

Blending machine learning, graph theory and spectral analysis to better understand student engagement and regulation\*

Following the white rabbit of trace data

\* Otherwise known as *Couldn't think of a shorter title*

# This session

Ben Hicks

Charles Sturt University



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Menu:

1. Themes (**Questions, Mapping**)
2. Story (Examples of **Clustering, Spectrums, SNA, *maybe* TDA**)
3. Thinking and talking time
4. Play time

# This session

Me, Ben Hicks

Menu:

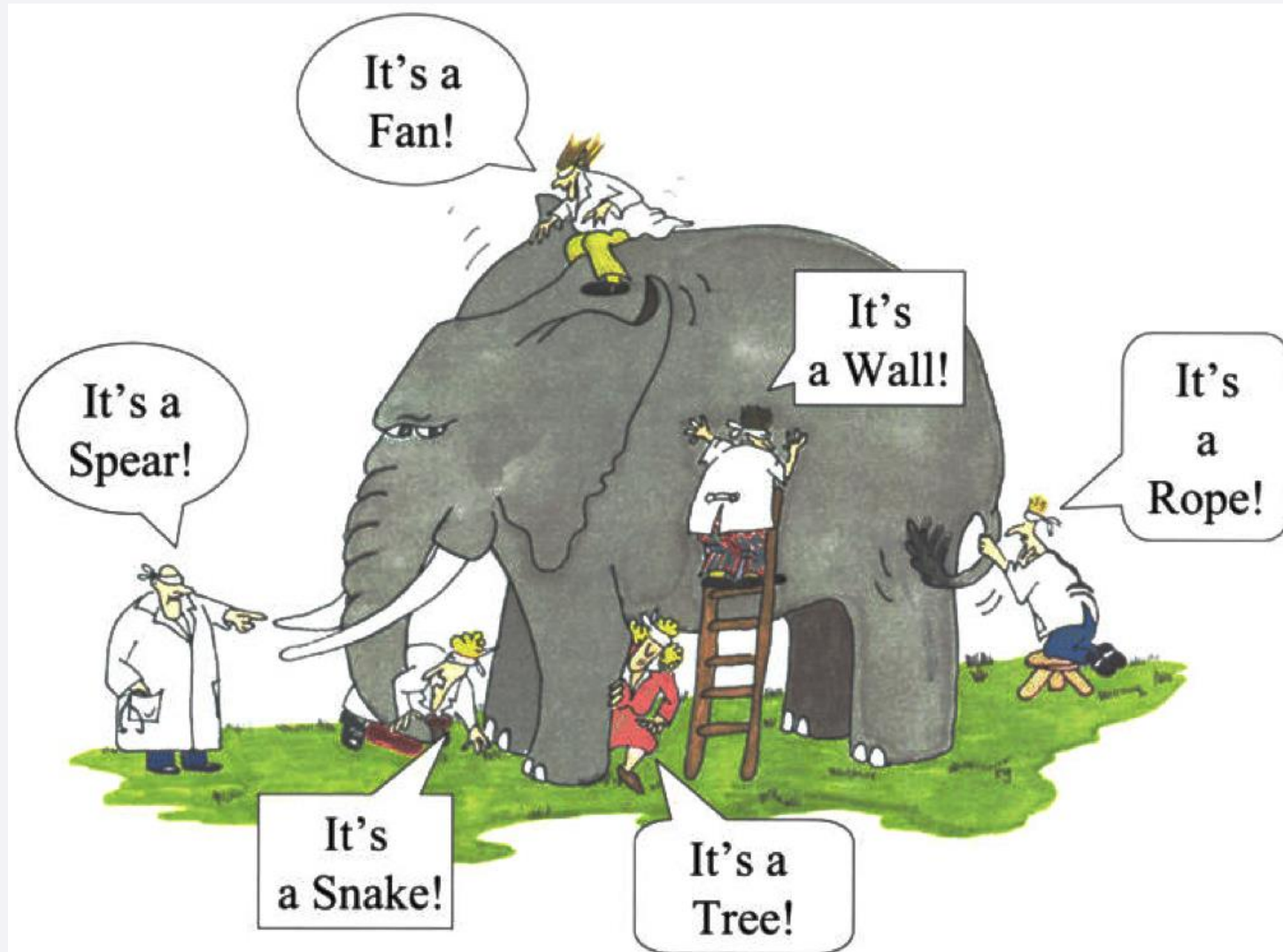
1. Themes (**Questions, Mapping**)
2. Story (Examples of **Clustering, Spectrums, SNA, *maybe* TDA**)
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4. Play time

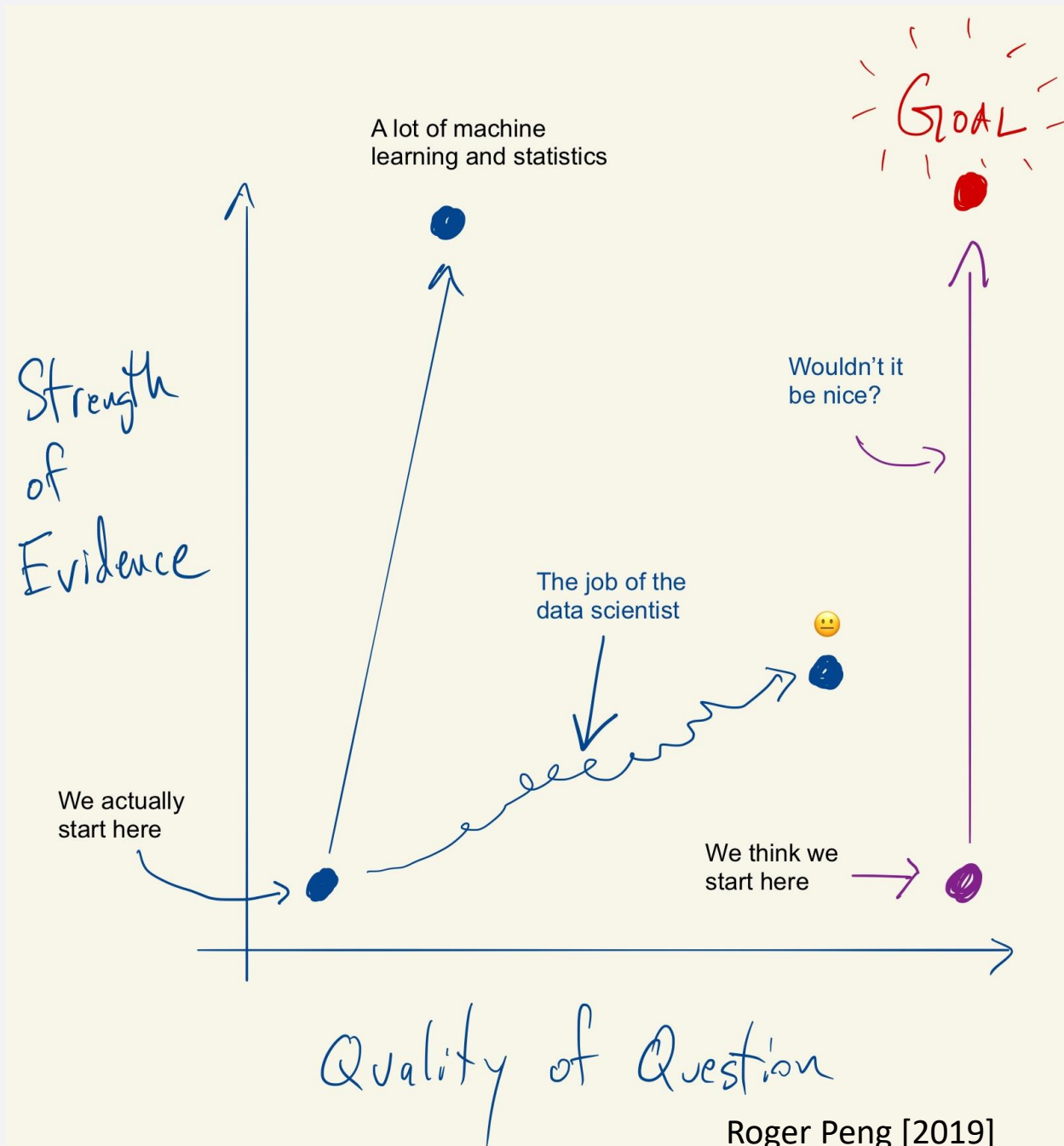
# Questions

Far better an approximate answer to the *right* question, which is often vague, than an *exact* answer to the wrong question, which can always be made precise

