

# Evaluating Effects of Background Stories on Graph Perception

## Supplementary Material: Experimental Graph Data Sets

### 1 Introduction

In this study, we conducted three experiments (Ex1, Ex2, and Ex3) to evaluate the effects of background stories on graph perception. We prepared 12 real-world graph data sets with background stories for the three experiments. The participants were randomly divided into two groups. One group of participants, called FBSers, were allowed to read the background stories of the graphs during the experiments. The other group, called UBSers, did not read the stories throughout the experiments. In Ex2, the participants were asked to answer preset objective questions. Each question inquired about a specific case of the three types of graph structures, namely high degree, community, and bridge structures, in the 12 graphs.

This supplementary material provides a detailed description of the 12 graph data sets, background stories, and objective questions. We first provide a table to summarize the basic information of the graph data sets. We then provide an overview of objective questions. Last, we detail the background story, objective questions, graph visualizations, and references of each graph data set.

### 2 Overview of Graph Data Sets

In this section, we provide the basic information of the 12 graph data sets. Information in Table 1 is ordered by data set ID. GD1 and GD2 are the data sets for training.

**Table 1:** Descriptions of graph data sets. The number of nodes and edges were obtained using the TULIP software [1]

| Graph Data Set ID | Graph Data Set Name   | Graph Type            | Number of Nodes | Number of Edges |
|-------------------|---|-----------------------|-----------------|-----------------|
| GD1               | Co-appearance network of characters in <i>Les Misérables</i> (for training) | Co-appearance Network | 77              | 254             |
| GD2               | Animal social network of bottlenose dolphins (for training)                 | Animal Network        | 62              | 159             |
| GD3               | Friendship network of members of the Zachary's karate club                  | Friendship Network    | 34              | 78              |
| GD4               | Relationship network of characters in <i>Game of Thrones</i>                | Relationship Network  | 107             | 352             |
| GD5               | Friendship network of the Transatlantic Industries (TI) baseball team       | Friendship Network    | 13              | 37              |
| GD6               | Games schedule network of American college football                         | Sport Network         | 115             | 615             |
| GD7               | Social network of employees in a wood-processing facility                   | Social Network        | 24              | 38              |
| GD8               | Network of states and legal bases for divorce                               | Affiliation Network   | 59              | 225             |
| GD9               | Co-purchasing network of political books in the United States               | Co-purchasing Network | 105             | 441             |
| GD10              | Friendship network in a German boys' school class                           | Friendship Network    | 48              | 179             |
| GD11              | Strong political tie network in a midwestern county in the US               | Political Tie Network | 14              | 56              |
| GD12              | Friendship network of the Sharpstone Auto (SA) baseball team                | Friendship Network    | 13              | 39              |

In the experiments, each graph is visualized in a node-link diagram. The diagram is drawn within a rectangle area of  $900 \times 620$  pixels using a white background. A gray circle with a radius of about 8.43 pixels represented a node, a gray line with a width of about 2.5 pixels represented an edge, and the graph layout was generated by the Fast Multipole Embedder algorithm. We use four metrics, namely edge crossings, edge crossings angle and angular resolution (deviation), and density, to quantitatively measure the readability of the visualization result of each graph data set. The metrics of edge crossings, edge crossings angle and angular resolution (deviation) are calculated by using the Readability.js [2][3]. The density metric is calculated by using the method mentioned in [4]. The measurement results are shown in Table 2.

**Table 2:** Readability measurement results of graph visualizations

| Graph Data Set ID | Graph Data Set Name   | Edge crossings | Edge crossing angle | Angular resolution (deviation) | Density |
|-------------------|---|----------------|---------------------|--------------------------------|---------|
| GD1               | Co-appearance network of characters in <i>Les Miserables</i> (for training) | 0.941          | 0.725               | 0.657                          | 0.043   |
| GD2               | Animal social network of bottlenose dolphins (for training)                 | 0.961          | 0.742               | 0.663                          | 0.042   |
| GD3               | Friendship network of members of the Zachary's karate club                  | 0.950          | 0.756               | 0.546                          | 0.070   |
| GD4               | Relationship network of characters in <i>Game of Thrones</i>                | 0.917          | 0.733               | 0.611                          | 0.031   |
| GD5               | Friendship network of the Transatlantic Industries (TI) baseball team       | 0.968          | 0.859               | 0.545                          | 0.237   |
| GD6               | Games schedule network of American college football                         | 0.940          | 0.738               | 0.568                          | 0.047   |
| GD7               | Social network of employees in a wood-processing facility                   | 0.993          | 0.742               | 0.653                          | 0.069   |
| GD8               | Network of states and legal bases for divorce                               | 0.778          | 0.749               | 0.613                          | 0.066   |
| GD9               | Co-purchasing network of political books in the United States               | 0.945          | 0.732               | 0.568                          | 0.040   |
| GD10              | Friendship network in a German boys' school class                           | 0.591          | 0.738               | 0.506                          | 0.079   |
| GD11              | Strong political tie network in a midwestern county in the US               | 0.964          | 0.876               | 0.586                          | 0.308   |
| GD12              | Friendship network of the Sharpstone Auto (SA) baseball team                | 0.847          | 0.817               | 0.504                          | 0.250   |

### 3 Overview of Objective Questions in Ex2

In this section, we provide an overview of objective questions that are attached to the graph data sets and related to the identifications of the three types of graph structures in Ex2. Information in Table 3 is clustered by whether the questions include background information or not.

