What is coming up?

- Sentiment Analysis
- Converting text to numbers
- DTM and TF-IDF matrix
- Some more text cleaning exercises and examples
- Cosine Similarity

TF-IDF Motivation

text, analytics, boring,

interesting, sports, want

Consider the following 3 sentences -

- □ S1 = Text Analytics is boring boring boring
- □ S2 = Analytics is interesting
- □ S3 = We want interesting sports analytics
- □ S4 = Analytics is interesting. Analytics is interesting

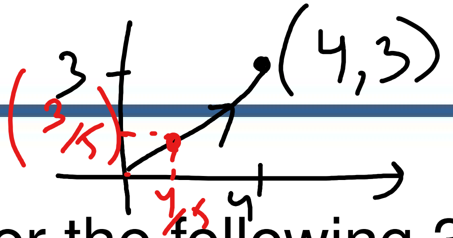
We can choose to remove the stopwords, convert everything to lowercase and construct the following matrix. We call this DTM or Document Term Matrix.

	analytics	boring	interesting	sports	text	want
S-1	1	3	0	0	1	0
S-2	1	0	1	0	0	0
S-3	1	0	1	1	0	1

Structured Data

~~TF-IDF~~ Motivation

"Document Term Matrix"



$\rightarrow \left(\frac{4}{5}, \frac{3}{5}\right)$

Binary DTM

Consider the following 3 sentences -

- ❑ S1 = Text Analytics is boring boring boring
- ❑ S2 = Analytics is interesting
- ❑ S3 = We want interesting sports analytics

$\sqrt{1^2+3^2+0^2+0^2+1^2+0^2}$

$= \sqrt{11}$

We can choose to remove the stopwords, convert everything to lowercase and construct the following matrix. We call this DTM or Document Term Matrix.

	analytics	boring	interesting	sports	text	want
S-1	1	3 1	0	0	1	0
S-2	1	0	1	0	0	0
S-3	1	0	1	1	0	1

$\left(\frac{1}{\sqrt{11}}, \frac{3}{\sqrt{11}}, 0, 0, \frac{1}{\sqrt{11}}, 0\right) \leftarrow (1, 3, 0, 0, 1, 0)$

$(0, 0, 0, 0, 0, 0)$

6 dimensional vector

TF-IDF Motivation

	analytics	boring	interesting	sports	text	want
S-1	1	3	0	0	1	0
S-2	1	0	1	0	0	0
S-3	1	0	1	1	0	1

We see that analytics and sports is getting the same weightage in S-3, whereas "sports" is exclusive to S-3, "analytics" can be found in all sentences.

In TF-IDF Matrix, we increase the weightage of the words that are exclusive to a document/sentence and decrease the weightage of the words that are common to many sentences.

TF-IDF Motivation

→ Term Frequency - Inverse Document Frequency

	analytics	boring	interesting	sports	text	want
S-1	1 × (1/3)	3 × 1	0 × 1	0	1	0
S-2	1 × (1/3)	0 × 1	1 × (1/2)	0	0	0
S-3	1 × (1/3) ↓	0 × 1	1 × (1/2)	1 ↑	0	1
	(3)	(1)	(2)	(1)	(1)	(1)

We see that analytics and sports is getting the same weightage in S-3, whereas "sports" is exclusive to S-3, "analytics" can be found in all sentences.

In TF-IDF Matrix, we increase the weightage of the words that are exclusive to a document/sentence and decrease the weightage of the words that are common to many sentences.