-- Tukey, 1962

# Questions





Roger Peng [2019]

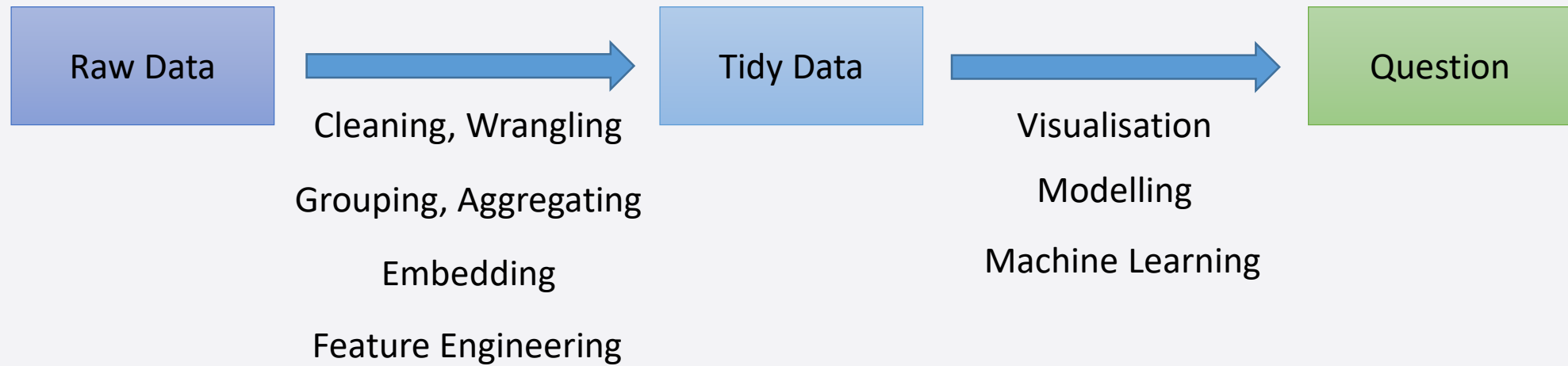
<https://simplystatistics.org/2019/04/17/tukey-design-thinking-and-better-questions/>

# Questions - Example

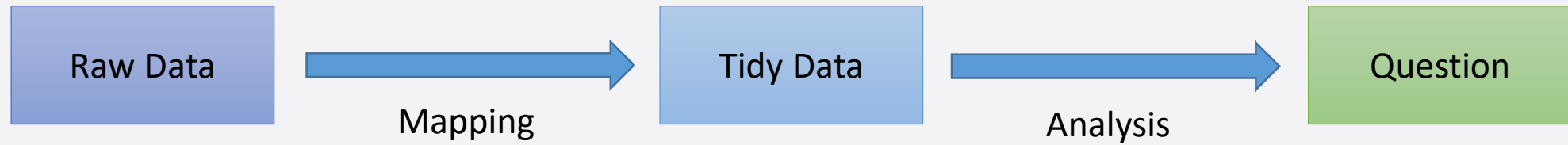
- *How did students engage with the content?*
- *Did the forums assist learning?*



# Mapping



# Mapping



# Mapping - Example

When	Who	What
timestamp <dtm>	person <chr>	data <chr>
2018-08-04 11:55:22	Student62	/webapps/blackboard/content/contentWrapper.~
2018-07-09 11:53:19	Student1~	/webapps/blackboard/execute/content/blankPa~
2018-09-24 16:42:22	Student2~	"{\\"\\\"handler\\"\\":\\"\\\"resource/x-bb-externa~
2018-08-31 09:41:36	Student65	Assessment 2 (research report) information
2018-09-05 13:29:19	Student2~	Discussion Board
2018-10-16 09:31:01	Student97	"{\\"\\\"handler\\"\\":\\"\\\"resource/x-bb-folder\\~
2018-07-28 14:50:51	Student2~	Discussion Board
2018-10-16 19:13:37	Student3~	"{\\"\\\"handler\\"\\":\\"\\\"resource/x-bb-folder\\~
2018-08-06 21:22:04	Student2~	"{\\"\\\"handler\\"\\":\\"\\\"resource/x-bb-folder\\~
2018-07-15 09:51:38	Student1~	/webapps/blackboard/content/contentWrapperI~

Mapping

$$\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{pmatrix}$$

How did *students* engage with the content?

When	Who	What
timestamp <dtm>	person <chr>	data <chr>
2018-08-04 11:55:22	Student62	/webapps/blackboard/content/contentWrapper.~
2018-07-09 11:53:19	Student1~	/webapps/blackboard/execute/content/blankPa~
2018-09-24 16:42:22	Student2~	"{"\"\"handler\"\"\":\"\"resource/x-bb-externa~
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2018-07-28 14:50:51	Student2~	Discussion Board
2018-10-16 19:13:37	Student3~	"{"\"\"handler\"\"\":\"\"resource/x-bb-folder\~
2018-08-06 21:22:04	Student2~	"{"\"\"handler\"\"\":\"\"resource/x-bb-folder\~
2018-07-15 09:51:38	Student1~	/webapps/blackboard/content/contentWrapperI~

Mapping

Person	?	?	?	?	...
Student1					
Student2					
Student3					
Student4					
Student5					
Student6					
Student7					
...					

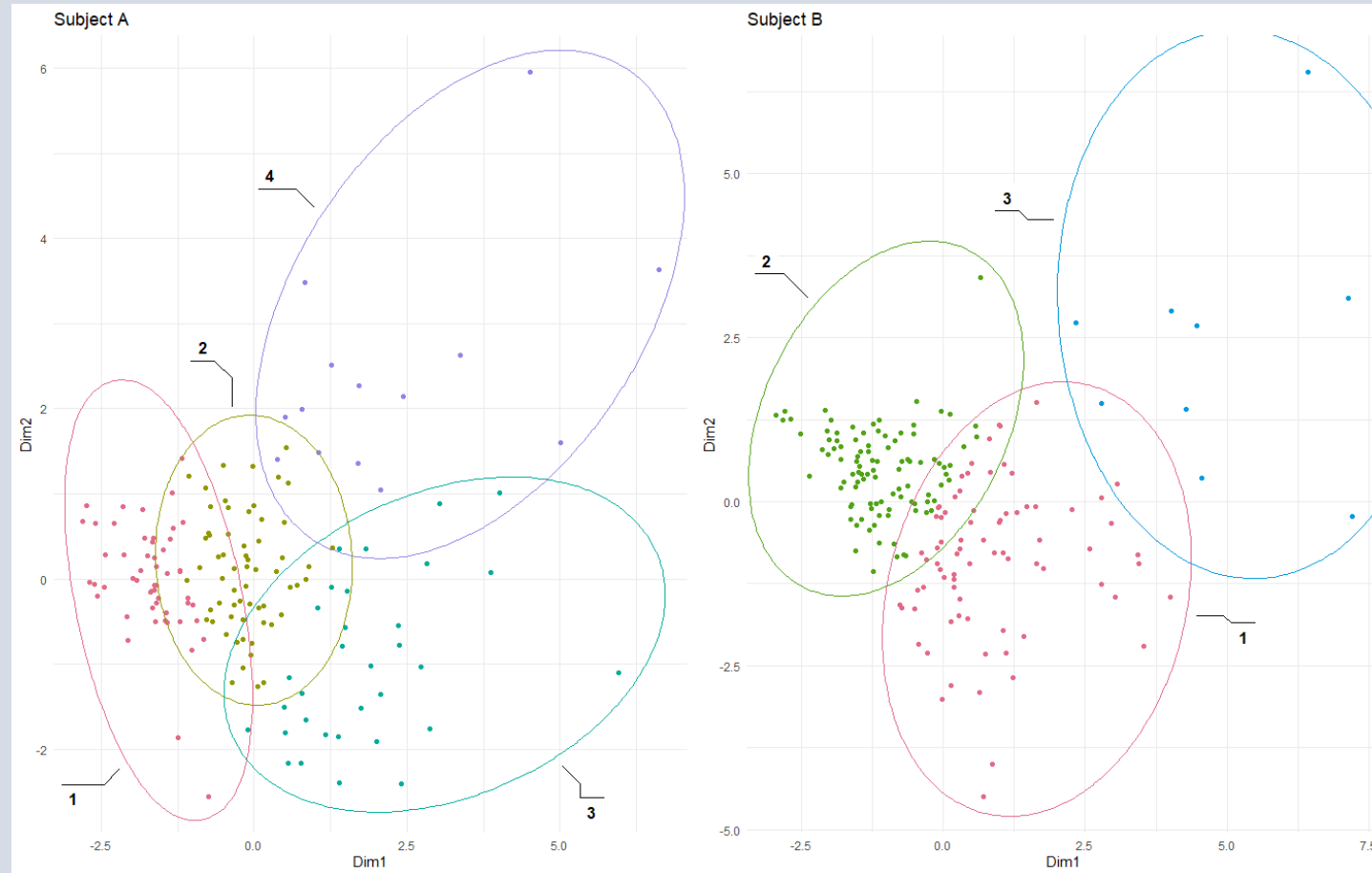
*How did **students** engage with the content?*