**Table 3:** Objective Questions in Ex2

| With Background (Yes / No) | Graph Data Set ID | Question ID | Objective Question  | Concerned Graph Structure |
|----------------------------|-------------------|-------------|---|---------------------------|
| Yes                        | GD1               | Q1          | The node that represents Jean Valjean is ____ .   | High degree node          |
| Yes                        | GD2               | Q2          | There is/are ____ dolphin group/groups in this graph.                                   | Community                 |
| Yes                        | GD2               | Q3          | Please find at least two dolphins who bridge different dolphin groups: ____ and ____ .  | Bridge                    |
| Yes                        | GD3               | Q4          | The nodes that represent the club president and the club instructor are ____ and ____ . | High degree node          |
| Yes                        | GD3               | Q5          | There is/are ____ faction/factions in the club.   | Community                 |
| Yes                        | GD4               | Q6          | There are ____ houses in this graph.  | Community                 |
| Yes                        | GD5               | Q7          | The node that represents the most popular member of TI team is ____ .                   | High degree node          |
| Yes                        | GD6               | Q8          | There are ____ conferences in the graph.  | Community                 |
| Yes                        | GD7               | Q9          | There is/are ____ employee group/groups in the graph.                                   | Community                 |

| With Background (Yes / No) | Graph Data Set ID | Question ID | Objective Question   | Concerned Graph Structure |
|----------------------------|-------------------|-------------|--|---------------------------|
| Yes                        | GD7               | Q10         | Please find three nodes that may represent employees who bridge different employee groups: ____ , ____ and ____ .        | Bridge                    |
| Yes                        | GD8               | Q11         | The node that represents the legal base allowed by the most states is ____ .   | High degree node          |
| Yes                        | GD9               | Q12         | There is/are ____ kinds of books in the graph.   | Community                 |
| Yes                        | GD10              | Q13         | There are ____ popular students (Popular students are those who have friendship with more than 8 students in the class). | High degree node          |
| Yes                        | GD11              | Q14         | Two nodes that represent political actors who may bridge the support and opposition groups are ____ and ____ .           | Bridge                    |
| Yes                        | GD12              | Q15         | The nodes representing the three important SA players are ____ , ____ and ____ .   | High degree node          |
| No                         | GD1               | Q1          | The highest degree node in the graph is ____ .   | High degree node          |
| No                         | GD2               | Q2          | There is/are ____ community/communities in this graph.   | Community                 |
| No                         | GD2               | Q3          | Please find at least two nodes that bridge different communities: ____ and ____ .  | Bridge                    |
| No                         | GD3               | Q4          | The top 2 highest degree nodes in this graph are ____ and ____ .   | High degree node          |
| No                         | GD3               | Q5          | There is/are ____ community/communities in this graph.   | Community                 |
| No                         | GD4               | Q6          | There are ____ communities in this graph.  | Community                 |
| No                         | GD5               | Q7          | Please find out the highest degree node in the graph: ____ .   | High degree node          |
| No                         | GD6               | Q8          | There are ____ communities in this graph.  | Community                 |
| No                         | GD7               | Q9          | There is/are ____ community/communities in this graph.   | Community                 |
| No                         | GD7               | Q10         | Please find three nodes that may bridge different communities: ____ , ____ and ____ .                                    | Bridge                    |
| No                         | GD8               | Q11         | The highest degree node is ____ .  | High degree node          |
| No                         | GD9               | Q12         | There is/are ____ community/communities in the graph.  | Community                 |
| No                         | GD10              | Q13         | There are ____ high degree nodes (High degree nodes refer to the nodes with degree greater than 8 in this graph).        | High degree node          |
| No                         | GD11              | Q14         | Please find two nodes that may bridge different communities: ____ and ____ .   | Bridge                    |
| No                         | GD12              | Q15         | The top 3 highest degree nodes are ____ , ____ and ____ .  | High degree node          |

#### References

- [1] D. Auber, D. Archambault, R. Bourqui, M. Delest, J. Dubois, A. Lambert, et al. Tulip 5, 2017. doi: 10.1007/978-1-4614-7163-9 315-1
- [2] Greadability.js. <https://github.com/rpgove/greadability/>, 2020.
- [3] R. Gove. It pays to be lazy: Reusing force approximations to compute better graph layouts faster, Nov 2018. doi: 10.31219/osf.io/wgzn5.
- [4] V. Yoghoudjian, D. Archambault, S. Diehl, T. Dwyer, K. Klein, H. C. Purchase, and H.-Y. Wu. Exploring the limits of complexity: A survey of empirical studies on graph visualisation. Visual Informatics, 2(4):264-282, 2018. doi:10.1016/j.visinf.2018.12.006.

## 4 Descriptions of Graph Data Sets

### 4.1 GD1: Co-appearance network of characters in *Les Miserables* (for training)

#### (1) Background story

This case describes the co-appearance network of characters in the novel *Les Miserables*, where nodes represent characters and any pair of co-appearing characters in a chapter is connected by an edge.

*Les Miserables* mainly describes the course of Jean Valjean's attempt to atone for his sins after his release. The characters in the course of atonements mainly include: the bishop of Miriam who accepts Jean Valjean after his release from prison, and the relevant personnel in the church; the people who Jean Valjean comes into contact with after running a business and being elected mayor; the adopted daughter of Jean Valjean, and a friend of her mother Fantine; and the people who take part in Paris people's uprising, etc.

#### (2) Analytical question for UBSers

Q1: The highest degree node in the graph is \_\_\_\_\_ .

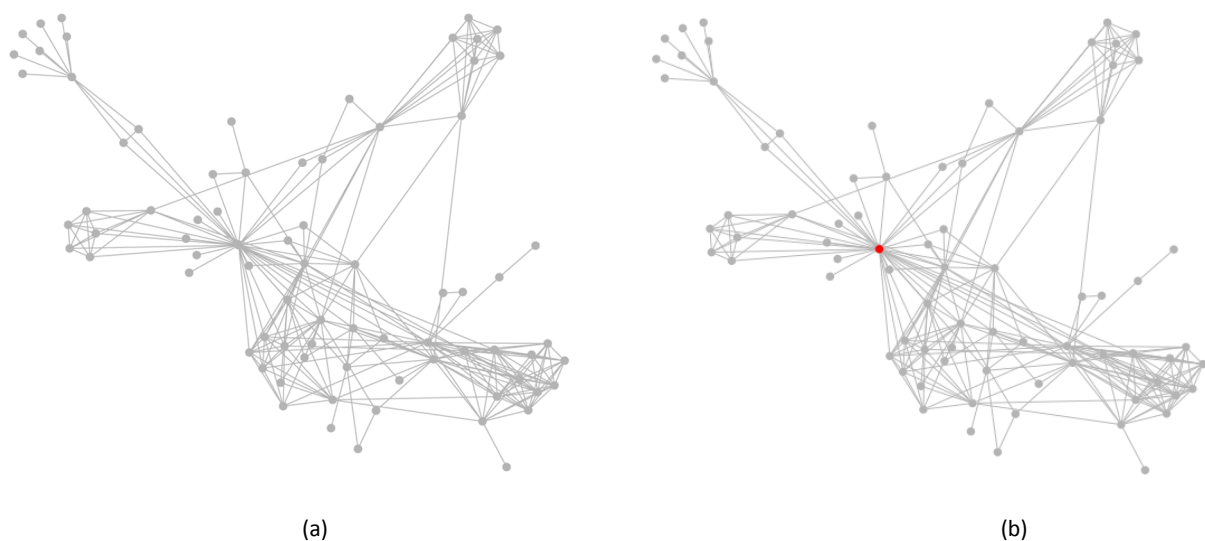
Answer: 11, which is explicitly provided in the story's contents marked with red.

