Topic Model Network Visualization

Lynn Cherny (@arnicas)
lynn@ghostweather.com
www.ghostweather.com

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WHAT IS TOPIC ANALYSIS?

Problems We're Attacking

- Document collections are hard work to explore/manage manually
- Sometimes the contents are completely or mostly "unknown" (e.g., an email archive, or a collection of research papers)
- We'd like at least semi-automated methods to group them, annotate them, explore relationships

The Topic Problem

Text 1

We present a statistical parsing framework for sentence-level sentiment classification in this article. Different from previous work employing linguistic parsing results for sentiment analysis, we develop a statistical parser to directly analyze the sentiment structure of a sentence. We show that the complicated phenomena in sentiment analysis (e.g., negation, intensification, and contrast) can be elegantly handled the same as simple

Text 2

Sentiment analysis of Twitter data is performed. The researcher has made the following contributions via this paper: (1) an innovative method for deriving sentiment score dictionaries using an existing sentiment dictionary as seed words is explored, and (2) an analysis of clustered tweet sentiment scores based on tweet length is performed.

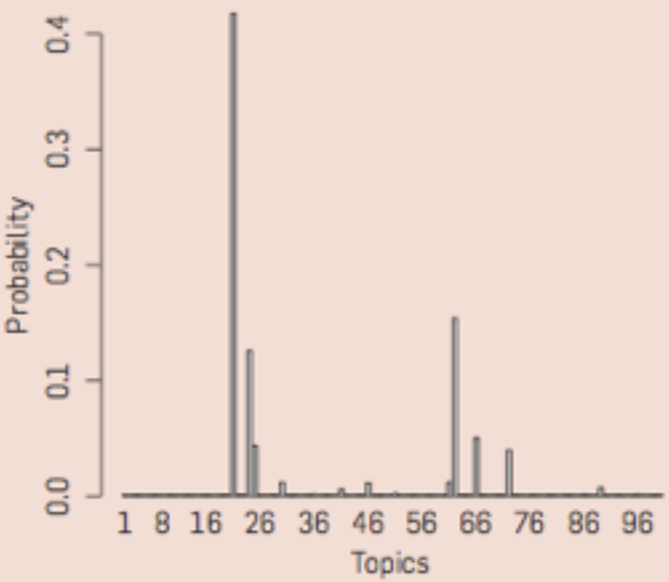
Text 3

We perform a large-scale linguistic analysis of language diatopic variation using geotagged microblogging datasets. By collecting all Twitter messages written in Spanish over more than two years, we build a corpus from which a carefully selected list of concepts allows us to characterize Spanish varieties on a global scale. A cluster analysis proves the existence of well defined macroregions sharing common lexical

Intuitions

- Documents are composed of multiple words (“bag of words”)
- Documents may express multiple topics

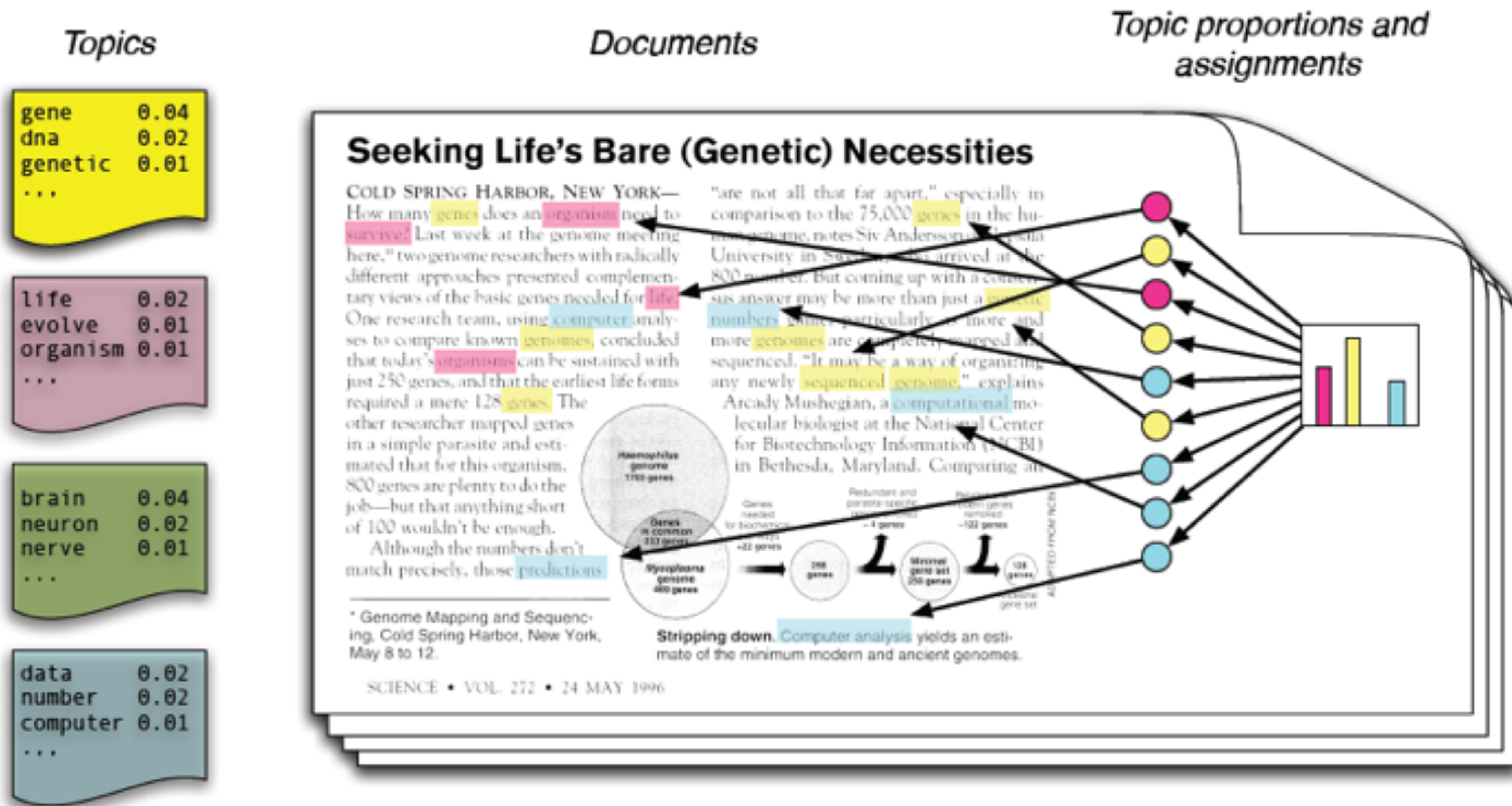
Figure 2. Real inference with LDA. We fit a 100-topic LDA model to 17,000 articles from the journal *Science*. At left are the inferred topic proportions for the example article in Figure 1. At right are the top 15 most frequent words from the most frequent topics found in this article.



"Genetics"	"Evolution"	"Disease"	"Computers"
human	evolution	disease	computer
genome	evolutionary	host	models
dna	species	bacteria	information
genetic	organisms	diseases	data
genes	life	resistance	computers
sequence	origin	bacterial	system
gene	biology	new	network
molecular	groups	strains	systems
sequencing	phylogenetic	control	model
map	living	infectious	parallel
information	diversity	malaria	methods
genetics	group	parasite	networks
mapping	new	parasites	software
project	two	united	new
sequences	common	tuberculosis	simulations

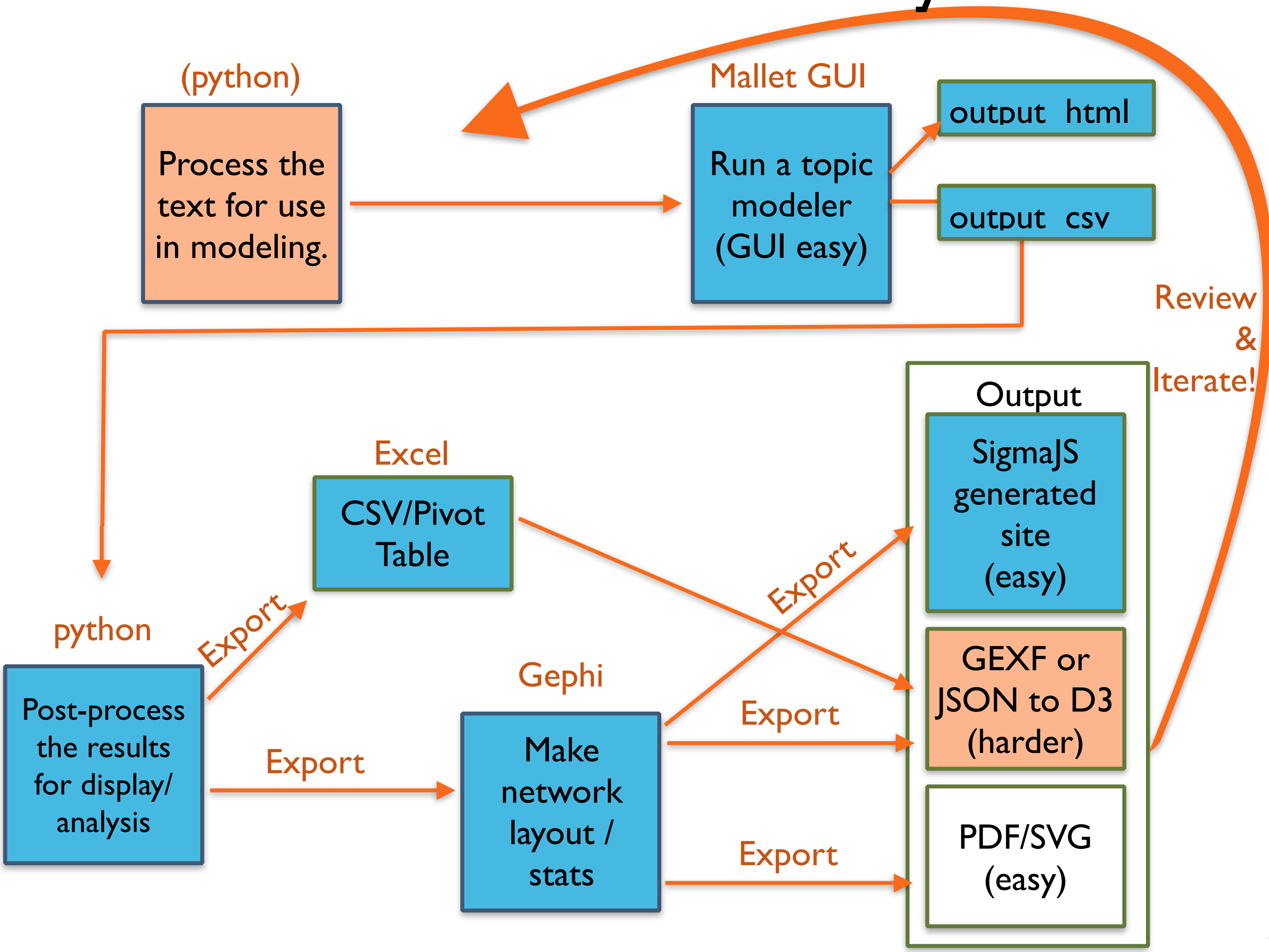
Blei(2012) review article: http://www.cs.princeton.edu/~blei/papers/Blei2012.pdf