- What did I miss?
- Which feature / variable do you think will discriminate student behaviour the most? The least?
- Which feature / variable do you think will discriminate student academic performance the most? The least?

*How did **students** engage with the content?*

- **What did I miss?**
- Which feature / variable do you think will discriminate student behaviour the most? The least?
- Which feature / variable do you think will discriminate student academic performance the most? The least?

How did *students* engage with the content?



*How did students engage with the **content**?*

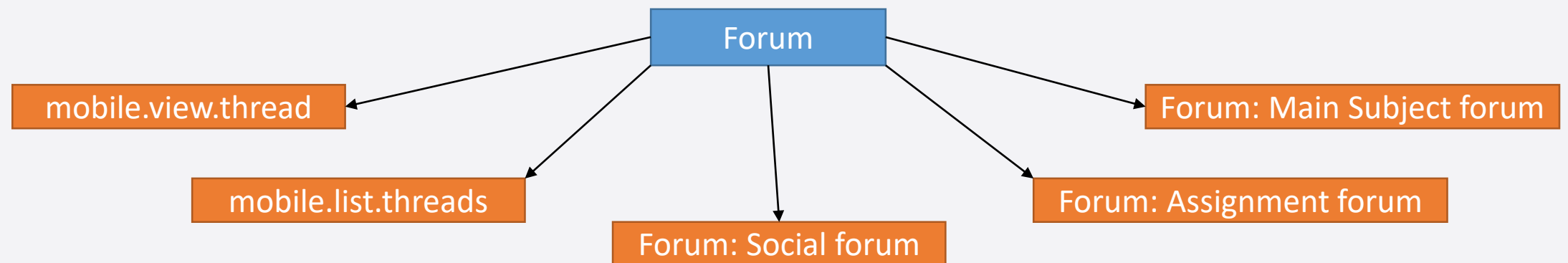
pk1	parent_pk1	title	handle
<chr>	<chr>	<chr>	<chr>
203	201	/webapps/discussionboard/do/showstreamdetail	forum
303	10	mobile.view.thread	forum
104	10	Forum: Social forum	forum
10	NA	Forum	forum
304	10	mobile.list.threads	forum
401	NA	/webapps/ppto-PanoptoCourseTool-BBLEARN/Content.jsp	panopto
202	201	Discussion Board Reply	forum
102	10	Forum: Assignment forum	forum
204	201	/webapps/discussionboard/do/message	forum
103	10	Forum: Main Subject Forum	forum

Forum



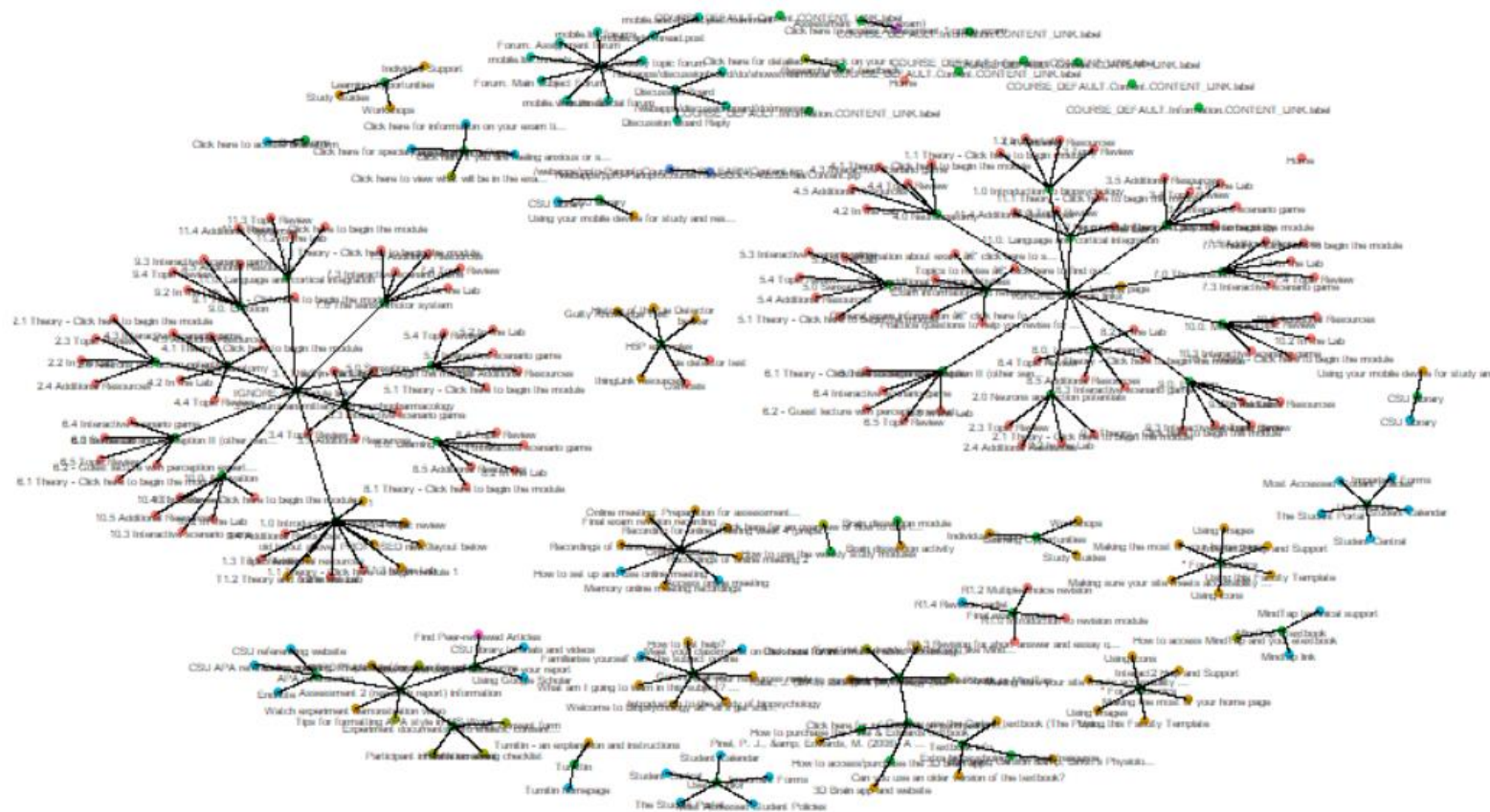
How did students engage with the *content*?

