

Natural Language Processing

BBC News Articles: Politics

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CS256-Fall 2022

[Project milestone Colab](#)

Introduction

- BBC News Articles: 2004 - 2005
- New Articles and Summaries - 417 Articles
 - Each article has a corresponding summary with only 'important' sentences that help to summarize the article
 - Total: 8772 sentences with 3671 summary sentences
- Coding done in Python

Goal: Can we predict which sentences from any given article will be important to summarize the entire article?

Data Preparation

Sentence separation:

- Separate title sentence of documents by '\n\n'
- Removed punctuations and newlines (such as “,\n) other than period, question mark and exclamation mark that sometimes cause sentence separation issues
- Inserted space after a period, question mark, and exclamation mark if it was followed by a word or non-digit character (This prevents a number like 4.5 from becoming split as a sentence)
- Merge multiple periods and space into one.
- Remove numbers after a period if the character before period is non-digit (Such as John.2)

NLP Technique

- We removed stop words, and applied lemmatization

Test/Train Data split

- Split the data with a 80/20 ratio. The first 20% of the articles (1 - 83) as the Testing data and last 80% of the articles as the Training data (84 - 417)

Tokenizing Sentence

- Stemming: removes last few characters from a word. Often not keeping the original meaning of the word
- Lemmatization: considers the context and converts the word to its meaningful base form

Training Data

This is good
I am a good student
This is bad



Features

This	is	a	I	am	good	bad	student
1	1	0	0	0	1	0	0
0	0	1	1	1	1	0	1
1	1	0	0	0	0	1	0

Function Scores

6 Functions are used to help determine a sentences importance

F1: Title Feature

Measure the presence of title words in the sentence

$$F1(\text{Sentence, article title}) = (\text{number of title words in the sentence}) / (\text{total number of words in the sentence})$$

Title features (F1)

		Sentence	F1
0		Maternity pay for new mothers is to rise by £1,400 as part of new proposals announced by the Trade and Industry Secretary Patricia Hewitt.	0.6
1		It would mean paid leave would be increased to nine months by 2007, Ms Hewitt told GMTV's Sunday programme.	0.0
2		Other plans include letting maternity pay be given to fathers and extending rights to parents of older children.	0.6
3		The Tories dismissed the maternity pay plan as "desperate", while the Liberal Democrats said it was misdirected.	0.4
4		Ms Hewitt said: "We have already doubled the length of maternity pay, it was 13 weeks when we were elected, we have already taken it up to 26 weeks.	0.4
5		"We are going to extend the pay to nine months by 2007 and the aim is to get it right up to the full 12 months by the end of the next Parliament."	0.2
6		She said new mothers were already entitled to 12 months leave, but that many women could not take it as only six of those months were paid.	0.0
7		"We have made a firm commitment.	0.0
8		We will definitely extend the maternity pay, from the six months where it now is to nine months, that's the extra £1,400."	0.4
9		She said ministers would consult on other proposals that could see fathers being allowed to take some of their partner's maternity pay or leave period, or extending the rights of flexible working to carers or parents of older children.	0.4
10		The Shadow Secretary of State for the Family, Theresa May, said: "These plans were announced by Gordon Brown in his pre-budget review in December and Tony Blair is now recycling it in his desperate bid to win back women voters."	0.2
11		She said the Conservatives would announce their proposals closer to the General Election.	0.0
12		Liberal Democrat spokeswoman for women Sandra Gidley said: "While mothers would welcome any extra maternity pay the Liberal Democrats feel this money is being misdirected."	0.4
13		She said her party would boost maternity pay in the first six months to allow more women to stay at home in that time.	0.4
14		Ms Hewitt also stressed the plans would be paid for by taxpayers, not employers.	0.2
15		But David Frost, director general of the British Chambers of Commerce, warned that many small firms could be "crippled" by the move.	0.0
16		"While the majority of any salary costs may be covered by the government's statutory pay, recruitment costs, advertising costs, retraining costs and the strain on the company will not be," he said.	0.2
17		Further details of the government's plans will be outlined on Monday.	0.2
18		New mothers are currently entitled to 90% of average earnings for the first six weeks after giving birth, followed by £102.80 a week until the baby is six months old.	0.0

Function scores are as expected for above article with title "Labour plans maternity pay rise"