"LDA": Latent Dirichlet Allocation



Blei (2011)

Workflow for Today

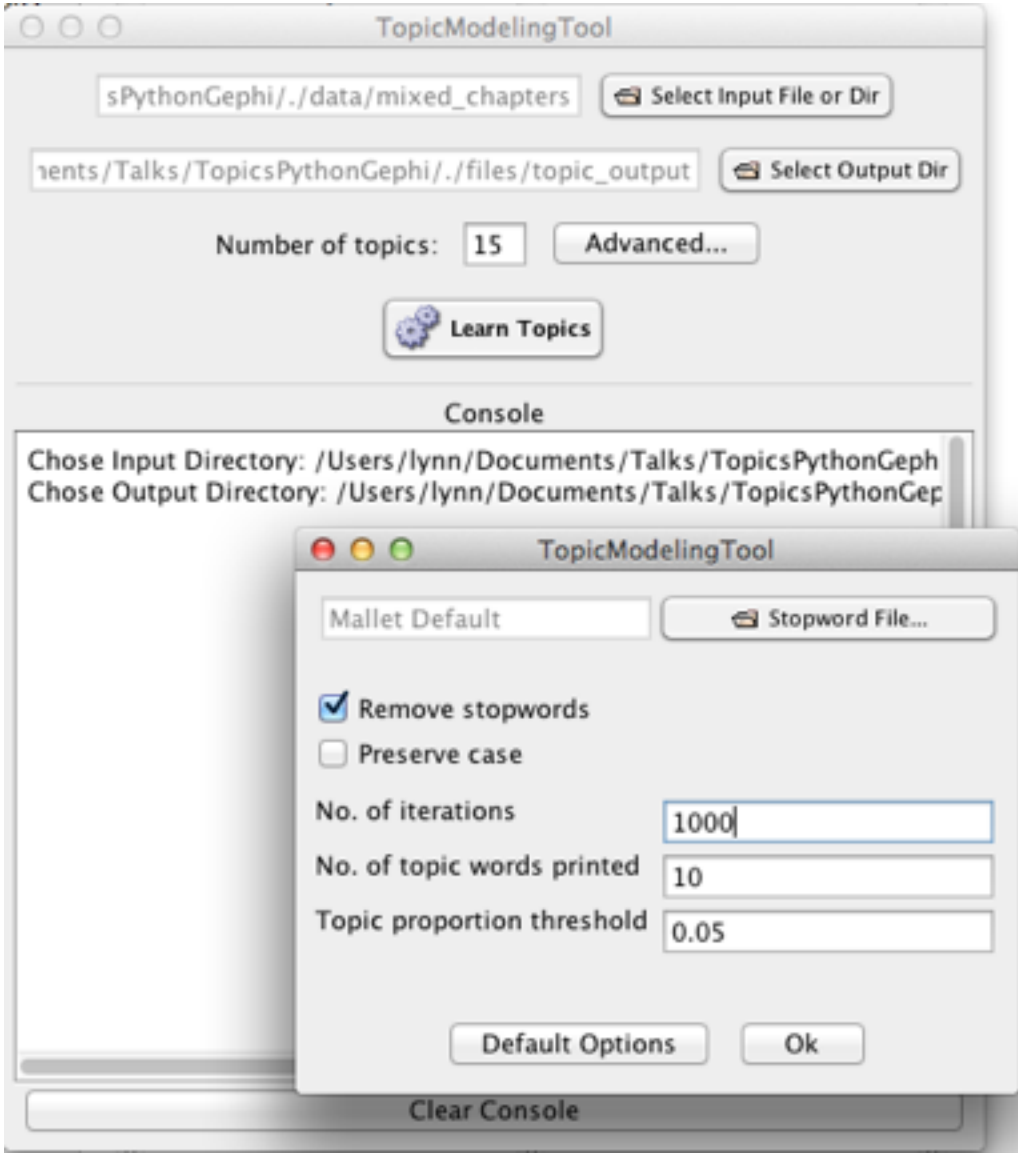


Save us some time: David Newman's Topic Modeling GUI

- A tool available for non-technical audiences! A GUI wrapper on the state-of-the-art mallet (java-based app by David Mimno).
- https://code.google.com/p/topic-modeling-tool/

  (Also in the workshop files)
- More of his work: http://www.ics.uci.edu/~newman/

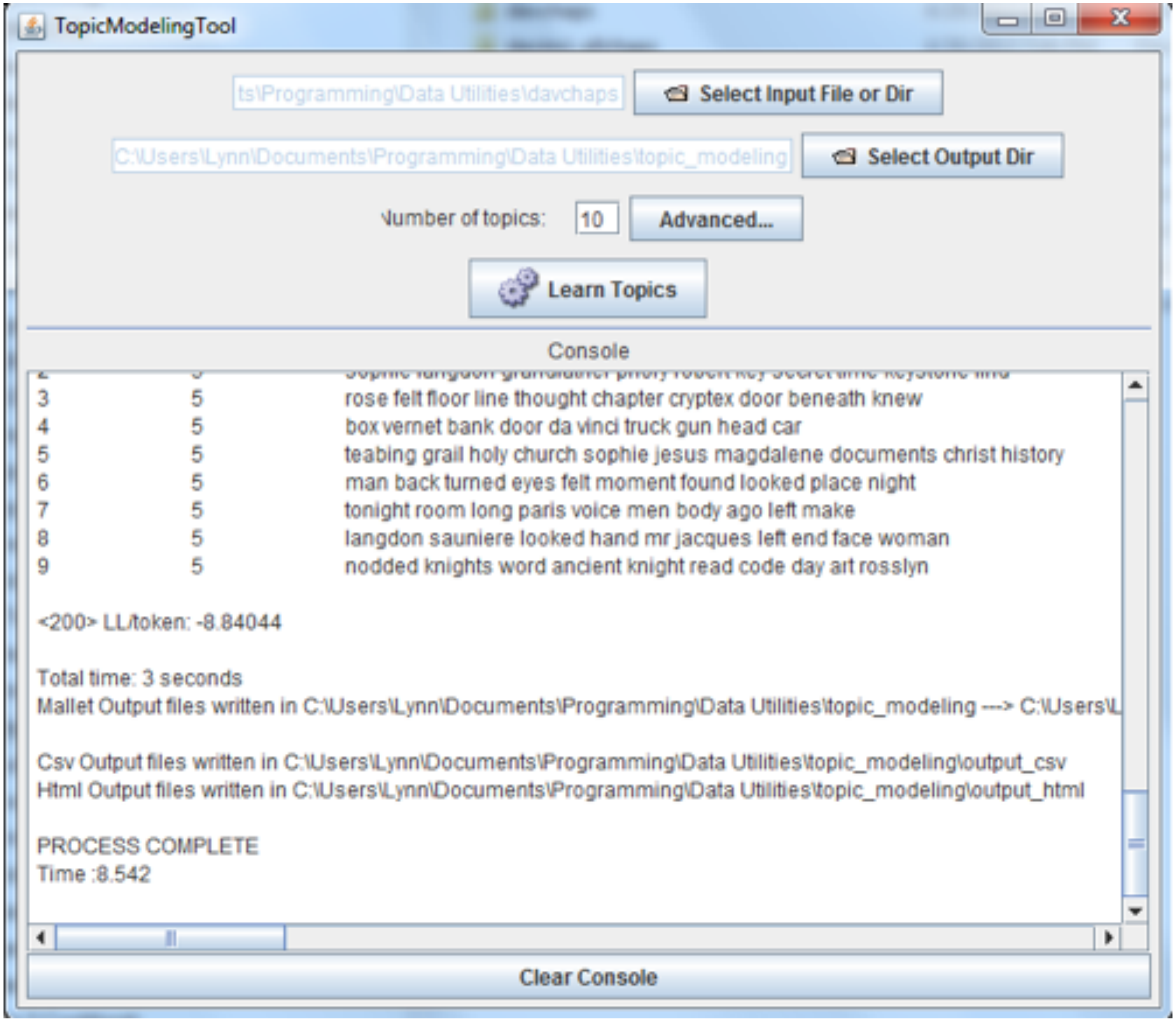
Topic Modeling Tool (GUI)



Create an output dir called "topic_output" before you try to select.