#### (3) Analytical question for FBSers

Q1: The node that represents Jean Valjean is \_\_\_\_\_ .

Answer: 11, which is explicitly provided in the story's contents marked with red.

#### (4) Graph visualizations



**Figure 1.** Graph visualizations of the co-appearance network of characters in the novel *Les Miserables*. (a) Graph visualization with no answer; (b) Graph visualization with answer. The red node represents Jean Valjean.

#### (5) References

- [1] M. E. J. Newman. Mark Newman's data archive. <http://www-personal.umich.edu/~mejn/netdata/>, Accessed on Feb 2020.
- [2] D. E. Knuth. *The Stanford GraphBase: A Platform for Combinatorial Computing*. Reading, MA, USA: Addison-Wesley, 1993.

### 4.2 GD2: Animal social network of bottlenose dolphins (for training)

#### (1) Background story

This case describes a social network of bottlenose dolphins inhabiting in Doubtful Sound, New Zealand. Nodes represent dolphins and edges represent frequent associations between dolphins.

These bottlenose dolphins can be divided into two groups with a total of 62 dolphins. A feature of this network is that each small

group has a "center", which shows that not all individuals have equal positions in this society. Some dolphins play crucial roles in contacting the two groups. They are also important in maintaining the cohesion of the entire dolphin community.

(2) Analytical questions for UBSers

Q2: There is/are \_\_\_\_\_ community/communities in this graph.

- A. 1    B. 2    C. 3    D. 4

Answer: B, which is explicitly provided in the story's contents marked with red.

Q3: Please find at least two nodes that bridge different communities: \_\_\_\_\_ and \_\_\_\_\_ .

Answer: 1, 7, 36, 40, which is implicitly provided in the story's contents marked with blue.

(3) Analytical questions for FBSers

Q2: There is/are \_\_\_\_\_ dolphin group/groups in this graph.

- A. 1    B. 2    C. 3    D. 4

Answer: B, which is explicitly provided in the story's contents marked with red.

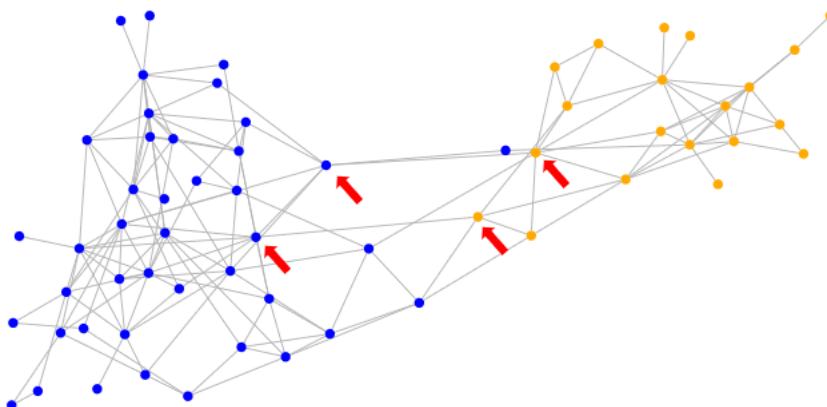
Q3: Please find at least two dolphins who bridge different dolphin groups: \_\_\_\_\_ and \_\_\_\_\_ .

Answer: 1, 7, 36, 40, which is implicitly provided in the story's contents marked with blue.

(4) Graph visualizations



(a)



(b)

**Figure 2.** Graph visualizations of the association network of bottlenose dolphins. (a) Graph visualization with no answers. (b) Graph visualization with answers. Node colors represent different dolphin groups. Red arrows point at dolphins who bridge dolphin groups.

(5) References

- [1] M. E. J. Newman. Mark Newman's data archive. <http://www-personal.umich.edu/~mejn/netdata/>, Accessed on Feb 2020.
- [2] D. Lusseau and M.E.J. Newman. Identifying the role that animals play in their social networks. *Proceedings of the Royal Society of London B: Biological Sciences*, vol. 271, pp. S477–S481, 2004.

### 4.3 GD3: Friendship network of members of the Zachary's karate club

#### (1) Background story

This case describes the friendship network between members of the Zachary's karate club. Nodes represent the club members and edges represent the friendship between members.

There was a conflict between the club president, John A., and the club instructor, Mr. Hi over the price of karate lessons. Mr. Hi, who wished to raise prices, claimed the authority to set his own lesson fees. But John A., who wished to stabilize prices. The officers, led by John A., fired Mr. Hi. The supporters of Mr. Hi retaliated by resigning and forming a new organization headed by Mr. Hi, thus completing the fission of the club.

#### (2) Analytical questions for UBSers

Q4: The top 2 highest degree nodes in this graph are \_\_\_\_\_ and \_\_\_\_\_ .

Answer: 0 and 33, which is explicitly provided in the story's contents marked with red.

Q5: There is/are \_\_\_\_\_ community/communities in this graph.

A. 1   B. 2   C. 3   D. 4

Answer: B, which is explicitly provided in the story's contents marked with orange.

#### (3) Analytical questions for FBSers

Q4: The nodes that represent the club president and the club instructor are \_\_\_\_\_ and \_\_\_\_\_ .