pk1	parent_pk1	title	handle
<chr>	<chr>	<chr>	<chr>
203	201	/webapps/discussionboard/do/showstreamdetail	forum
303	10	mobile.view.thread	forum
104	10	Forum: Social forum	forum
10	NA	Forum	forum
304	10	mobile.list.threads	forum
401	NA	/webapps/ppto-PanoptoCourseTool-BBLEARN/Content.jsp	panopto
202	201	Discussion Board Reply	forum
102	10	Forum: Assignment forum	forum
204	201	/webapps/discussionboard/do/message	forum
103	10	Forum: Main Subject Forum	forum



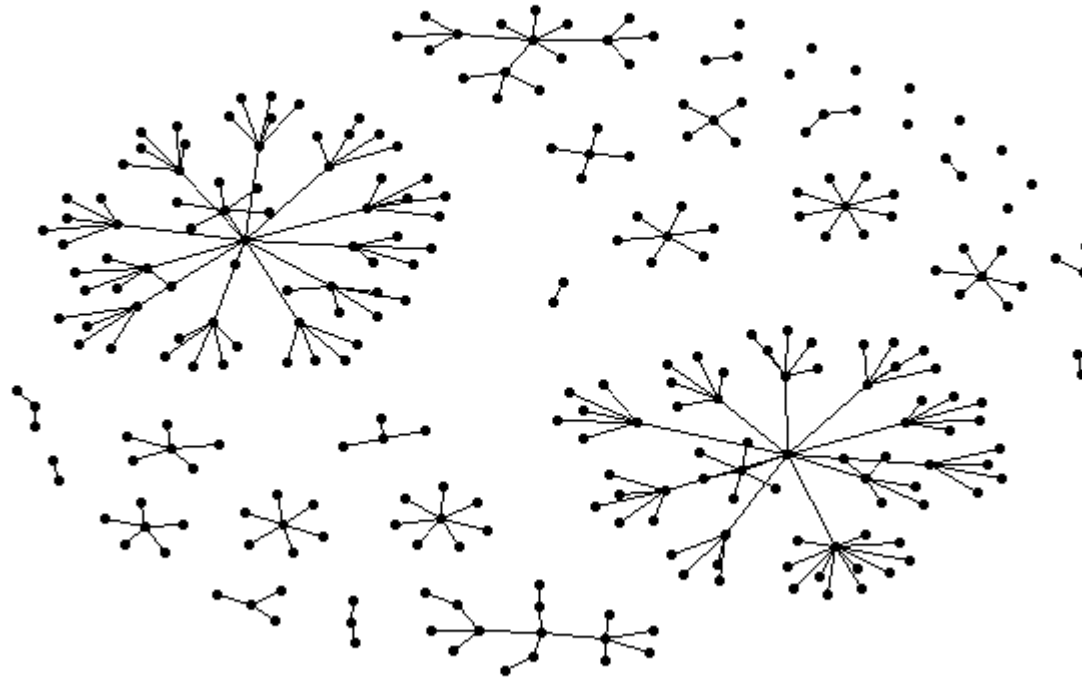
*How did students engage with the **content**?*