Click "Advanced…"

Post run…


TopicModelingTool
ts\Programming\Data Utilities\davchaps
Select Input File or Dir
C:\Users\Lynn\Documents\Programming\Data Utilities\topic_modeling
Select Output Dir
Number of topics:
10
Advanced...
Learn Topics
Console
3 5 rose felt floor line thought chapter cryptex door beneath knew
4 5 box vernet bank door da vinci truck gun head car
5 5 teabing grail holy church sophie jesus magdalene documents christ history
6 5 man back turned eyes felt moment found looked place night
7 5 tonight room long paris voice men body ago left make
8 5 langdon sauniere looked hand mr jacques left end face woman
9 5 nodded knights word ancient knight read code day art rosslyn
<200> LL/token: -8.84044
Total time: 3 seconds
Mallet Output files written in C:\Users\Lynn\Documents\Programming\Data Utilities\topic_modeling ---> C:\Users\L
Csv Output files written in C:\Users\Lynn\Documents\Programming\Data Utilities\topic_modeling\output_csv
Html Output files written in C:\Users\Lynn\Documents\Programming\Data Utilities\topic_modeling\output_html
PROCESS COMPLETE
Time :8.542
Clear Console

Understanding the Output

StackOverflow post: http://stackoverflow.com/questions/8447393/how-to-understand-the-output-of-topic-model-class-in-mallet

```
<1450> LL/token: -9.11846
<1460> LL/token: -9.11803
<1470> LL/token: -9.10896
<1480> LL/token: -9.11237
<1490> LL/token: -9.10845
```

Iteration number

Log Likelihood per word (we want this to increase as the algorithm runs)

Output files: Data (csv), text web site

output_csv

List of T topics:

Topics_Words.csv

List of topics in each of D documents:

TopicsInDocs.csv

List of top-ranked documents in each of T topics

DocsInTopics.csv

output_html

all_topics.html

Mallet command line

You could also run mallet from the command line:

http://programminghistorian.org/lessons/topic-modeling-and-mallet

Or use a Python (or R) wrapper:

http://radimrehurek.com/2014/03/tutorial-on-mallet-in-python/

To do the rest of this workshop, you'd need to process the output files yourself similarly to our

py code (assume \t seps, not csv)

Pros/Cons vs CMD-Line Mallet

Pros of GUI

- Allows stopword file input
- Takes folder or file of text
- Produces csv and html output in a neat dir structure
- Has a GUI! (simpler to just get going without code and help)
- A nice intro to using mallet on the command line

Cons of GUI

- Runs with defaults, so no optimize-interval or other cmd line options
- No diagnostic output (a command-line option)
- Can get slightly fewer stats for your vis, as a result

2 of the 3 CSV Output files

topicId	words..
1	silas aringarosa remy teacher church dei opus bishop tomb vatican
2	fache collet police message neveu agent phone captain plane sir
3	sophie langdon grandfather priory robert key secret keystone time find
4	rose floor felt line thought chapter cryptex door knew began
5	box vernet bank vinci door head da louvre truck gun
6	teabing grail holy church sophie jesus magdalene documents history ch
7	man back turned felt eyes moment found looked place night

DocsInTopics.csv
Topics_Words.csv
TopicsInDocs.csv

docId	filename	top topics	and contribution to doc ...														
1	C:\Users\I	9	0.21	4	0.188	8	0.147	7	0.13	5	0.13	6	0.063	1	0.055		
2	C:\Users\I	8	0.232	9	0.21	7	0.143	4	0.095	2	0.095	3	0.072	10	0.068	5	0.057
3	C:\Users\I	4	0.274	1	0.212	7	0.137	8	0.127	5	0.062	3	0.053				
4	C:\Users\I	1	0.442	7	0.106	8	0.097	4	0.091	6	0.085						
5	C:\Users\I	6	0.175	3	0.165	4	0.146	9	0.124	7	0.098	5	0.097	1	0.076	8	0.062
6	C:\Users\I	1	0.333	8	0.235	4	0.216	6	0.069								
7	C:\Users\I	1	0.222	2	0.197	7	0.191	8	0.098	6	0.095	9	0.065				
8	C:\Users\I	4	0.242	10	0.18	3	0.178	7	0.118	9	0.104	6	0.065	5	0.057		
9	C:\Users\I	9	0.252	3	0.187	6	0.134	4	0.097	7	0.087	10	0.08	5	0.055	8	0.054
10	C:\Users\I	4	0.353	8	0.155	7	0.124	9	0.114	10	0.075	5	0.072				
11	C:\Users\I	2	0.314	9	0.24	3	0.097	7	0.09	8	0.073	10	0.072				
12	C:\Users\I	2	0.261	9	0.229	3	0.15	8	0.132	7	0.083						
13	C:\Users\I	9	0.309	2	0.16	3	0.157	8	0.091	7	0.091	6	0.058				
14	C:\Users\I	2	0.459	8	0.176	3	0.102	7	0.083	9	0.059						
15	C:\Users\I	1	0.25	4	0.182	7	0.12	8	0.104	5	0.089	3	0.089	6	0.057		
16	C:\Users\I	3	0.347	8	0.18	2	0.117	7	0.107	9	0.1	10	0.05	4	0.05		
17	C:\Users\I	2	0.354	8	0.173	3	0.116	9	0.104	10	0.065	7	0.057	5	0.051		
18	C:\Users\I	8	0.292	2	0.223	5	0.185	3	0.085	7	0.071	9	0.064	4	0.06		
19	C:\Users\I	8	0.244	1	0.199	4	0.124	3	0.11	9	0.09	5	0.076	7	0.07	6	0.059
20	C:\Users\I	1	0.312	8	0.157	3	0.114	6	0.107	4	0.1	7	0.084	5	0.066		
21	C:\Users\I	10	0.368	9	0.284	3	0.066	7	0.06	5	0.06	2	0.053				
22	C:\Users\I	3	0.256	9	0.216	5	0.165	8	0.09	7	0.079	2	0.069	4	0.062		
23	C:\Users\I	4	0.461	1	0.145	8	0.07	7	0.068	9	0.066	10	0.062				
24	C:\Users\I	3	0.368	5	0.131	8	0.111	4	0.107	9	0.099	7	0.087				
25	C:\Users\I	4	0.336	8	0.185	1	0.185	3	0.126	6	0.059						
26	C:\Users\I	2	0.457	8	0.104	9	0.098	7	0.098	10	0.069	3	0.069	4	0.064		
27	C:\Users\I	5	0.34	9	0.261	7	0.084	4	0.07	3	0.07	10	0.059				

The default HTML output is a little lacking…

<u>TOPIC</u> : man back turned felt eyes moment found looked place night ...

top-ranked docs in this topic (#words in doc assigned to this topic)

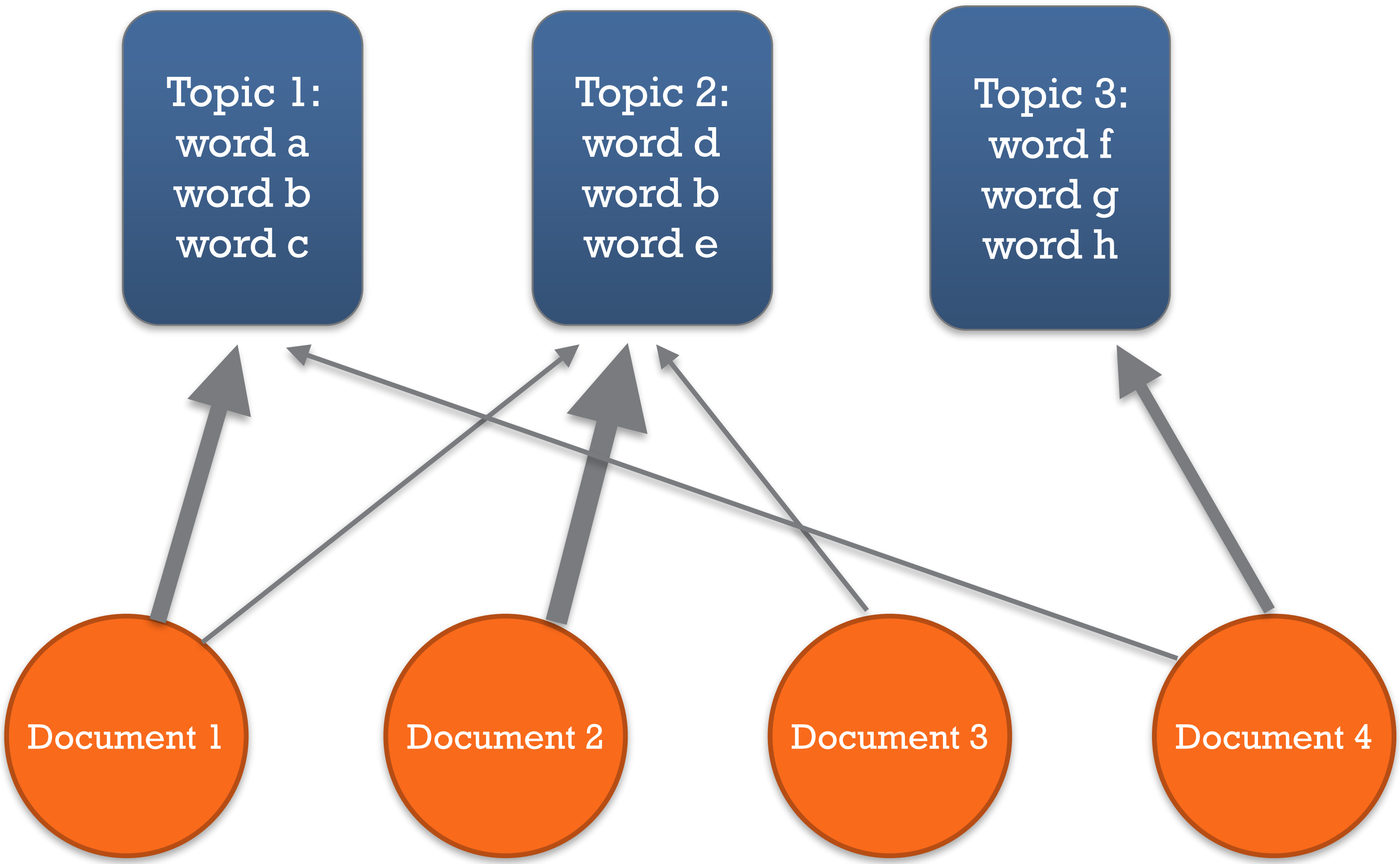
2. (219) chap_67.txt
3. (193) chap_104.txt
4. (180) chap_84.txt
5. (179) chap_99.txt
6. (160) chap_51.txt
7. (153) chap_32.txt
8. (145) chap_81.txt

A bipartite graph of chapters and topics is an obvious vis method….