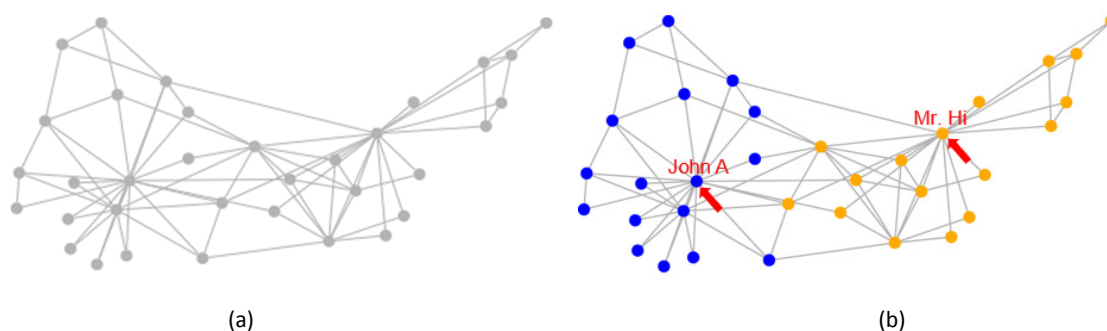
Answer: 0 and 33, which is explicitly provided in the story's contents marked with red.

Q5: There is/are \_\_\_\_\_ faction/factions in the club.

A. 1   B. 2   C. 3   D. 4

Answer: B, which is explicitly provided in the story's contents marked with orange.

#### (4) Graph visualizations



**Figure 3.** Graph visualizations of the friendship network between members of the Zachary's karate club. (a) Graph visualization with no answers. (b) Graph visualization with answers. Node colors represent different factions. Red arrows point at the club president (John A) and the club instructor (Mr. Hi).

#### (5) References

- [1] M. E. J. Newman. Mark Newman's data archive. <http://www-personal.umich.edu/~mejn/netdata/>, Accessed on Feb 2020.
- [2] W. W. Zachary. An information flow model for conflict and fission in small groups. *Journal of Anthropological Research*, vol. 33, no. 4, pp. 452-473, 1977.

#### 4.4 GD4: Relationship network of characters in *Game of Thrones*

##### (1) Background story

This case describes the relationship network of characters in *Game of Thrones*. Nodes represent the characters. Edges represent the relationships between the characters.

The narrative starts at a time of peace, with **all the houses** unified under the rule of King Robert Baratheon, who holds the Iron Throne. Early on, King Robert dies in a hunting accident. As a result, **the war for the Iron Throne breaks out**. Driven by cause or circumstance, the characters from **the houses launch into arduous and intertwined journeys**. Powerful houses mainly include the **honorable Stark family, the pompous Lannisters, the slighted Baratheons, and the exiled Daenerys**.

##### (2) Analytical question for UBSers

Q6: There are \_\_\_\_\_ communities in this graph.

- A. 3    B. 5    C. 7    D. 9

Answer: C, which is implicitly provided in the story's contents marked with blue.

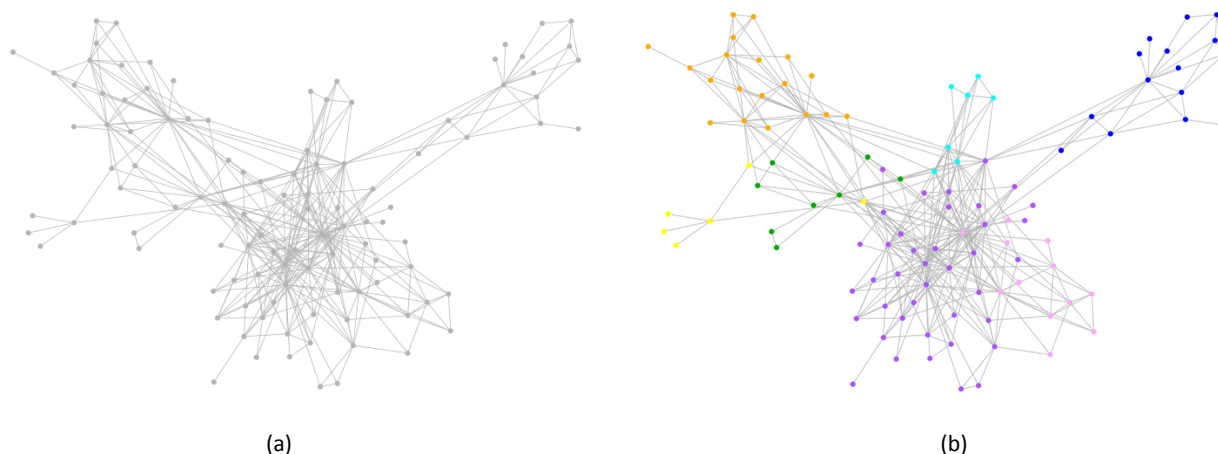
##### (3) Analytical question for FBSers

Q6: There are \_\_\_\_\_ houses in this graph.

- A. 3    B. 5    C. 7    D. 9

Answer: C, which is implicitly provided in the story's contents marked with blue.

##### (4) Graph visualizations



**Figure 4.** Graph visualizations of the relationship network of characters in *Game of Thrones*. (a) Graph visualization with no answer. (b) Graph visualization with answer. Node colors represent different houses.

##### (5) References

- [1] M. Walsh. Melanie Walsh's data archive. <https://github.com/melaniewalsh/sample-social-network-datasets/>, Accessed on Feb 2020.
- [2] A. Beveridge and J. Shan. Network of thrones. *Math Horizons*, vol. 23, no. 4, pp. 18-22, 2016.

#### 4.5 GD5: Friendship network of the Transatlantic Industries (TI) baseball team

##### (1) Background story

This case describes the network of friendships between members of the TI's baseball team. Nodes represent the members of the TI team. Edges represent the friendships between members.

Descriptions of **three popular members** in the TI team are as follows. **Ron is the most popular player** in the team. **Tom is regarded**

as one of TI's best players with seven friends in the team. Frank is coach's son who receives preferential treatment from his father in terms of playing time. Frank has five friends in the team, including Ron and Tom.

(2) Analytical question for UBSers

Q7: Please find out the highest degree node in the graph: \_\_\_\_\_ .

