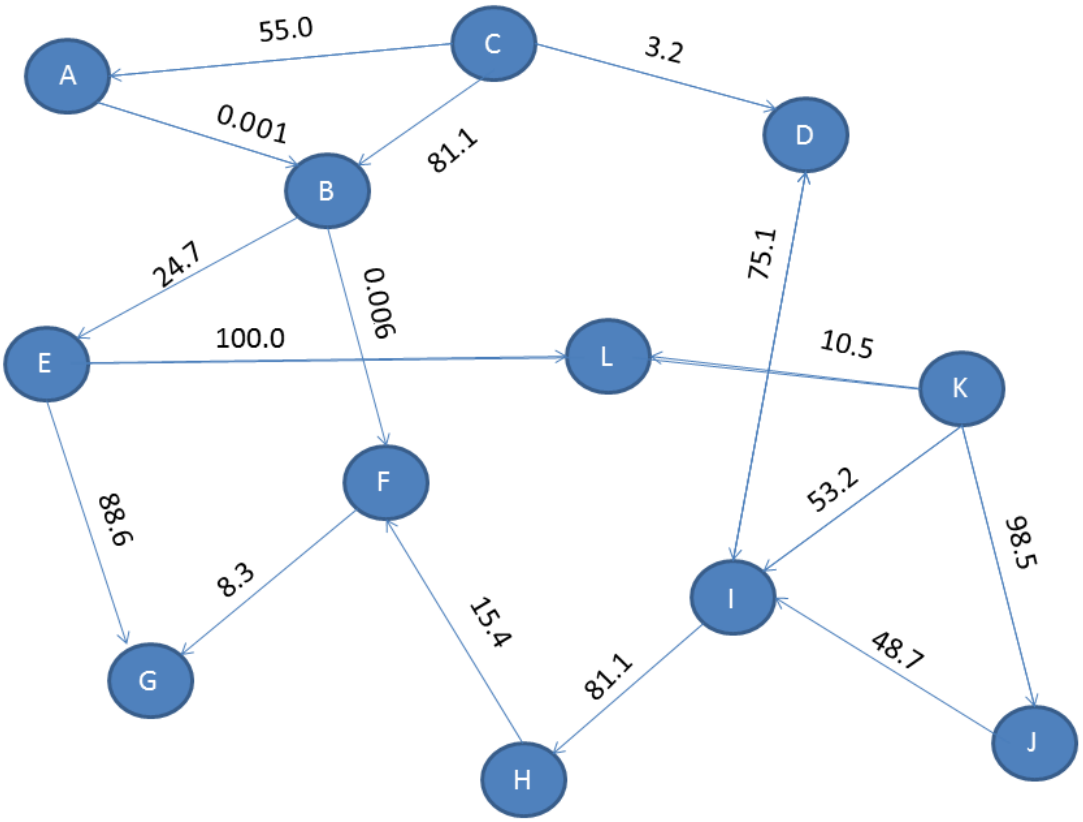
- D-B
- G-H
- F-I
- Cannot be determined

7.Please rank how confident or non-confident you were in distinguishing edge magnitude

1 Not Confident | 2 | 3 | 4 | 5 Very Confident

DataViz: Exploring Pathway Visualization

Please use the following Graph to answer question 1 to 6



1.Between which two nodes is the edge magnitude greatest?

- Between nodes F and B
- Unable to determine
- Between nodes D and I
- Between nodes E and L

.Between H-I and E-B which edge has a greater magnitude?

- H-I
- E-B
- Unable to determine
- They are about the same

3.What factor is this difference between the magnitudes of edges B/E and D/I?

- 4x
- 3x
- 2x
- They are about the same

4.Between nodes H and F, which direction are the edges pointing?

- From F to H
- From H to F

5.Between the nodes E to G, which direction are the edges pointing?

- From E to G
- From G to E

6.Which of the following edges is bidirectional?