This workshop has lots of code to process these files… see the .ipynb files and make_gephi_file.py

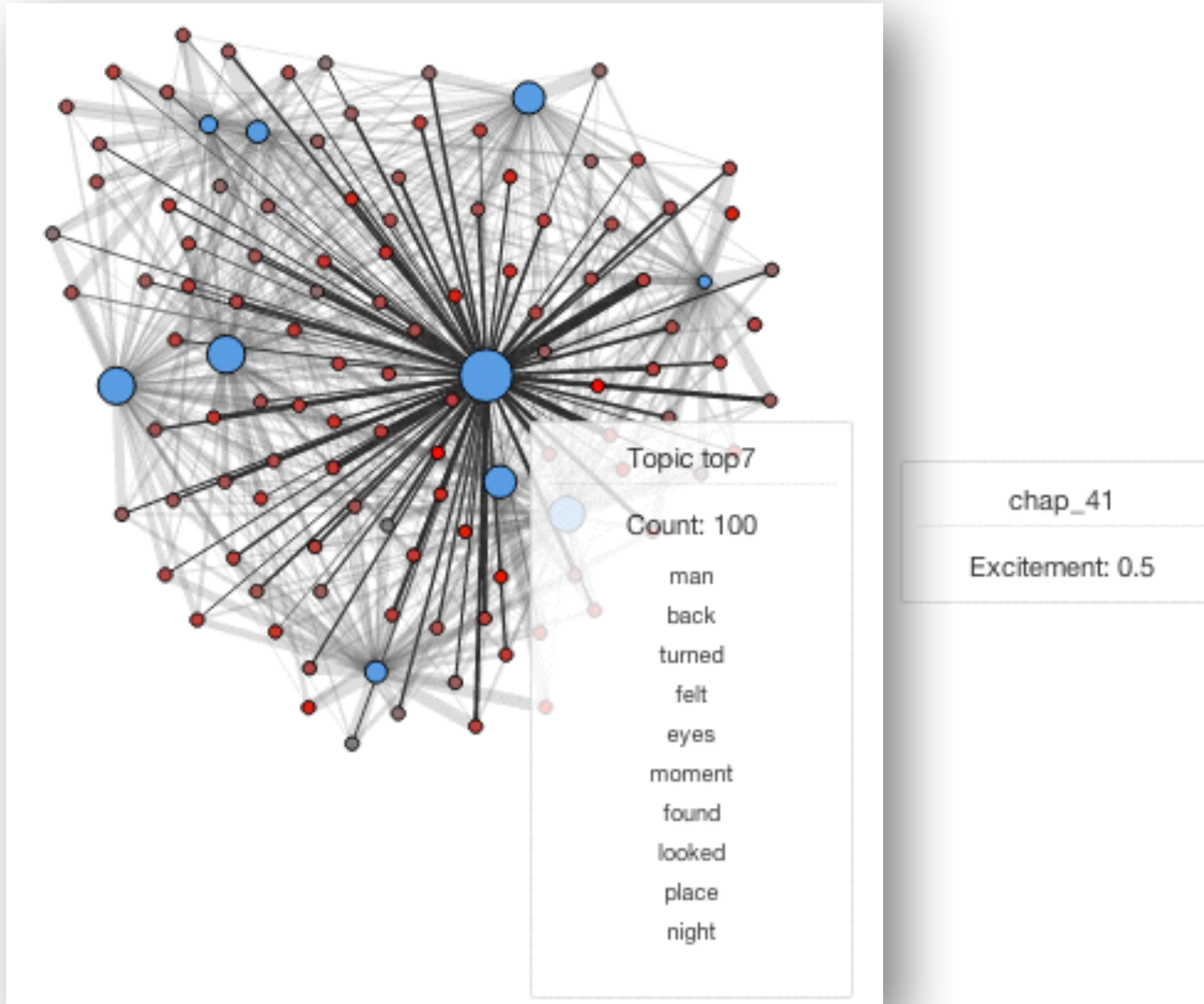
```
In [36]: topics_per_doc = read_doctopics(topic_docs)  # keep in mind the input GUI said to cut off classification a

chap_0 {'1': '0.055', '5': '0.130', '4': '0.188', '7': '0.130', '6': '0.063', '9': '0.210', '8': '0.147'}
chap_1 {'10': '0.068', '3': '0.072', '2': '0.095', '5': '0.057', '4': '0.095', '7': '0.143', '9': '0.210'
chap_10 {'1': '0.212', '3': '0.053', '5': '0.062', '4': '0.274', '7': '0.137', '8': '0.127'}
chap_100 {'1': '0.442', '8': '0.097', '4': '0.091', '7': '0.106', '6': '0.085'}
chap_101 {'1': '0.076', '3': '0.165', '5': '0.097', '4': '0.146', '7': '0.098', '6': '0.175', '9': '0.124
chap_102 {'1': '0.333', '8': '0.235', '4': '0.216', '6': '0.069'}
chap_103 {'1': '0.222', '2': '0.197', '7': '0.191', '6': '0.095', '9': '0.065', '8': '0.098'}
chap_104 {'10': '0.180', '3': '0.178', '5': '0.057', '4': '0.242', '7': '0.118', '6': '0.065', '9': '0.10
chap_105 {'10': '0.080', '3': '0.187', '5': '0.055', '4': '0.097', '7': '0.087', '6': '0.134', '9': '0.25
chap_106 {'10': '0.075', '5': '0.072', '4': '0.353', '7': '0.124', '9': '0.114', '8': '0.155'}
chap_11 {'10': '0.072', '3': '0.097', '2': '0.314', '7': '0.090', '9': '0.240', '8': '0.073'}
chap_12 {'9': '0.229', '8': '0.132', '3': '0.150', '2': '0.261', '7': '0.083'}
chap_13 {'3': '0.157', '2': '0.160', '7': '0.091', '6': '0.058', '9': '0.309', '8': '0.091'}
chap_14 {'9': '0.059', '8': '0.176', '3': '0.102', '2': '0.459', '7': '0.083'}
```

The results of topic modeling



The basic idea… without coding so much.

Demo:
http://www.ghostweather.com/essays/talks/openvisconf/topic_docs_network/index_better.html



Our next step: Process GUI CSV Output

After running the Topic Modeling gui, we start with the IPython notebook "Topic Analysis of Mixed Fiction.ipynb."

If you want to run the notebooks, make sure you are in an active virtual env:

```
> source activate topic_workshop
(topic_workshop)> ipython notebook
```

If you don't want to run it, you can achieve the same outputs with the path to the gui output csv file:

```
(topic_workshop)> cd files
(topic_workshop)> python make_gephi_file.py topic_output/output_csv all
```

Our next steps:

1. Excel pivot table analysis with the for_excel.csv file
2. Gephi for the gdf file output!

Tips on Gephi layout and UI are in the PDF:

GephiToSigmaJS_Mixed.pdf

How can you improve on the results?

Iterate on number of topics you output. Try 10, instead of 15!

Rerun the GUI with 10, then use command line:

```
> cd files
> python make_gephi_file.py topic_output/output_csv 10
```

How else can you improve?

Pre-process the documents — change what's modeled! Maybe only verbs?

- Use stop words tuned for your data set (don't want proper nouns? or only proper nouns?)
- Read in a document, parse it, save out a new "document" of the POS you want, then use those in the topic modeler

Our next step… Prepocess docs.

Use the notebook POS_Text_Conversion.ipynb

In this notebook, we'll look at how to handle text: tokenize it, clean it, strip out words/punctuation, find parts of speech…

For faster, command-line use (requires pattern and nltk installed!)

```
>cd files
>python preprocess_files.py ../data/mixed_chapters ../data/verbs_only VB
```