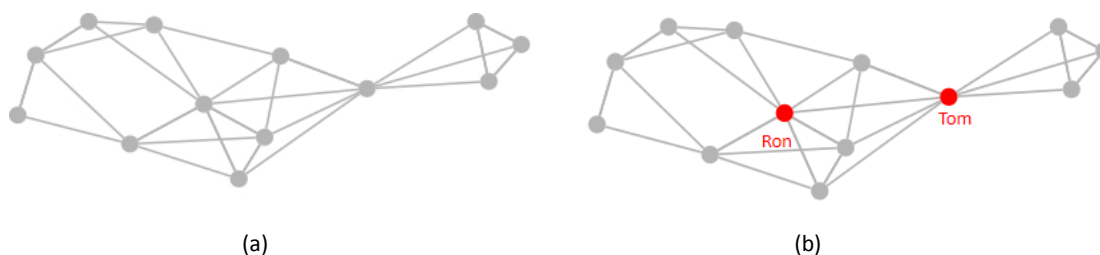
Answer: 0 or 1, which is explicitly provided in the story's contents marked with red.

(3) Analytical question for FBSers

Q7: The node that represents the most popular member of TI team is \_\_\_\_\_ .

Answer: 0 or 1, which is explicitly provided in the story's contents marked with red.

(4) Graph visualizations



**Figure 5.** Graph visualizations of the friendship network of members of the TI's baseball team. (a) Graph visualization with no answer. (b) Graph visualization with answer. The red node represents the most popular member (Ron or Tom).

(5) References

- [1] V. Batagelj and A. Mrvar. Pajek datasets. <http://vlado.fmf.uni-lj.si/pub/networks/data/>, Accessed on Feb 2020.
- [2] G. A. Fine. *With the boys: Little league baseball and preadolescent culture*. University of Chicago Press, 1987.

#### 4.6 GD6: Games schedule network of American college football

(1) Background story

This case describes the games schedule network of American college football in the 2000 season. Nodes represent college teams. Edges represent regular season games between the two teams.

The teams are divided into several conferences. Each conference contains around 8 to 12 teams. Games are more frequent between members of the same conference than between members of different conferences, with teams playing an average of about 7 intra-conference games and 4 inter-conference games. Inter-conference play is not uniformly distributed. Teams that are geographically close to one another but belong to different conferences are more likely to play one another than teams separated by large geographic distances.

(2) Analytical question for UBSers

Q8: There are \_\_\_\_\_ communities in this graph.

A. 3    B. 8    C. 12    D. 16

Answer: C, which is implicitly provided in the story's contents marked with blue.

(3) Analytical question for FBSers

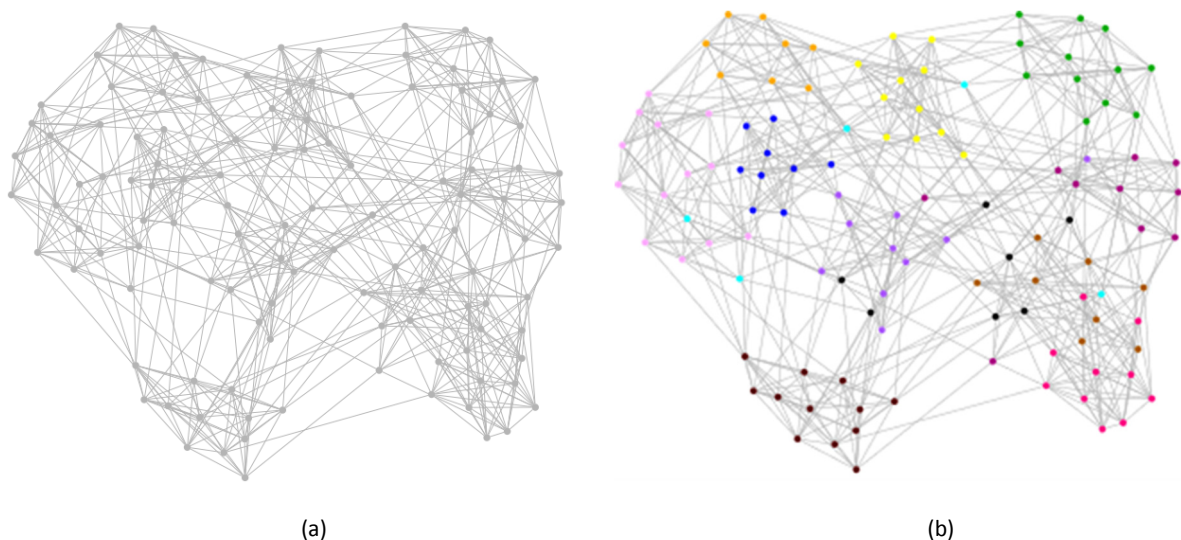
Q8: There are \_\_\_\_\_ conferences in the graph.

A. 3    B. 8    C. 12    D. 16

Answer: C, which is implicitly provided in the story's contents marked with blue.

(4) Graph visualizations





**Figure 6.** Graph visualizations of the games schedule network of American college football. (a) Graph visualization with no answer. (b) Graph visualization with answer. Node colors represent different conferences.

#### (5) References

- [1] M. E. J. Newman. Mark Newman's data archive. <http://www-personal.umich.edu/~mejn/netdata/>, Accessed on Feb 2020.
- [2] M. Girvan and M. E. J. Newman. Community structure in social and biological networks. *Proc. Nat. Acad. Sci. USA*, vol. 99, no. 12, pp. 7821–7826, 2002.

### 4.7 GD7: Social network of employees in a wood-processing facility

#### (1) Background story

This case describes the social network of employees in a wood-processing facility. Nodes represent employees and edges represent communication between employees.

The employees speak Spanish and English. The people in the same language keep close communication and those in different languages communicate scarcely. Among the employees who speak Spanish, Alejandro is good at English. Among the English-speaking employees, Bob can speak Spanish. Among the English-speaking employees, young employees keep little communication with the old ones, except for young Bob who builds a friendship with old Norm due to job duties.

#### (2) Analytical questions for UBSers

Q9: There is/are \_\_\_\_\_ community/communities in this graph.