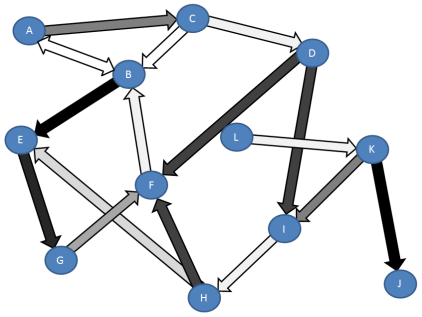
- D-I
- E-L
- J-I
- Cannot be determined

7.Please rank how confident or non-confident you were in distinguishing edge magnitude

1 Not Confident | 2 | 3 | 4 | 5 Very Confident

DataViz: Exploring Pathway Visualization

Graph 1



Please evaluate how easy it was to determine edge direction for Graph 1

1 2 3 4 5 6 7 8 9 10

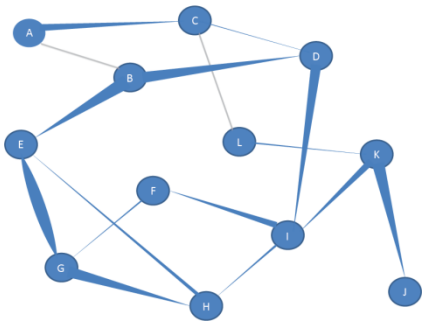
Very Easy — Very Difficult

Please evaluate how easy it was to determine edge magnitude for Graph 1

1 2 3 4 5 6 7 8 9 10

Very Easy — Very Difficult

Graph 2



Please evaluate how easy it was to determine edge direction for Graph 2

1 2 3 4 5 6 7 8 9 10

Very Easy — Very Difficult

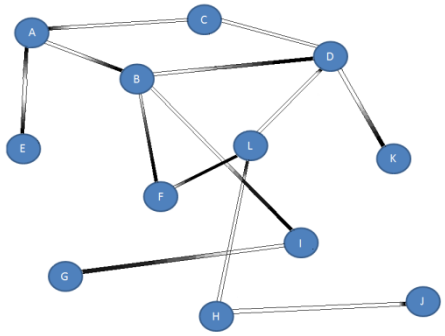
Please evaluate how easy it was to determine edge magnitude for Graph 2

1 2 3 4 5 6 7 8 9 10

Very Easy

Very Difficult

Graph 3



Please evaluate how easy it was to determine edge direction for Graph 3

1 2 3 4 5 6 7 8 9 10

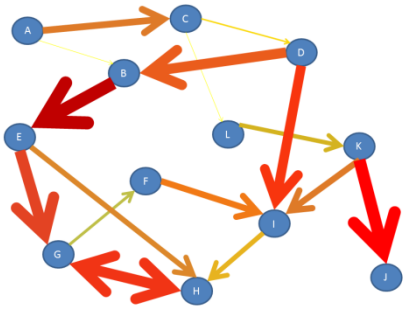
Very Easy — Very difficult

Please evaluate how easy it was to determine edge magnitude for Graph 3

1 2 3 4 5 6 7 8 9 10

Very Easy — Very Difficult

Graph 4



Please evaluate how easy it was to determine edge direction for Graph 4

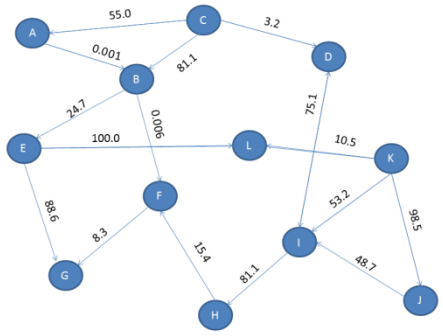
1 2 3 4 5 6 7 8 9 10

Very Easy — Very Difficult

Please evaluate how easy it was to determine edge magnitude for Graph 4

1 (Very Easy) 2 3 4 5 6 7 8 9 10 (Very Difficult)

Graph 5



Please evaluate how easy it was to determine edge direction for Graph 5

1 (Very Easy) 2 3 4 5 6 7 8 9 10 (Very Difficult)

Please evaluate how easy it was to determine edge magnitude for Graph 5

1 (Very Easy) 2 3 4 5 6 7 8 9 10 (Very Difficult)

Which two graphs did you find the most useful and why?

Which graph did you find the hardest to use and why?

If you had to pick one layout, which one would you choose and why?

DataViz: Exploring Pathway Visualization

What, if any visualization programs have you used before? Select all that apply:

	Never	Daily	Weekly	Monthly	Yearly
Cytoscape					
VizANT					
PathCase					
Other					

Other (Please List the Software)

What is your major/department?

How familiar are you with biological pathways?

1 Not Familiar 2 3 4 5 6 7 8 9 10 Very Familiar

Please Select your current Degree Level:

Select your gender:

	Female	Male
Gender		

Thank you for taking our survey.