Now look at those results…

1. Make a directory for the new topic modeled files under files:

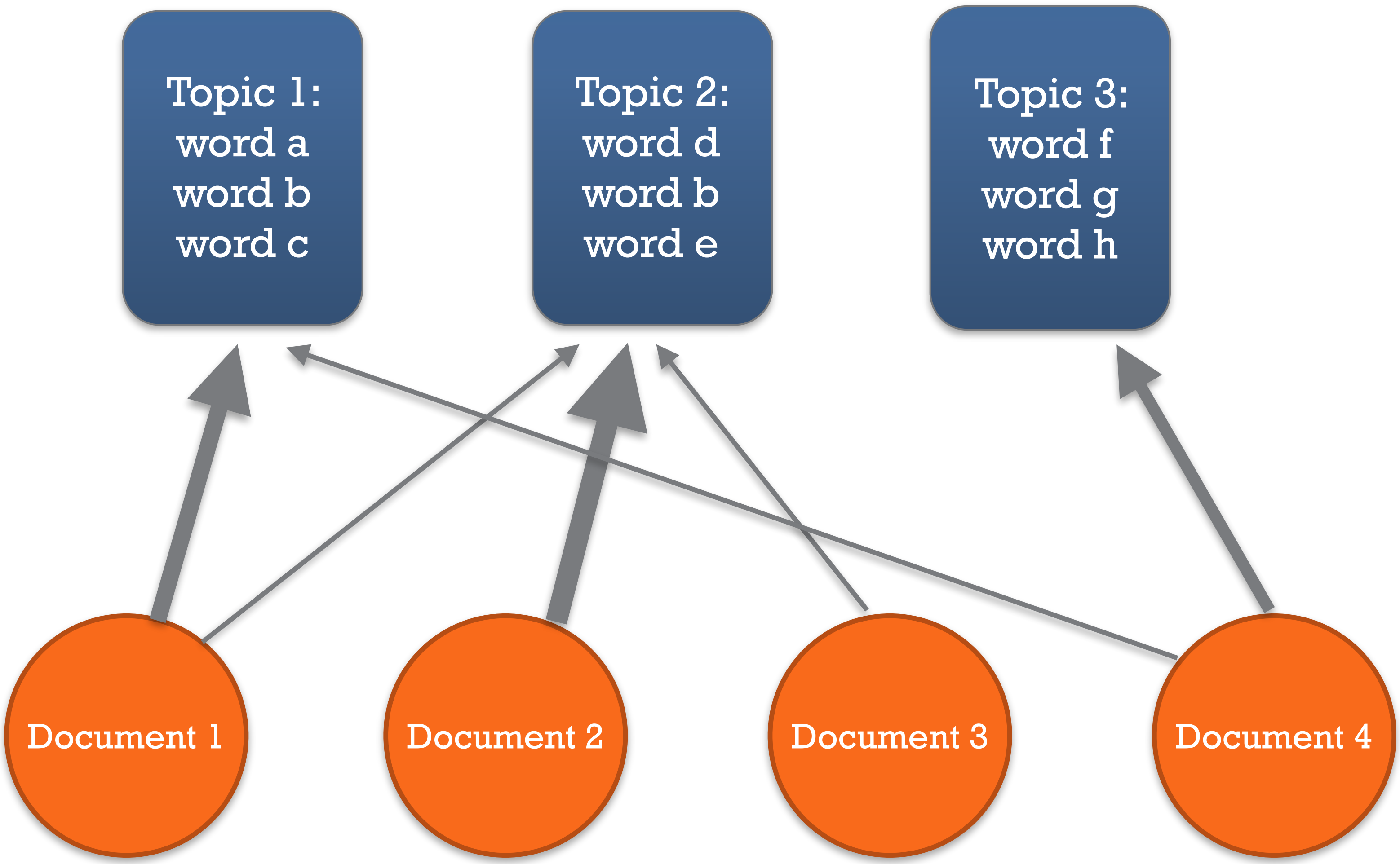
   ```
   >mkdir verb_output
   ```

2. Rerun the GUI with this as output directory, and the verb files as your input files!
3. Then use command line:

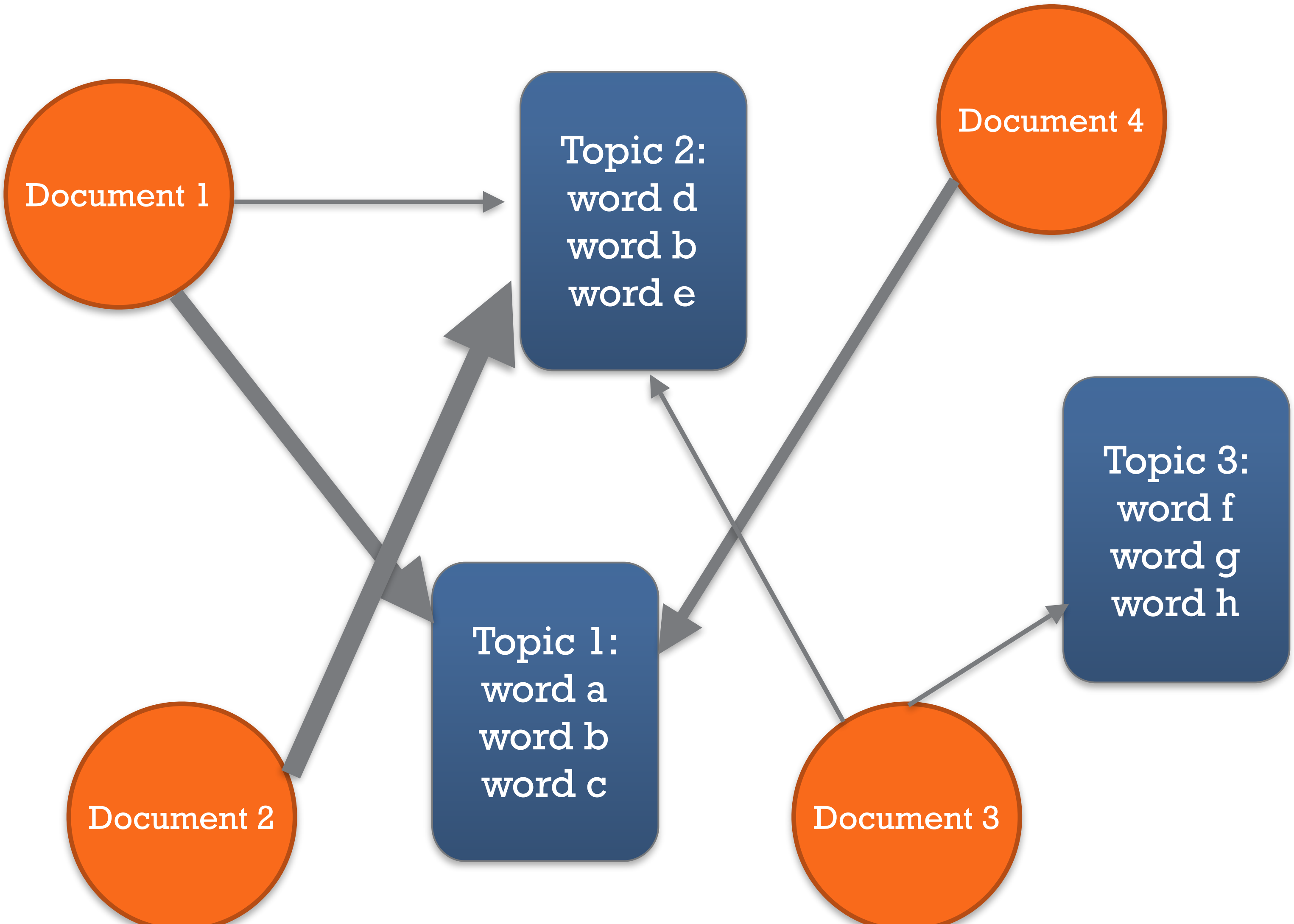
   ```
   > cd files
   > python make_gephi_file.py verb_output/output_csv verbs
   ```

4. Then find the output for_gephi_topics_verbs.gdf & visualize in Gephi.

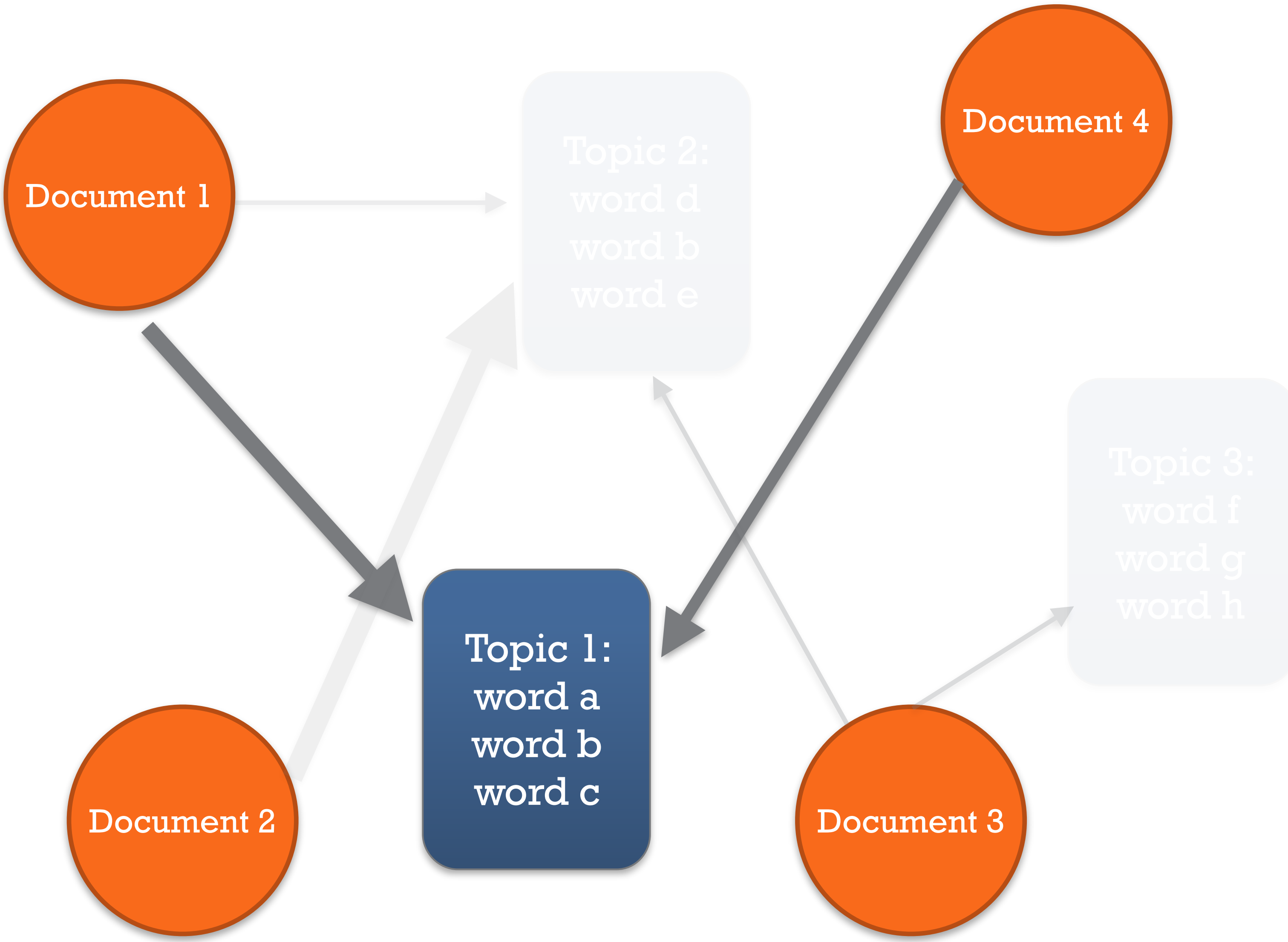
How we started…



Another view: More Like Ours



Another view: Related Document to Document



Going to D3

- Raw nodes-edges json:
  - export json from gephi (using JSON plugin)
  - or post-process and create the json: see next step
  - Example of d3 network use: http://bl.ocks.org/mbostock/4062045
- Export gexf and use Elijah Meeks' code to process and display it from gexf format:
  - http://bl.ocks.org/emeeks/9357371

But we need to account for link weights

- Doc A — Topic 1, 40% words
- Doc B — Topic 1, 20% words

- How do you compute the weight of the relation between the Doc A and Doc B?
  - Options: difference (1 / diff) (normalized)
  - Average, Median, Count of edges

Our next step… Advanced: Doc to Doc in D3.