- A. 1    B. 2    C. 3    D. 4

Answer: C, which is explicitly provided in the story's contents marked with red.

Q10: Please find three nodes that may bridge different communities: \_\_\_\_\_ , \_\_\_\_\_ and \_\_\_\_\_ .

Answer: 8, 9, 13, which is explicitly provided in the story's contents marked with orange.

#### (3) Analytical questions for FBSers

Q9: There is/are \_\_\_\_\_ employee group/groups in the graph.

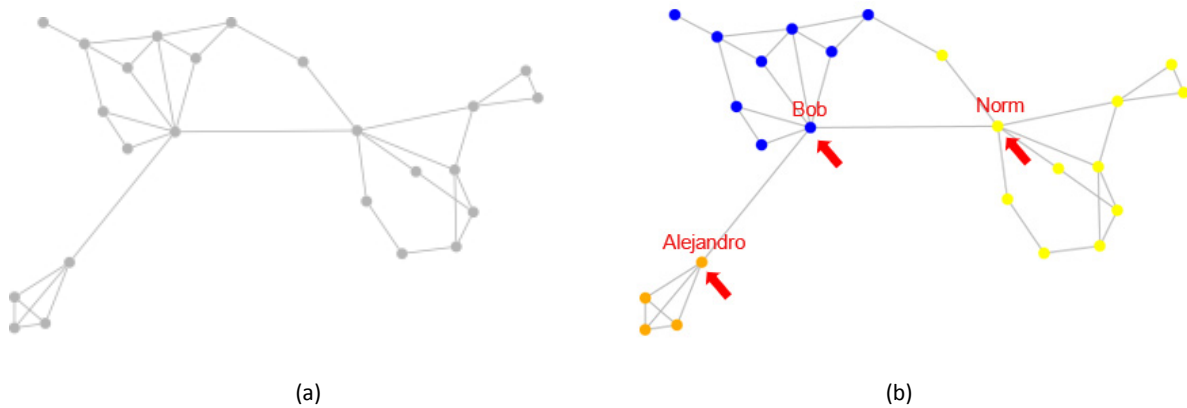
- A. 1    B. 2    C. 3    D. 4

Answer: C, which is explicitly provided in the story's contents marked with red.

Q10: Please find three nodes that may represent employees who bridge different employee groups: \_\_\_\_\_ , \_\_\_\_\_ and \_\_\_\_\_ .

Answer: 8, 9, 13, which is explicitly provided in the story's contents marked with orange.

(4) Graph visualizations



**Figure 7.** Graph visualizations of the communication network of employees in a wood-processing facility. (a) Graph visualization with no answers. (b) Graph visualization with answers. Node colors represent different groups. Red arrows point at the employees who bridge different employee groups.

(5) References

- [1] V. Batagelj and A. Mrvar. Pajek datasets. <http://vlado.fmf.uni-lj.si/pub/networks/data/>, Accessed on Feb 2020.
- [2] W. D. Nooy, A. Mrvar, and V. Batagelj. *Exploratory social network analysis with Pajek*. Cambridge University Press, 2005.

#### 4.8 GD8: Network of states and legal bases for divorce

(1) Background story

This case describes a network consisting of 50 states in the USA and 9 legal bases for divorce. Nodes represent states or legal bases of divorce. Edges represent the association between states and legal bases.

Every state in the USA has its own legal bases of divorce. If a state allows a legal base of divorce, there will be a connection between the state and the legal base in this network.

(2) Analytical question for UBSers

Q11: The highest degree node is \_\_\_\_\_ .

Answer: 50, which is implicitly provided in the story's contents marked with blue.

(3) Analytical question for FBSers

Q11: The node that represents the legal base allowed by the most states is \_\_\_\_\_ .

Answer: 50, which is implicitly provided in the story's contents marked with blue.

(4) Graph visualizations



**Figure 8.** Graph visualizations of the states and legal bases for divorce network in the USA with answer. (a) Graph visualization with no answer. (b) Graph visualization with answer. The red node represents the most allowed legal base.

#### (5) References

- [1] V. Batagelj and A. Mrvar. Pajek datasets. <http://vlado.fmf.uni-lj.si/pub/networks/data/>, Accessed on Feb 2020.
- [2] C. L. DuBois and P. Smyth. Uci network data repository. <http://networkdata.ics.uci.edu/>, Accessed on Feb 2020.

### 4.9 GD9: Co-purchasing network of political books in the United States

#### (1) Background story

This case describes the network of political books of the United States. Nodes represent books about US politics sold by the online bookseller Amazon.com. Edges represent frequent co-purchasing of books by the same buyer.

The books were sold in 2004, which was the year of the presidential election of the United States. Election candidates' political ideologies affected the sale of political books. **The political ideologies of these books mainly included "conservative", "liberal", or "neutral". The books of same political ideology tended to be co-purchased.**

#### (2) Analytical question for UBSers

Q12: There is/are \_\_\_\_\_ community/communities in the graph.

- A. 1    B. 2    C. 3    D. 4

Answer: C, which is explicitly provided in the story's contents marked with red.