### Subject A Site Structure

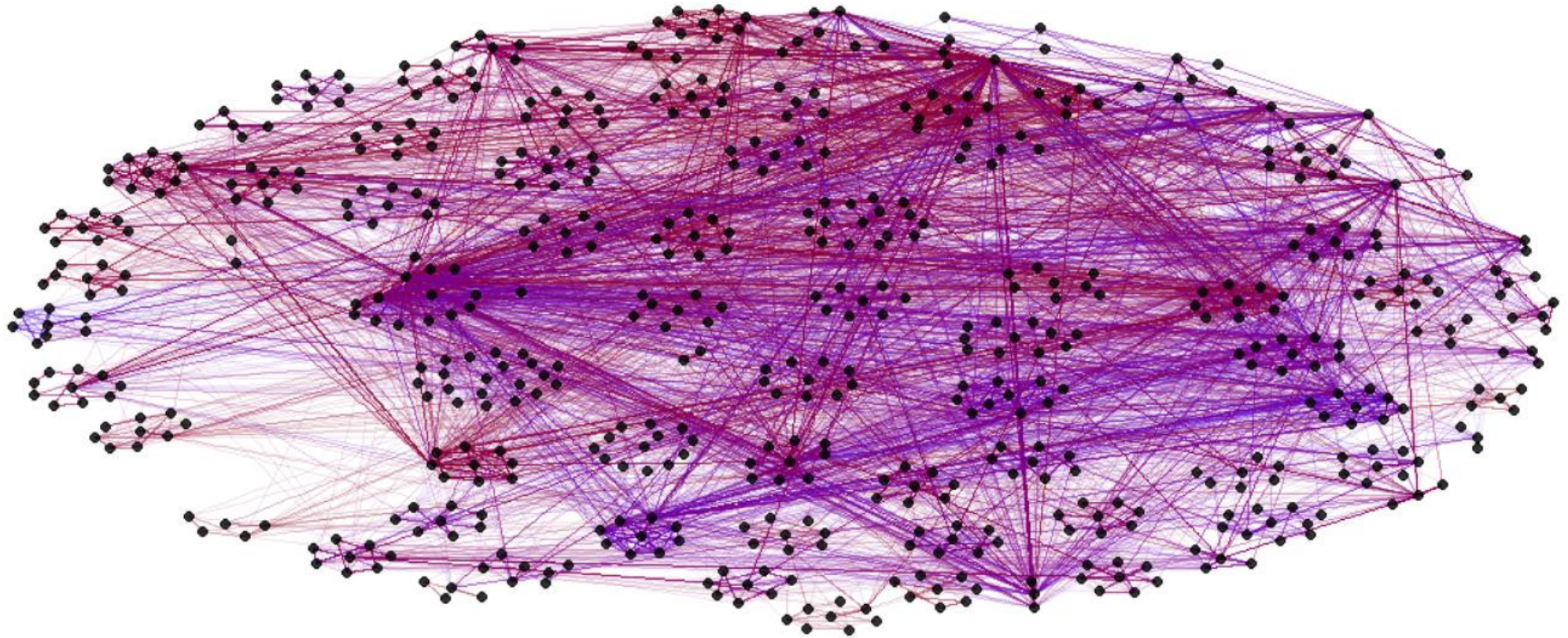


*How did students engage with the **content**?*

**2018-06-01**

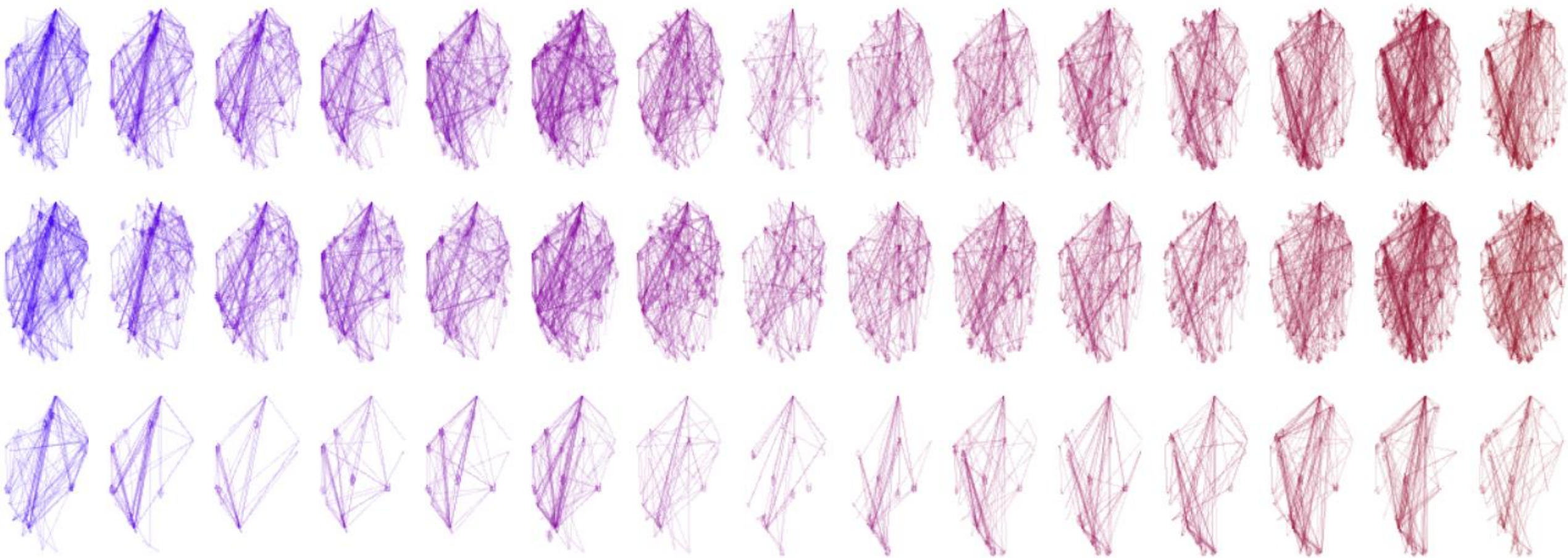


How did *students* engage with the *content*?





How did *students* engage with the *content*?

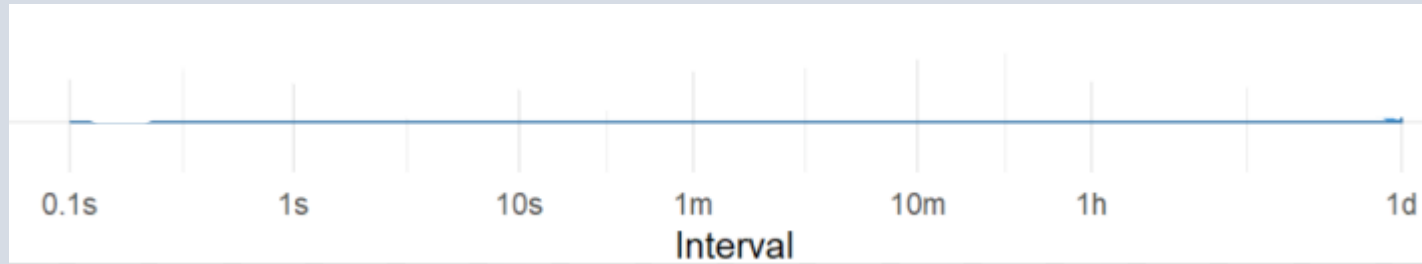


Time goes left to right, clusters are 1, 2, 3 from top to bottom

*How did students **engage** with the content?*

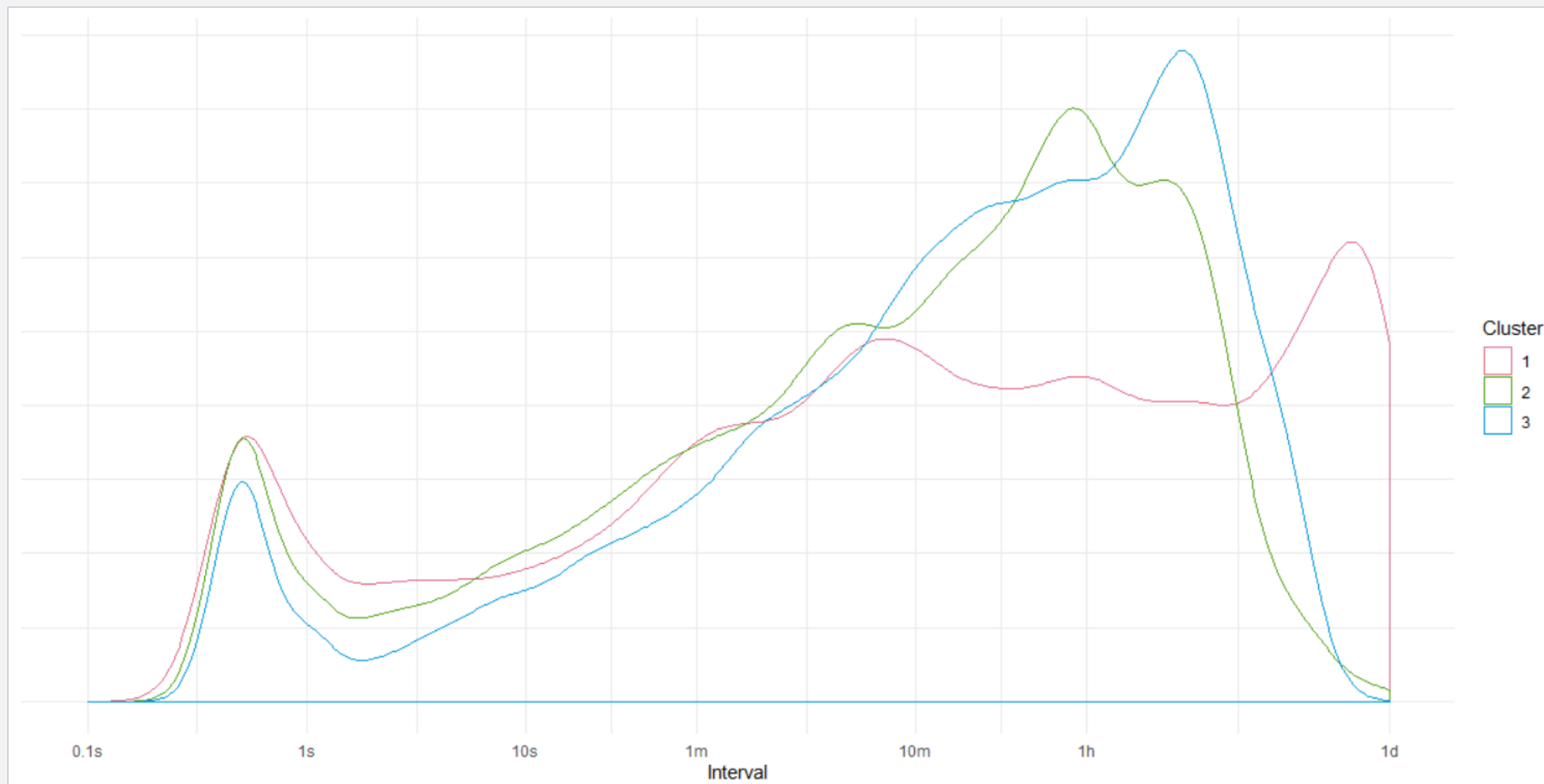
- Look at the spaces (duration) in between the clicks
- Evaluate the relative frequency of these durations
- Effectively a Fourier Transform, but for impulses instead of a signal

How did students *engage* with the content?



How did students *engage* with the content?