We want to combine some of the output we created as JSON files.

Use code in Advanced-D3 and GEXF Network of Docs Only.ipynb or files/d3_gexf.py.

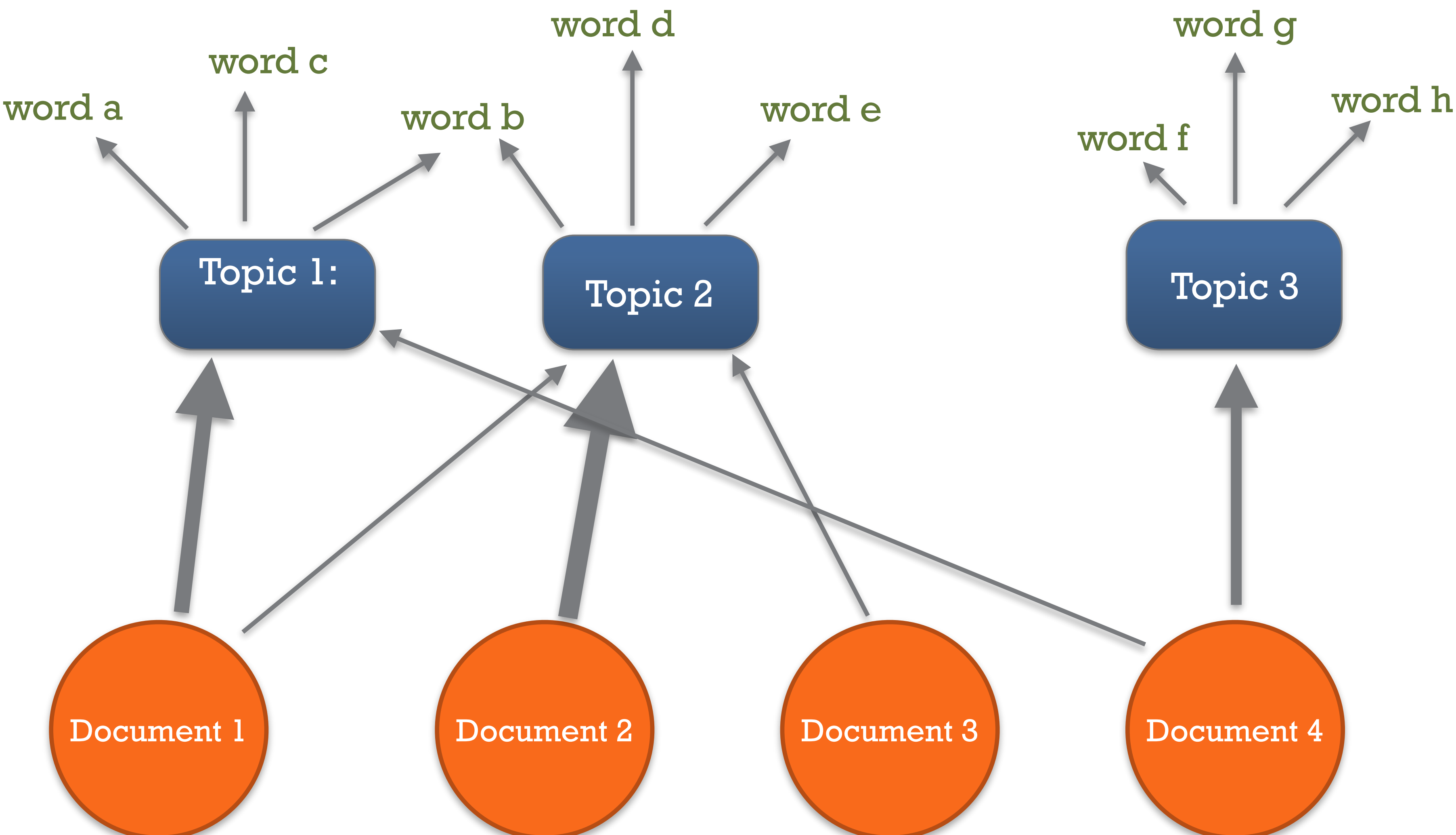
From the command line:

```
>cd files
>python d3_gexf.py for_excel.csv all for_excel_verbs.csv verbs
```

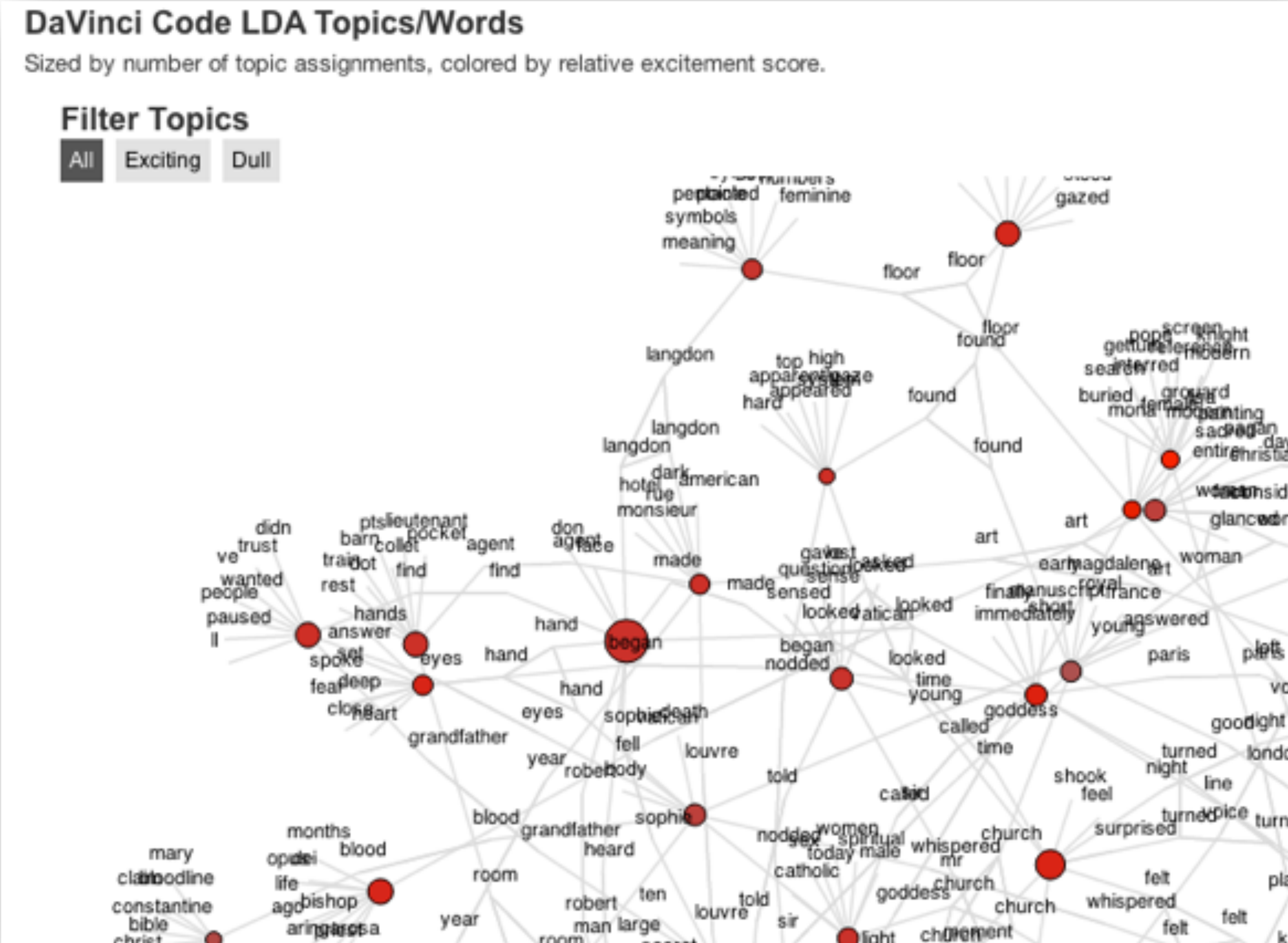
Output

- gexf file — for use in gephi if you want
- json files for use in d3
- combined json, if you input 2 csv files. Don't forget you need to include labels after each csv filename!

A further level of network you could draw….



