Topic Modelling

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About the Module

- What are Topics
- Introduction to topic modelling
- Latent dirichlet allocation
- Implementation of topic modelling

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Topics

- A repeating group of statistically significant tokens or words in a corpus

- Statistical Significance

  - Group of words occurring together in the documents
  - Similar term and inverse document frequencies intervals
  - Frequently occurring together

Topic 1		Topic 2		Topic 3	
term	**weight**	**term**	**weight**	**term**	**weight**
game	0.014	space	0.021	drive	0.021
team	0.011	nasa	0.006	card	0.015
hockey	0.009	earth	0.006	system	0.013
play	0.008	henry	0.005	scsi	0.012
games	0.007	launch	0.004	hard	0.011

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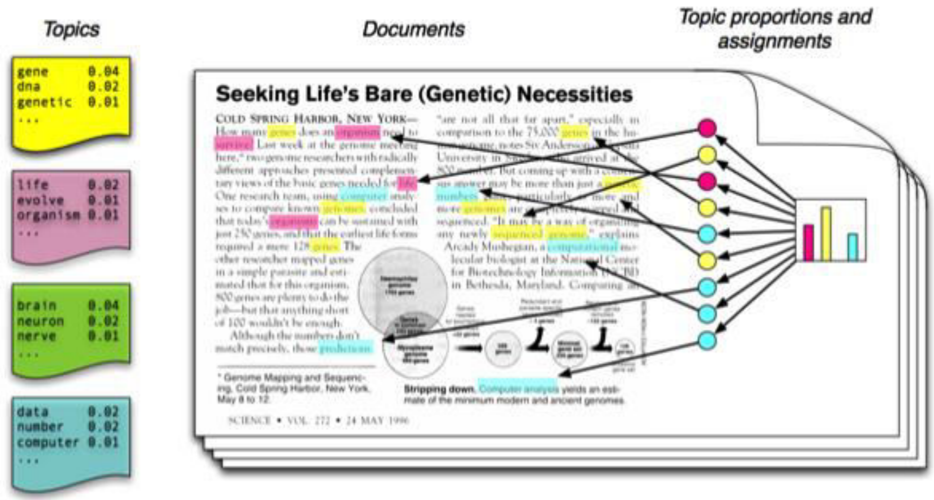
Topic Modelling



- Process to find the topics form documents in an unsupervised manner
- Text mining approach to find recurring patterns in the text documents

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Importance of Topic Modelling

- Document Categorization
- Document Summarization
- Dimensionality Reduction
- Information Retrieval
- Recommendation Engines

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Topic Modelling Techniques

- LDA – Latent Dirichlet Allocation
- NNMF – Non-Negative Matrix Factorization
- LSA – Latent Semantic Allocation

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Latent Dirichlet Allocation

Document 1: I want to have fruits for my breakfast.
Document 2: I like to eat almonds, eggs and fruits.
Document 3: I will take fruits and biscuits with me while going to Zoo
Document 4: The zookeeper feeds the lion very carefully
Document 5: One should give good quality biscuits to their dogs

LDA Output

- Topic 1: 30% fruits, 15% eggs, 10% biscuits… (… food)
- Topic 2: 20% lion, 10% dogs, 5% zoo… (… animals)

- Documents 1 and 2: 100% Topic 1
- Documents 3: 100% Topic 2
- Document 4 and Document 5: 70% Topic 1, 30% Topic 2

Latent Dirichlet Allocation

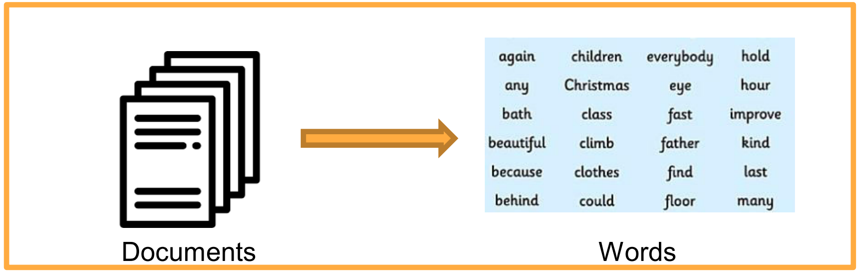
- Generative probabilistic model

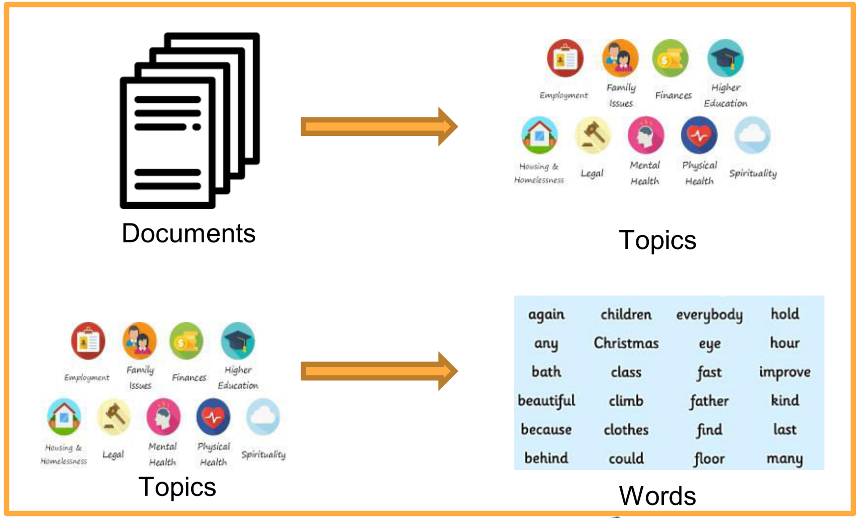
  Finds topics from a corpus
  Annotates documents with topics