Subject B

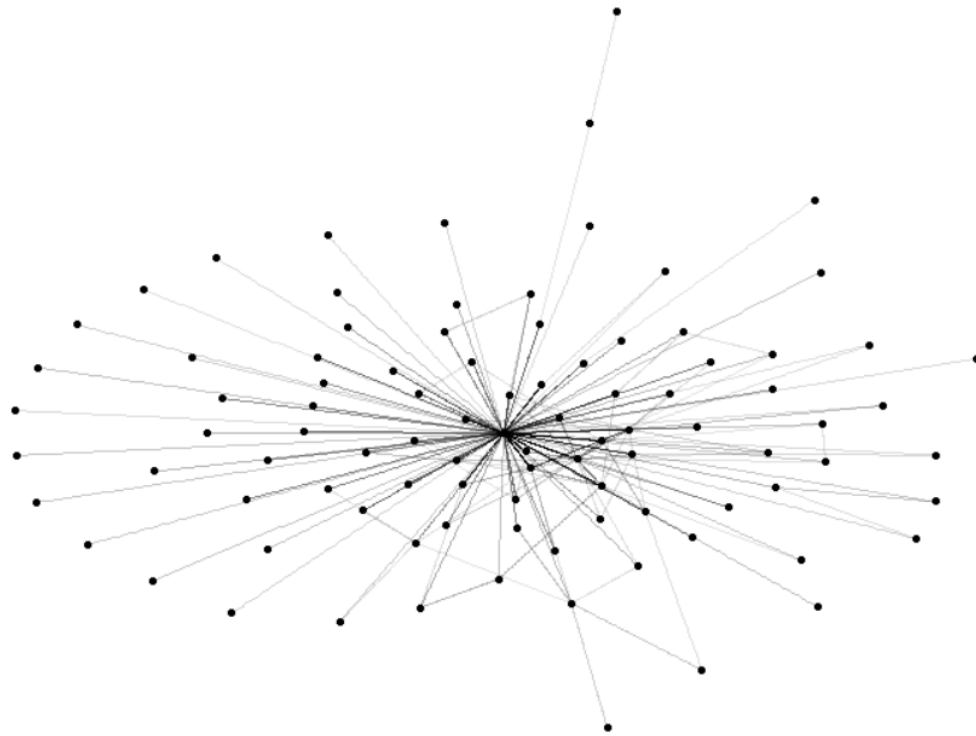




## *Did the forums assist learning?*

- Explore forum network layered with other data such as academic performance
- Explore the structural changes in the forum network from one year to the next

# *Did the forums assist learning?*

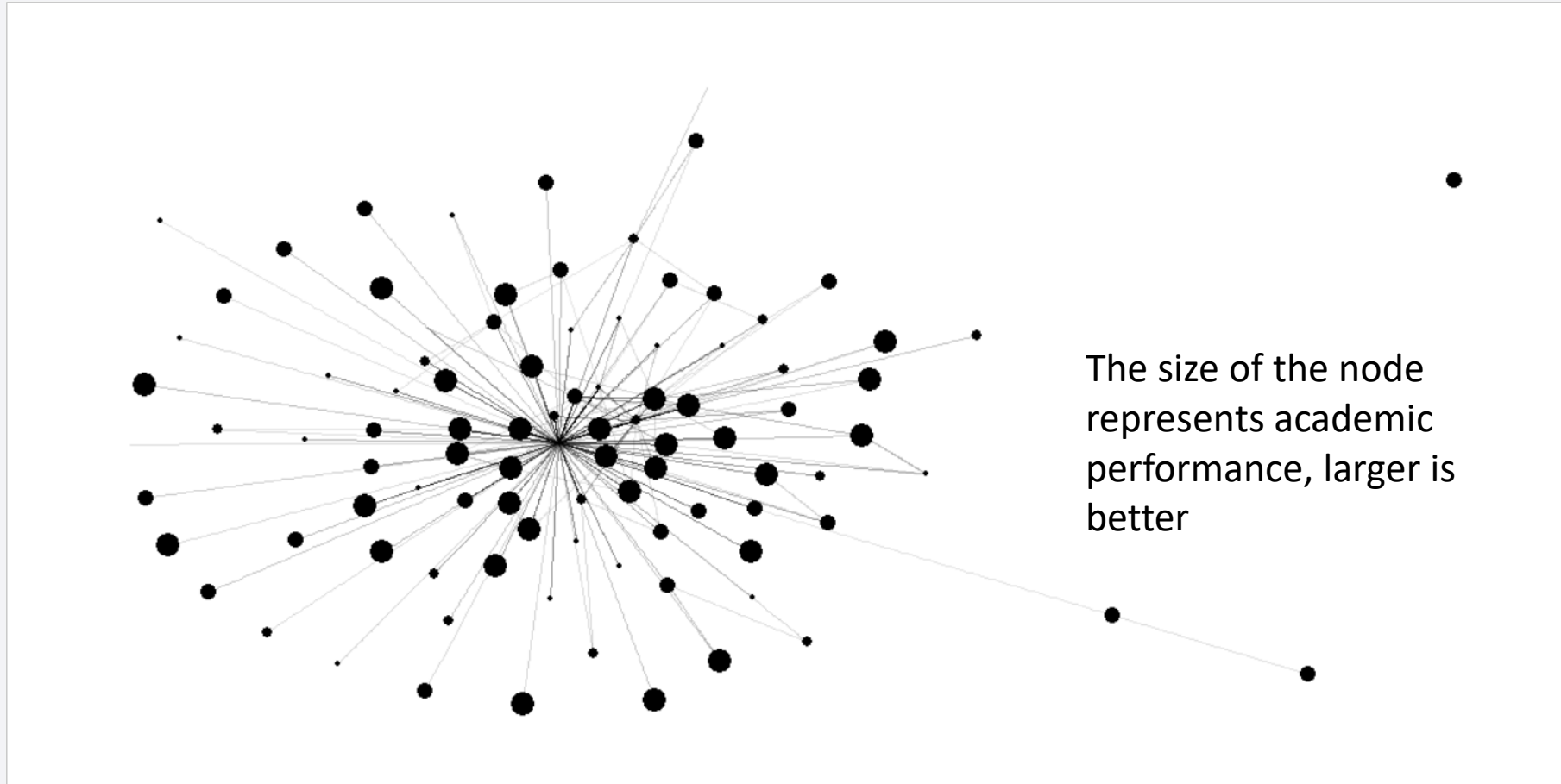


Each node (point) is a person

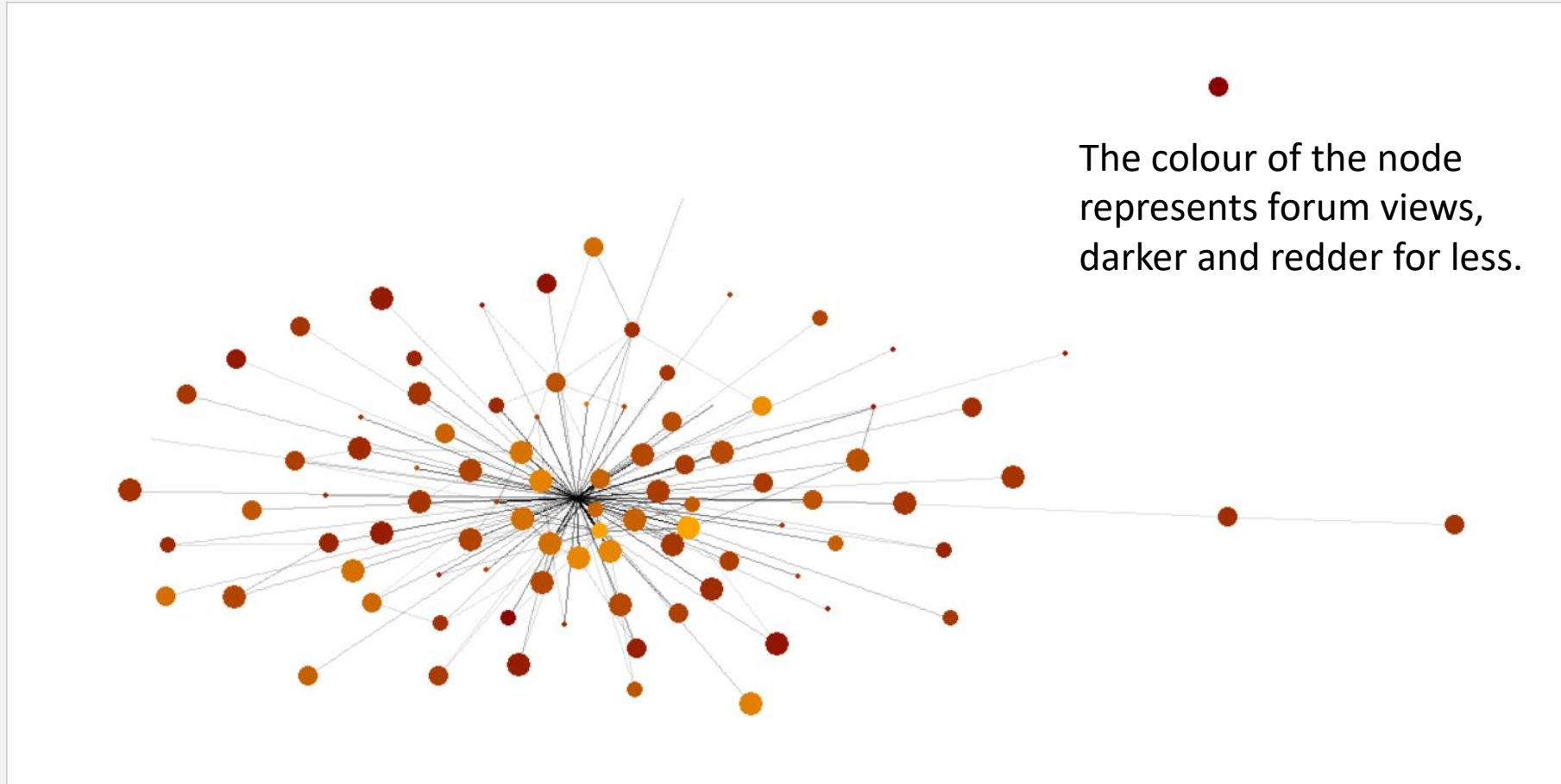
Each edge (line) is a collection of forum replies between the two people.