TF-IDF Motivation

DF = Document Frequency(computed for each term),
IDF = Inverse Document Frequency(computed for each term),
TF = Term Frequency (essentially the DTM matrix),
n = number of documents

	analytics	boring	interesting	sports	text	want
S-1	1	3	0	0	1	0
S-2	1	0	1	0	0	0
S-3	1	0	1	1	0	1
DF	3	1	2	1	1	1

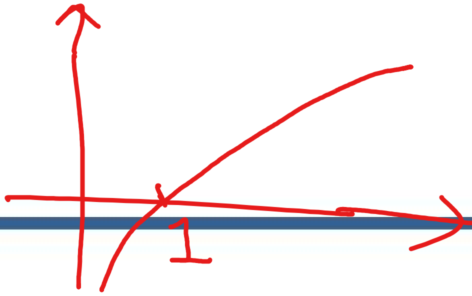
As the name suggests, we would multiply the elements in TF with the corresponding IDF.
Several methods have been proposed in literature for the formula of IDF, one of the common ones is -

$$\text{IDF} = 1 + \ln\left(\frac{1+n}{1+DF}\right)$$

TF-IDF Motivation

$$IDF = 1 + \ln\left(\frac{1+3}{1+3}\right)$$

$$(\text{D.F. interesting}) = 1 + \ln\left(\frac{1+3}{1+2}\right) = 1 + \ln\left(\frac{4}{3}\right)$$



DF = Document Frequency(computed for each term),
IDF = Inverse Document Frequency(computed for each term),
TF = Term Frequency (essentially the DTM matrix),
n = number of documents

$$IDF(\text{analytics}) = 1 + 0 = 1$$

	analytics	boring	interesting	sports	text	want
S-1	1	3	0	0	1	0
S-2	1	0	1	0	0	0
S-3	1	0	1	1	0	1
DF	3	1	2	1	1	1

As the name suggests, we would multiply the elements in TF with the corresponding IDF.

Several methods have been proposed in literature for the formula of IDF, one of the common ones is -

$$1 + \boxed{\ln\left(\frac{1+n}{1+DF}\right)} \rightarrow (\downarrow DF)$$

$$IDF = 1 + \ln\left(\frac{1+n}{1+DF}\right)$$

$$n = 3$$

TF-IDF

	analytics	boring	interesting	sports	text	want
S-1	1	3	0	0	1	0
S-2	1	0	1	0	0	0
S-3	1	0	1	1	0	1
DF	3	1	2	1	1	1
IDF	1+ln(1)	1+ln(2)	1+ln(4/3)	1+ln(2)	1+ln(2)	1+ln(2)

We then multiply the TFs with the corresponding IDFs to get-

	analytics	boring	interesting	sports	text	want
S-1	1*1	3*1.693	0*1.287	0*1.693	1*1.693	0*1.693
S-2	1*1	0*1.693	1*1.287	0*1.693	0*1.693	0*1.693
S-3	1*1	0*1.693	1*1.287	1*1.693	0*1.693	1*1.693

Finally, we convert every row vector to a unit vector.

TF-IDF

	analytics	boring	interesting	sports	text	want
S-1	1 \ IDF	3 x IDF	0	0	1	0
S-2	1	0	1	0	0	0
S-3	1	0	1	1	0	1
DF	3	1	2	1	1	1
→ IDF	1+ln(1)	1+ln(2)	1+ln(4/3)	1+ln(2)	1+ln(2)	1+ln(2)

We then multiply the TFs with the corresponding IDFs to get-

	analytics	boring	interesting	sports	text	want
S-1	1*1	3*1.693	0*1.287	0*1.693	1*1.693	0*1.693
S-2	1*1	0*1.693	1*1.287	0*1.693	0*1.693	0*1.693
S-3	1*1	0*1.693	1*1.287	1*1.693	0*1.693	1*1.693

Finally, we convert every row vector to a unit vector.

TF-IDF Matrix finally

From the previous slide,

	analytics	boring	interesting	sports	text	want
S-1	1*1	3*1.693	0*1.287	0*1.693	1*1.693	0*1.693
S-2	1*1	0*1.693	1*1.287	0*1.693	0*1.693	0*1.693
S-3	1*1	0*1.693	1*1.287	1*1.693	0*1.693	1*1.693

After normalization of each row,

TF-IDF Matrix						
	analytics	boring	interesting	sports	text	want
S-1	0.1836	0.9326	0	0	0.3109	0
S-2	0.6134	0	0.7898	0	0	0
S-3	0.3452	0	0.4445	0.5845	0	0.5845