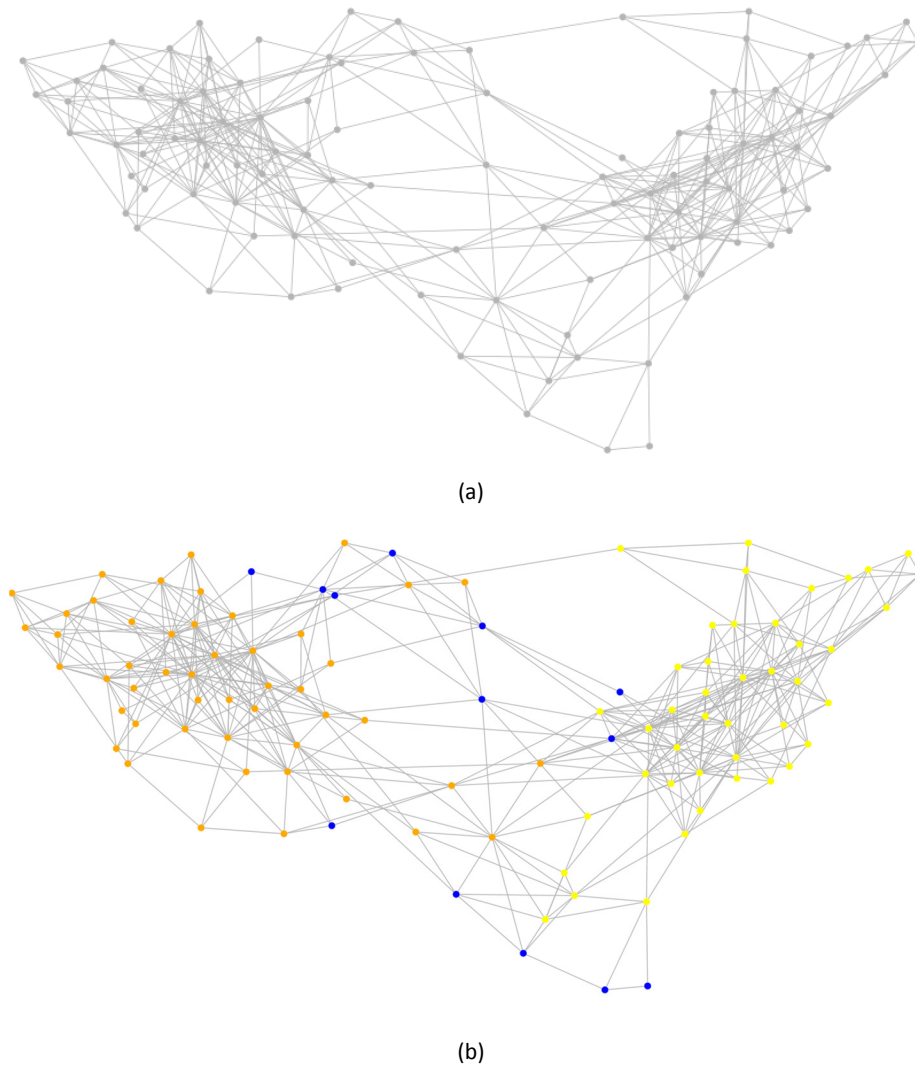
#### (3) Analytical question for FBSers

Q12: There is/are \_\_\_\_\_ kinds of books in the graph.

- A. 1    B. 2    C. 3    D. 4

Answer: C, which is explicitly provided in the story's contents marked with red.

#### (4) Graph visualizations



**Figure 9.** Graph visualizations of the co-purchasing network of political books in the United States. (a) Graph visualization with no answer. (b) Graph visualization with answer. Node colors represent different kinds of books.

#### (5) References

- [1] M. E. J. Newman. Mark Newman's data archive. <http://www-personal.umich.edu/~mejn/netdata/>, Accessed on Feb 2020.
- [2] V. Krebs. Valdis Krebs's web page. <http://www.orgnet.com/>, Accessed on Feb 2020.

### 4.10 GD10: Friendship network in a German boys' school class

#### (1) Background story

This case describes the friendship network in a German boys' school class. Nodes represent pupils and edges represent the friendship between pupils.

In a German boys' school class, the class ranking order has an impact on pupil popularity. Generally, **pupils with good performance are more popular**. But there are **five popular pupils whose positions in the rank ordering are not distinguished**. Four of them often **dominate extracurricular games**. The other pupil **"buys into" friendships with candy**.

#### (2) Analytical question for UBSers

Q13: There are \_\_\_\_\_ high degree nodes (High degree nodes refer to the nodes with degree greater than 8 in this graph).

- A. 4 to 6    B. 7 to 9    C. 10 to 12    D. 13 to 15

Answer: D, which is implicitly provided in the story's contents marked with blue.

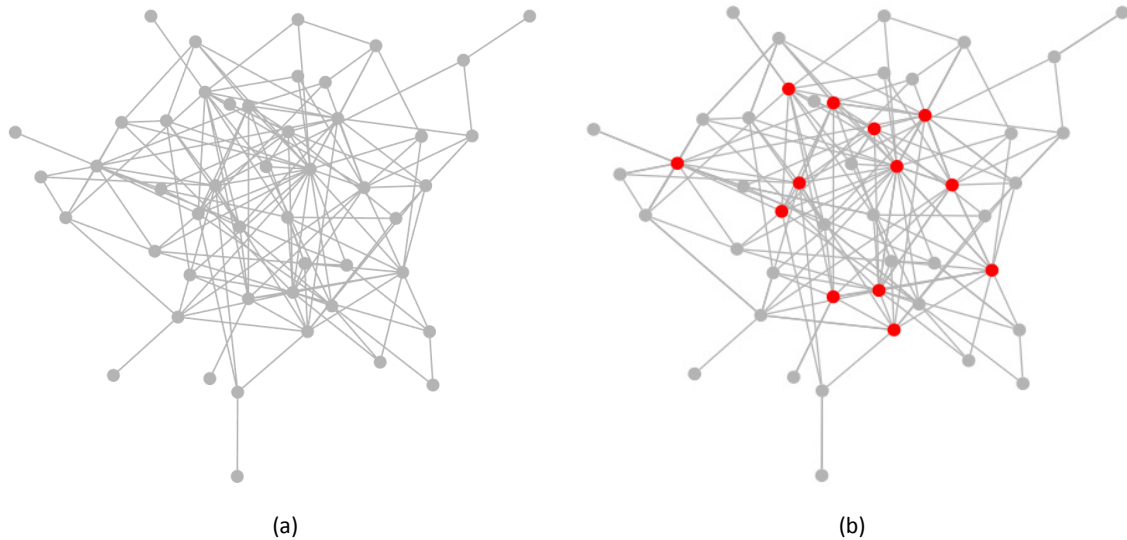
(3) Analytical question for FBSers

Q13: There are \_\_\_\_\_ popular students (Popular students are those who have friendship with more than 8 students in the class).

- A. 4 to 6    B. 7 to 9    C. 10 to 12    D. 13 to 15

Answer: D, which is implicitly provided in the story's contents marked with blue.

(4) Graph visualizations



**Figure 10.** Graph visualizations of the friendship network in a German boys' school class. (a) Graph visualization with no answer. (b) Graph visualization with answer. The red node represents popular students.