- LDA Assumptions

  Documents = mixture of topics
  Topics = mixture of words

- Documents : Probability Distributions of Topics
  Topics : Probability Distributions of Words





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Latent Dirichlet Allocation

- Corpus : Document Word Matrix
- Document Word Matrix = Document Topic Matrix + Topic Word Matrix

	W1	W2	W3	Wn
D1	0	2	1	3
D2	1	4	0	0
D3	0	2	3	1
Dn	1	1	3	0

	K1	K2	K3	K
D1	1	0	0	1
D2	1	1	0	0
D3	1	0	0	1
Dn	1	0	1	0

	W1	W2	W3	Wm
K1	0	1	1	1
K2	1	1	1	0
K3	1	0	0	1
K	1	1	0	0

- Goal – Optimize representations

  Document Topic distributions
  Topic Terms distributions

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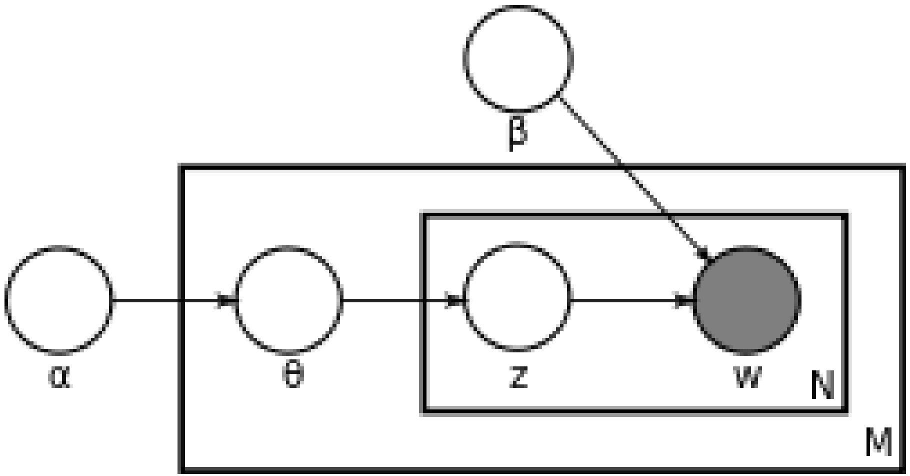
Latent Dirichlet Allocation



- M : Total Documents in Corpus
  N : No of words in a Document
  w : Word in a document
  z : Latent topic assigned to the word
  theta : Topic Distribution

- Alpha, Beta – LDA model parameters

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Latent Dirichlet Allocation

- Corpus:

D1 = (w1, w2, w3, w4, ……. wn)
D2 = (w'1, w'2, w'3, w'4, ……. w'n)
D3 = (w''1, w''2, w''3, w''4, ……. w''n)
...
...
Dm = (w1, w2, w3, w4, ……. wn)

- First step : Assign random topics to each word

D1 = (w1 (k4), w2 (k2), w3 (k2), w4 (k2), ……. wn (k3))
D2 = (w'1 (k1), w'2 (k7), w'3 (k3), w'4 (k6), ……. w'n (k2))
D3 = (w''1(k5), w''2 (k4), w''3 (k1), w''4 (k5), ……. w''n (k1))
...
...
Dm = (w1 (k4), w2 (k2), w3 (k6), w4 (k1), ……. wn (k2))

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D1 = (w1 (k4), w2 (k2), w3 (k2), w4 (k2), ……. wn (k3))
D2 = (w'1 (k1), w'2 (k7), w'3 (k3), w'4 (k6), ……. w'n (k2))
D3 = (w"1(k5), w"2 (k4), w"3 (k1), w"4 (k5), ……. w"n (k1))

Documents : Mixture of Topics:

D1 = k4 + k2 + k2 + k2 + … k3
D2 = k1 + k7 + k3 + k6 + … k2
D3 = k5 + k4 + k1 + k5 + … k1
Dn = ...

Topics : Mixture of Terms:

k1 = w'1 + w"3
k2 = w2 + w3 + w4 + …
…
kn = wi + ...

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Optimization Steps:

Iterate : each document d
Iterate : each word *w*

- Assume that all topic assignments except the current word are correct

- compute p1, p2

p1 = proportion (topic t / document d)

p2 = proportion (word w / topic t)

p1 -> proportion of words in document d that are currently assigned to topic t
p2 -> proportion of assignments to topic t that come from w, over all documents

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Latent Dirichlet Allocation

- Reassign word w of document d a new topic k’

  - Where we choose topic k’ with a new probability = p1 * p2

- Repeated large number of times until steady state

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