The darkness of the line represents how many times those forum posts were viewed.

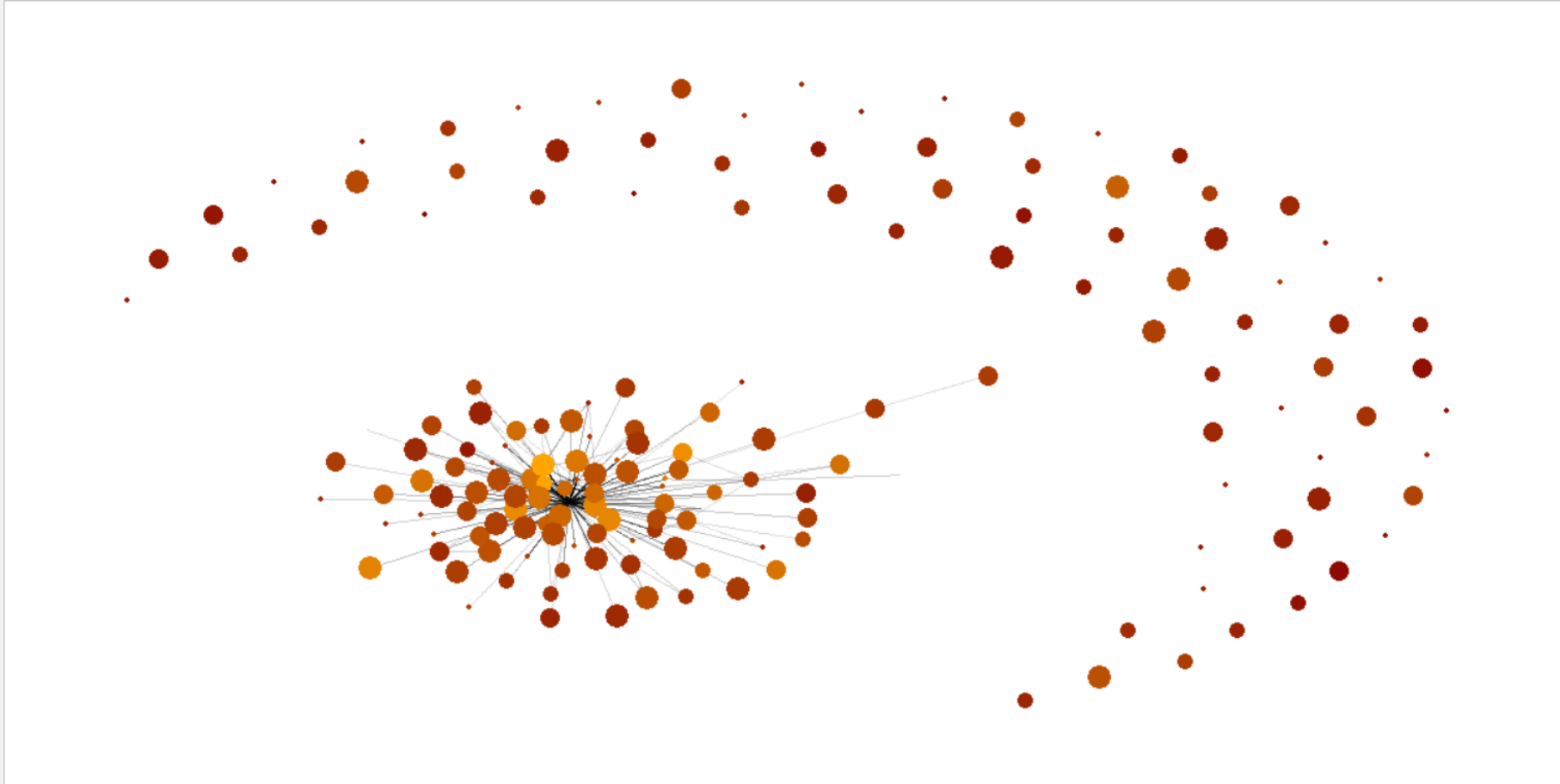
*Did the forums assist learning?*



## *Did the forums assist learning?*



*Did the forums assist learning?*



## *Did the forums assist learning?*

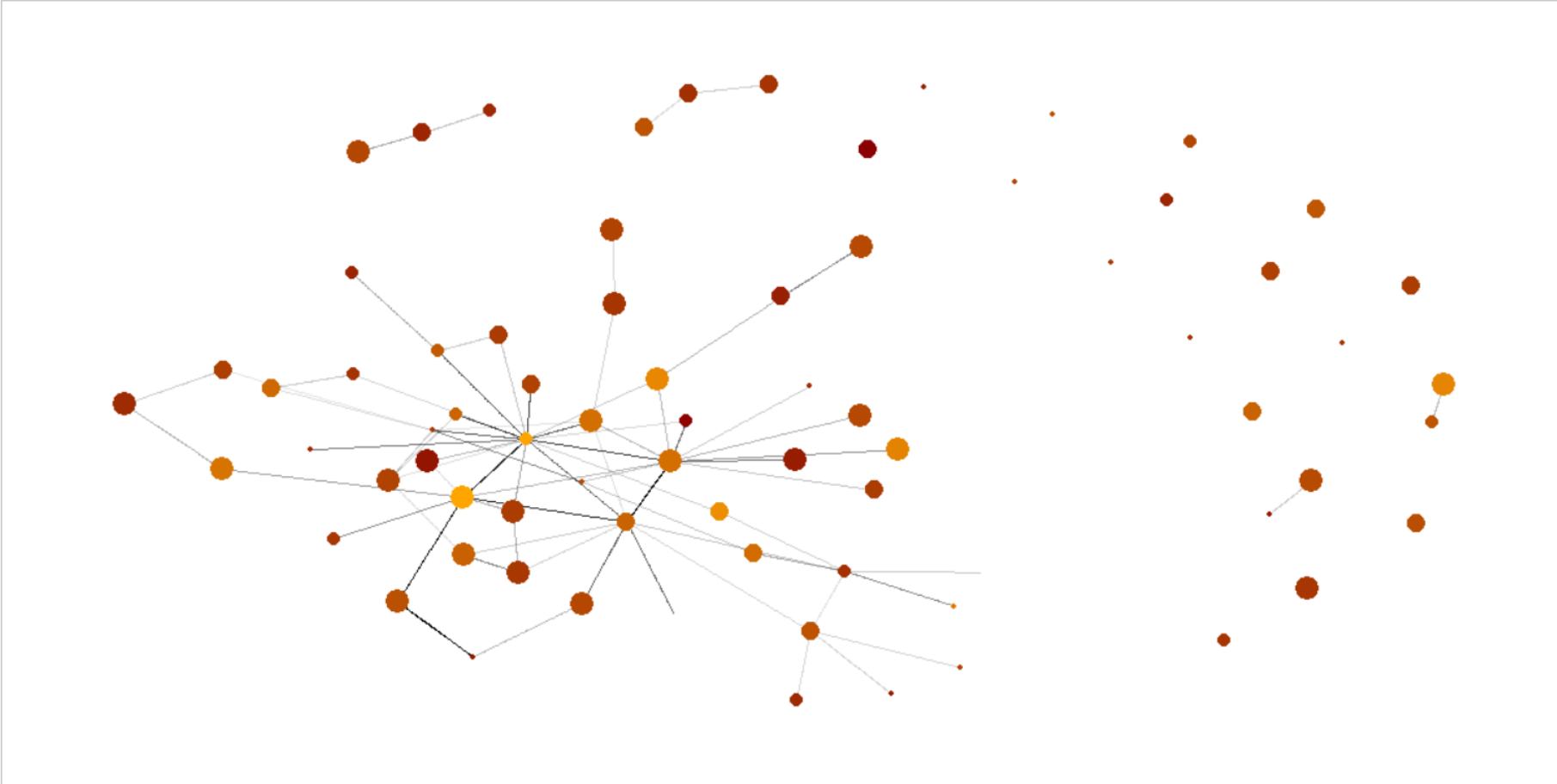
Comparing forums:

- Visually
- Density
- Reciprocity
- Transitivity
- Triadic Census