(5) References

- [1] M. Bastian, S. Heymann and M. Jacomy. Gephi datasets. <https://github.com/gephi/gephi/wiki/Datasets>, Accessed on Feb 2020.
- [2] R. Heidler, M. Gamper, A. Herz and F. Eßer. Relationship patterns in the 19th century: The friendship network in a German boys' school class from 1880 to 1881 revisited. *Social Networks*, vol. 37, pp. 1-13, 2014.

#### 4.11 GD11: Strong political tie network in a midwestern county in the US

(1) Background story

This case describes the network of strong political ties among the 14 most prominent politicians in a mid-Western County in the U.S. Nodes represent the politicians and edges represent strong political ties.

At present, a federally mandated new jail is to be built, **which is supported by the county executive but opposed by the county auditor**. They are strong political rivals with their own supporters. **The city mayor also disapproves of the construction of the jail, but holds some consistent political positions with the county executive and keeps close political relations.**

(2) Analytical question for UBSers

Q14: Please find two nodes that may bridge different communities: \_\_\_\_\_ and \_\_\_\_\_ .

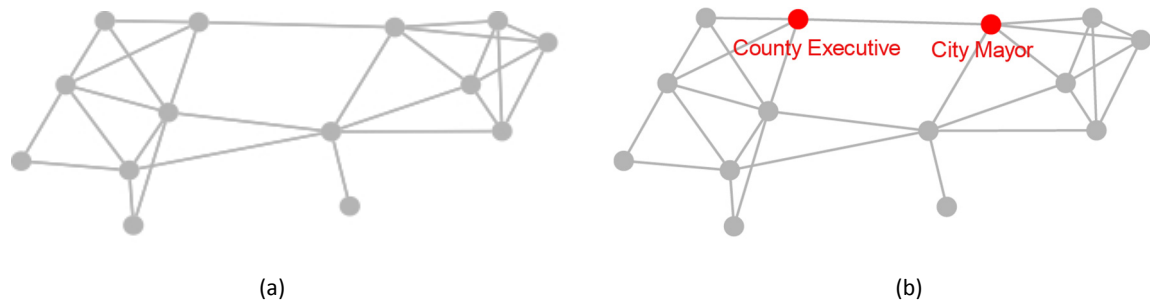
Answer: 0, 12, which is explicitly provided in the story's contents marked with red.

(3) Analytical question for FBSers

Q14: Two nodes that represent political actors who may bridge the support and opposition groups are \_\_\_\_\_ and \_\_\_\_\_ .

Answer: 0, 12, which is explicitly provided in the story's contents marked with red.

(4) Graph visualizations



**Figure 11.** Graph visualizations of the strong political tie network in a mid-Western County in the U.S. (a) Graph visualization with no answers. (b) Graph visualization with answers. The red nodes represent these who bridge the support and opposition groups.

#### (5) References

- [1] V. Batagelj and A. Mrvar. Pajek datasets. <http://vlado.fmf.uni-lj.si/pub/networks/data/>, Accessed on Feb 2020.
- [2] P. Doreian and L. H. Albert. Partitioning political actor networks: Some quantitative tools for analyzing qualitative networks. *Journal of Quantitative Anthropology*, vol. 1, pp. 279-291, 1989.

### 4.12 GD12: Friendship network of the Sharpstone Auto (SA) baseball team

#### (1) Background story

This case describes the network of friendships between members of the SA's baseball team. Nodes represent the members of the SA team and edges represent the friendships between members.

The following provides descriptions of **three popular members** in the SA team. **Justin is seen by many as the best player** in the league. **He is the team leader**. **Harry is the best pitcher** and Justin's best friend. **Whit is a good friend of both Justin and Harry**. **Justin, Harry and Whit constitute the heart and soul of the SA team**.

#### (2) Analytical question UBSers

Q15: The top 3 highest degree nodes are \_\_\_\_\_ , \_\_\_\_\_ and \_\_\_\_\_ .

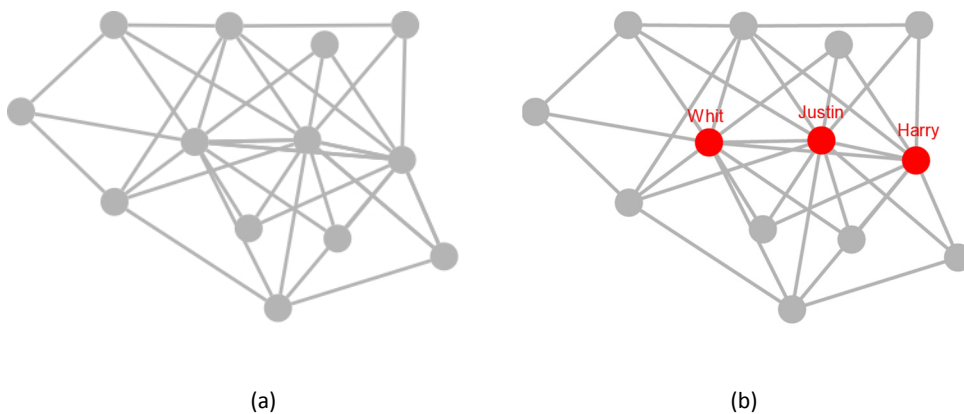
Answer: 0, 1, 2, which is explicitly provided in the story's contents marked with red.

#### (3) Analytical question for FBSers

Q15: The nodes representing the three important SA players are \_\_\_\_\_ , \_\_\_\_\_ and \_\_\_\_\_ .

Answer: 0, 1, 2, which is explicitly provided in the story's contents marked with red.

#### (4) Graph visualizations



**Figure 12.** Graph visualizations of the friendship network in the SA's baseball team. (a) Graph visualization with no answers. (b) Graph visualization with answers. The three important SA players are marked with red.

(5) References

- [1] V. Batagelj and A. Mrvar. Pajek datasets. <http://vlado.fmf.uni-lj.si/pub/networks/data/>, Accessed on Feb 2020.
- [2] G. A. Fine. *With the boys: Little league baseball and preadolescent culture*. University of Chicago Press, 1987.