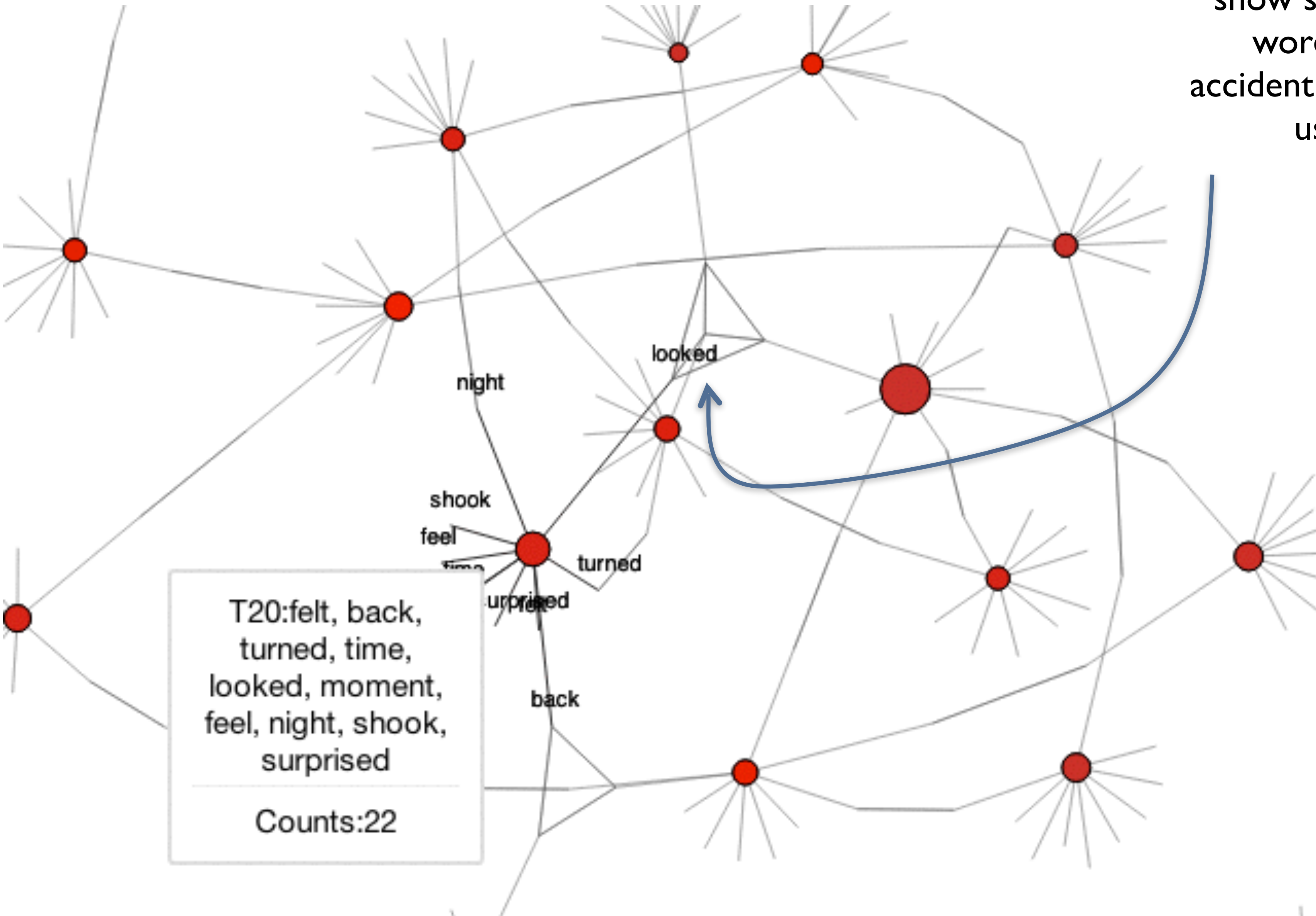
Maybe I need One More Tool. Any word relations of interest?
Let's try another hairball…



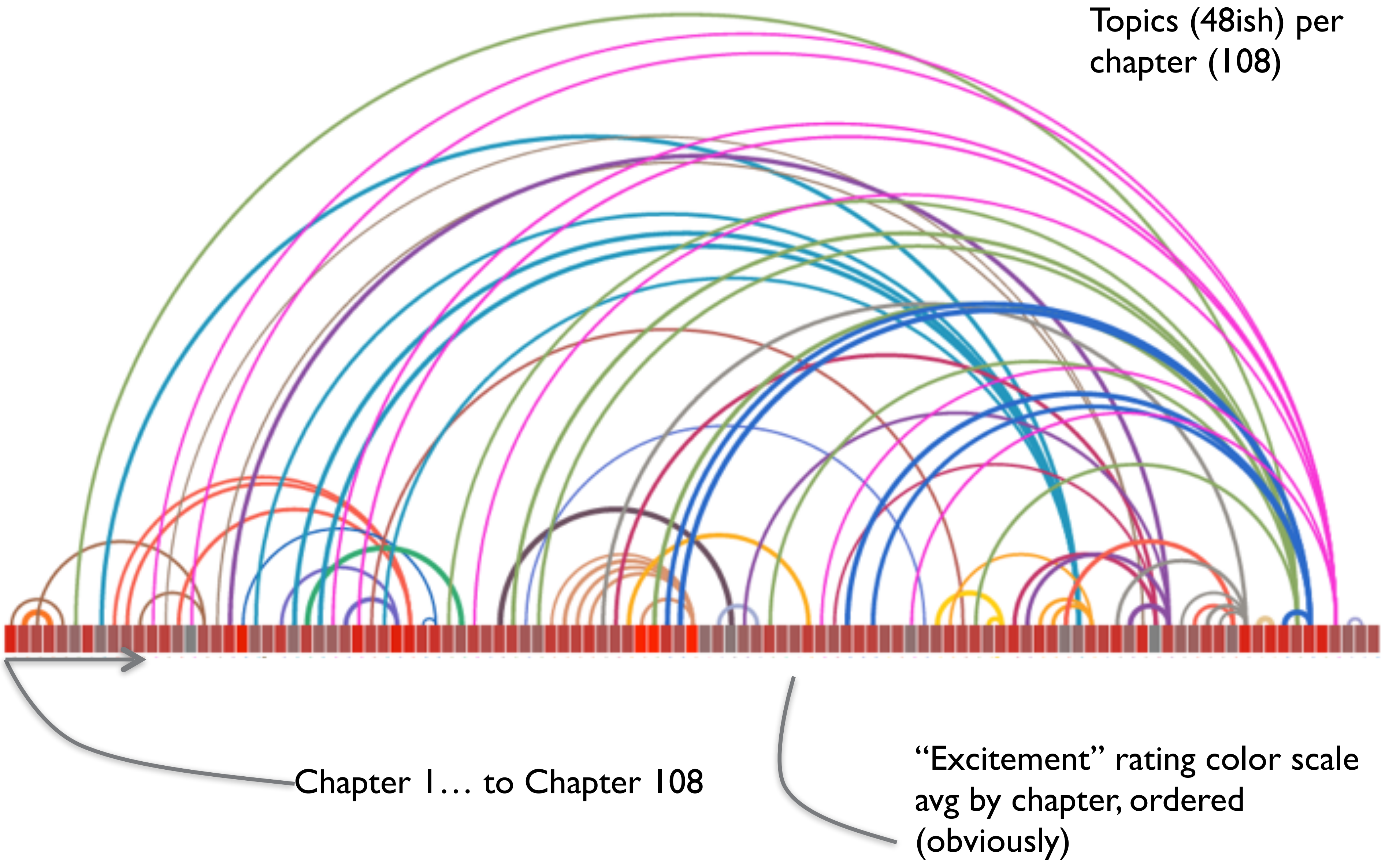
Demo: http://www.ghostweather.com/essays/talks/openvisconf/topic_words_network/index.html

Filtered to only the “exciting” nodes…

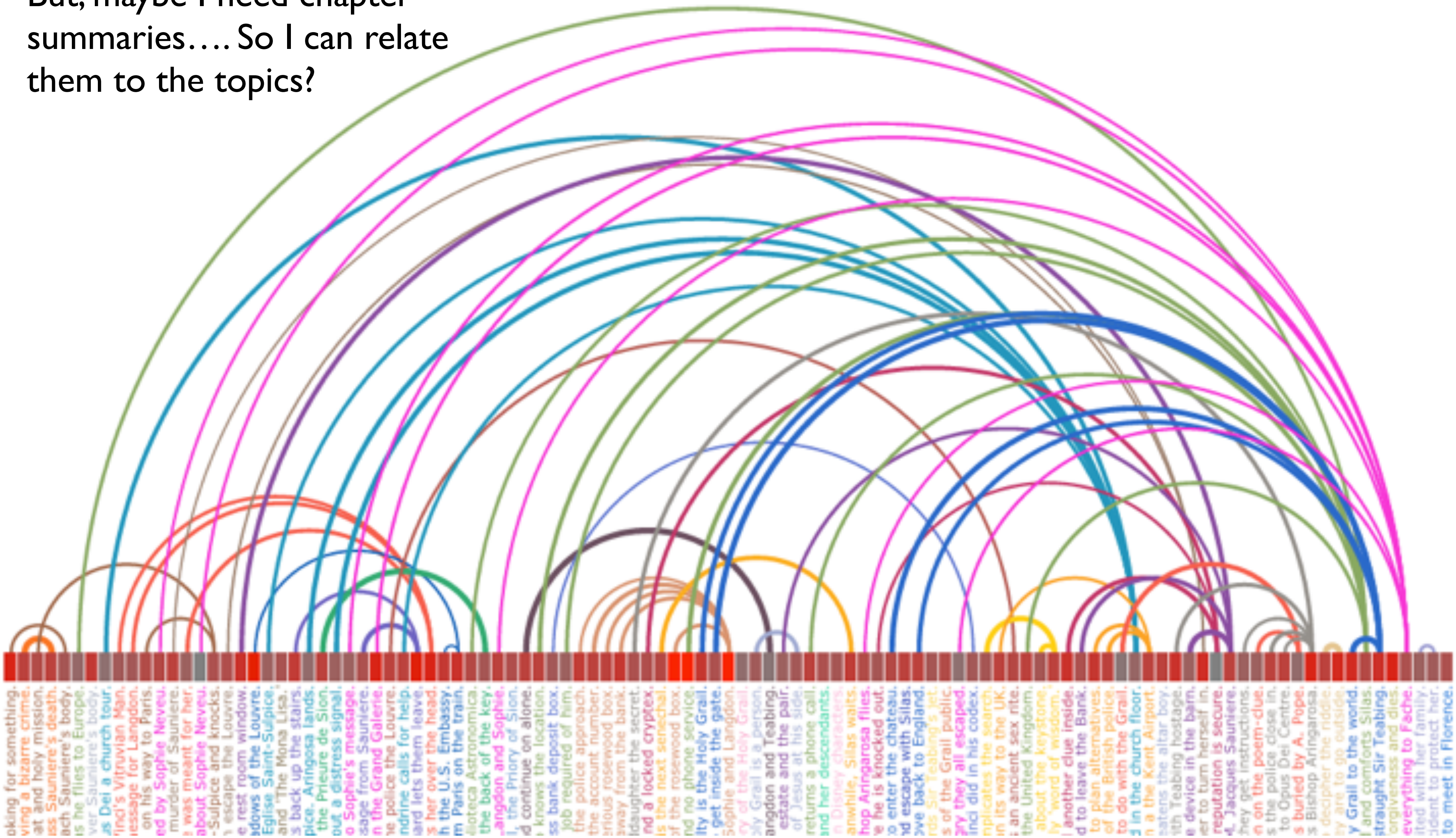
Small “constellations” show shared words (an accident that’s useful!)