# Play time

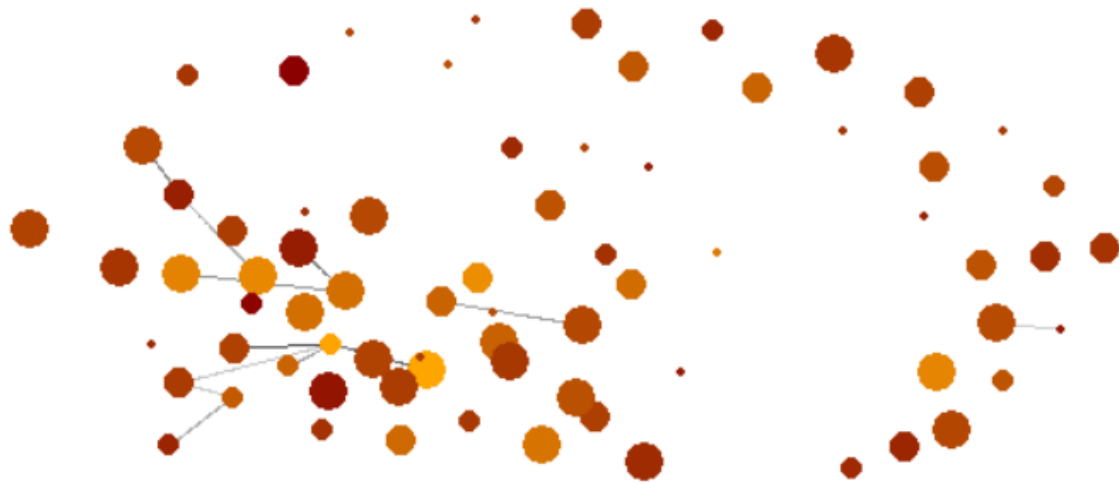
- Explore a mock data set: <https://ben-hicks.shinyapps.io/TraceData/>
- For the R enthusiast, code is available @  
<https://github.com/benwhicks/alasi.2019>  
<https://github.com/benwhicks/lakit>

# 2018 Forum, teacher removed

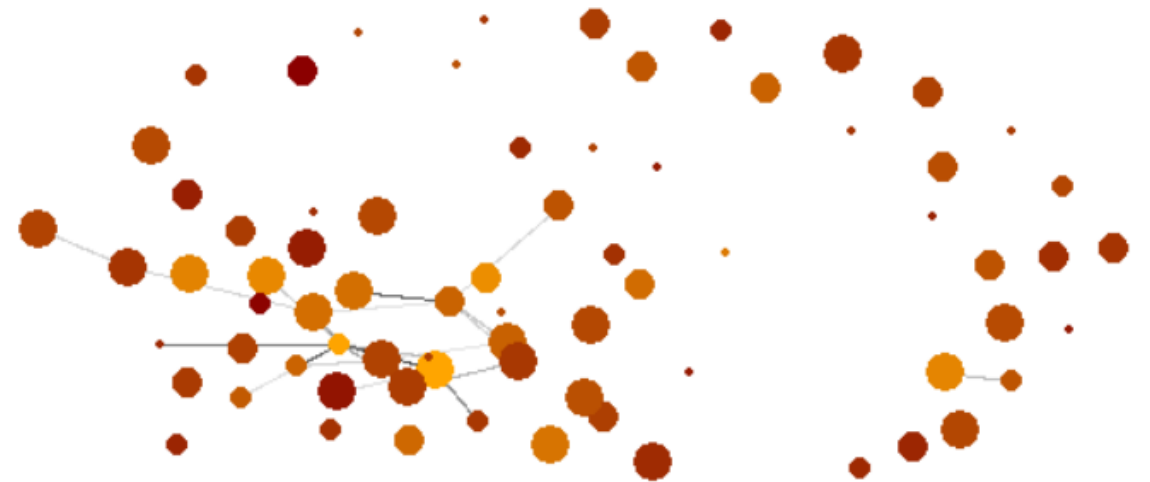




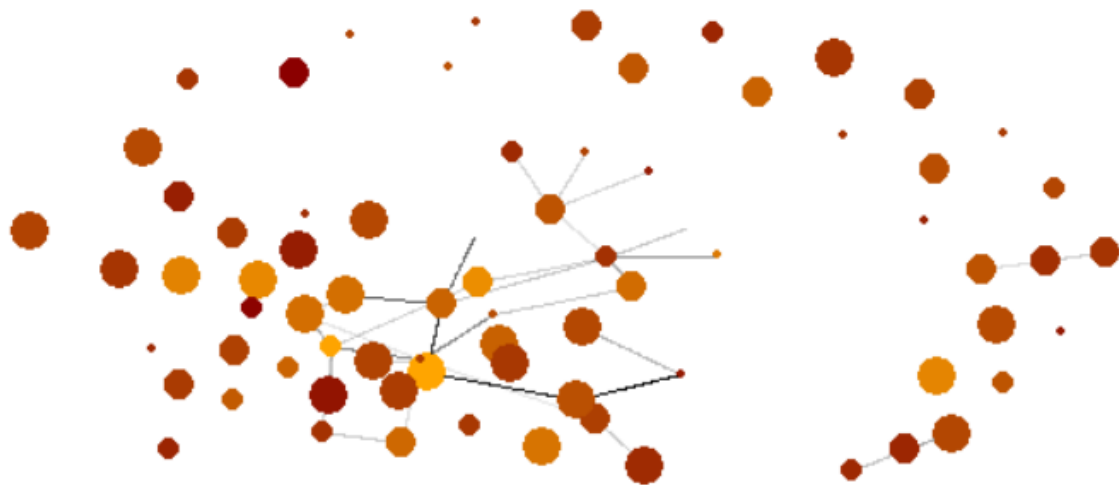
Assignment forum



Main Subject Forum



Social forum



Weekly topic forum