Another tool: Sequential documents, with topic arcs.
DaVinci Code topics to chapters mapping

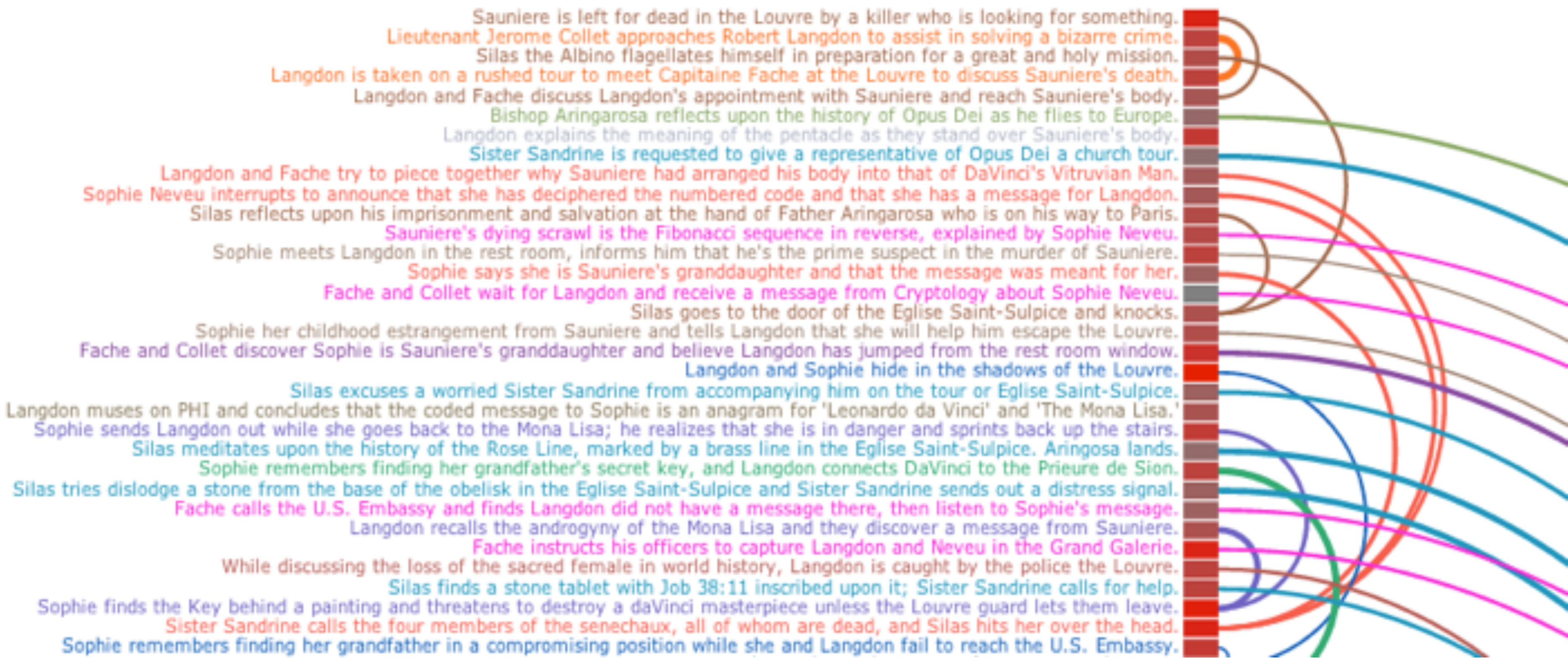


But, maybe I need chapter summaries…. So I can relate them to the topics?



Ah, but since it's svg/d3…

```
var chart = chart.append("g").attr("translate","0," + y).attr("transform","rotate(90 600 600)");
```

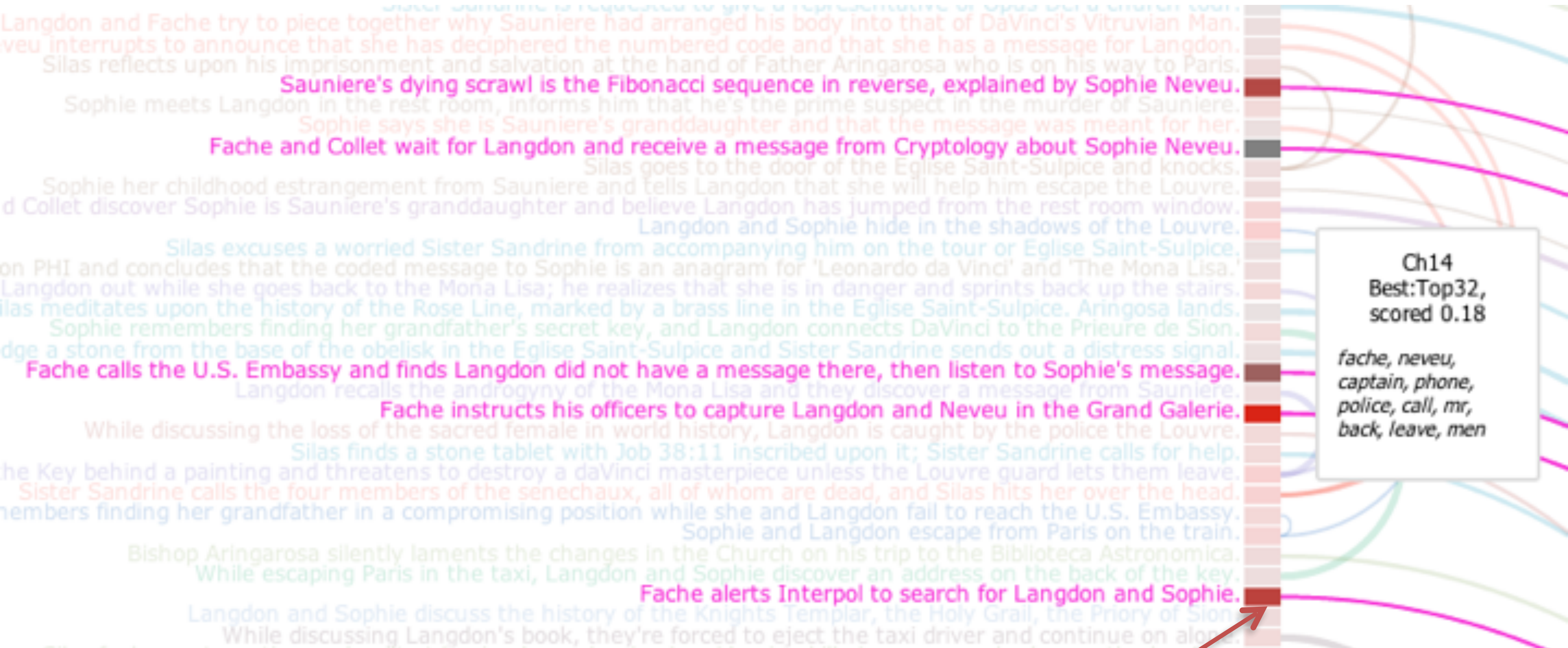


Add some topic-tooltips and fade-outs….

Demo: http://www.ghostweather.com/essays/talks/openvisconf/topic_arc_diagram/TopicArc.html

But what did this show?

Some topics are just neither exciting nor dull – topic clustering (as I did it) had little to do with action scenes. It's slightly helpful for topics, though ☺



These nodes are shaded from gray (dull) to red (exciting)

Improve the Results Display

- Visualize differently or more (chords, matrix…)
- Look for the topic words "in context" - find sentences with them and use those as part of your topic description
- Construct phrases from your topic words to make them "better" for descriptors
- Use only the interesting output words for a topic
- Don't use the result immediately — use as input to other methods (it's a data reduction technique like principal components analysis)

A Few More References

- Scott Weingart's nice overview of LDA Topic Modeling in Digital Humanities: http://www.scottbot.net/HIAL/?p=221
- Elijah Meeks' lovely set of articles on LDA & Digital Humanties vis: https://dhs.stanford.edu/comprehending-the-digital-humanities/
- Some pure python (and C) implementations (toy code, primarily) are listed on Blei's website: http://www.cs.princeton.edu/~blei/topicmodeling.html