F2: Sentence Length

Measure the length of a sentence

$$F2(\text{Sentence, article}) = (\text{total number of words in the sentence}) / (\text{total number of words in the longest sentence})$$

Sentence Length (F2)

	Sentence	F2
0	Maternity pay for new mothers is to rise by £1,400 as part of new proposals announced by the Trade and Industry Secretary Patricia Hewitt.	0.600
1	It would mean paid leave would be increased to nine months by 2007, Ms Hewitt told GMTV's Sunday programme.	0.475
2	Other plans include letting maternity pay be given to fathers and extending rights to parents of older children.	0.450
3	The Tories dismissed the maternity pay plan as "desperate", while the Liberal Democrats said it was misdirected.	0.425
4	Ms Hewitt said: "We have already doubled the length of maternity pay, it was 13 weeks when we were elected, we have already taken it up to 26 weeks.	0.725
5	"We are going to extend the pay to nine months by 2007 and the aim is to get it right up to the full 12 months by the end of the next Parliament."	0.825
6	She said new mothers were already entitled to 12 months leave, but that many women could not take it as only six of those months were paid.	0.675
7	"We have made a firm commitment.	0.150
8	We will definitely extend the maternity pay, from the six months where it now is to nine months, that's the extra £1,400."	0.550
9	She said ministers would consult on other proposals that could see fathers being allowed to take some of their partner's maternity pay or leave period, or extending the rights of flexible working to carers or parents of older children.	0.975
10	The Shadow Secretary of State for the Family, Theresa May, said: "These plans were announced by Gordon Brown in his pre-budget review in December and Tony Blair is now recycling it in his desperate bid to win back women voters."	1.000
11	She said the Conservatives would announce their proposals closer to the General Election.	0.325
12	Liberal Democrat spokeswoman for women Sandra Gidley said: "While mothers would welcome any extra maternity pay the Liberal Democrats feel this money is being misdirected."	0.625
13	She said her party would boost maternity pay in the first six months to allow more women to stay at home in that time.	0.600
14	Ms Hewitt also stressed the plans would be paid for by taxpayers, not employers.	0.350
15	But David Frost, director general of the British Chambers of Commerce, warned that many small firms could be "crippled" by the move.	0.550
16	"While the majority of any salary costs may be covered by the government's statutory pay, recruitment costs, advertising costs, retraining costs and the strain on the company will not be," he said.	0.800
17	Further details of the government's plans will be outlined on Monday.	0.275
18	New mothers are currently entitled to 90% of average earnings for the first six weeks after giving birth, followed by £102.80 a week until the baby is six months old.	0.750

Function scores are as expected, the longest sentence has the highest score of 1, and the shortest article has the lowest score.

F3: Sentence Position

Measure the position of the sentence within the article

$$F3(\text{Sentence, article}) = \text{MAX} [(1 / (\text{position of sentence})), (1 / ((\text{number of sentences in the article}) - (\text{position of sentence}) + 1))]$$

Sentence position (F3)

	Sentence	F3
0	Maternity pay for new mothers is to rise by £1,400 as part of new proposals announced by the Trade and Industry Secretary Patricia Hewitt.	1.000
1	It would mean paid leave would be increased to nine months by 2007, Ms Hewitt told GMTV's Sunday programme.	0.500
2	Other plans include letting maternity pay be given to fathers and extending rights to parents of older children.	0.333
3	The Tories dismissed the maternity pay plan as "desperate", while the Liberal Democrats said it was misdirected.	0.250
4	Ms Hewitt said: "We have already doubled the length of maternity pay, it was 13 weeks when we were elected, we have already taken it up to 26 weeks.	0.200
5	"We are going to extend the pay to nine months by 2007 and the aim is to get it right up to the full 12 months by the end of the next Parliament."	0.167
6	She said new mothers were already entitled to 12 months leave, but that many women could not take it as only six of those months were paid.	0.143
7	"We have made a firm commitment.	0.125
8	We will definitely extend the maternity pay, from the six months where it now is to nine months, that's the extra £1,400."	0.111
9	She said ministers would consult on other proposals that could see fathers being allowed to take some of their partner's maternity pay or leave period, or extending the rights of flexible working to carers or parents of older children.	0.100
10	The Shadow Secretary of State for the Family, Theresa May, said: "These plans were announced by Gordon Brown in his pre-budget review in December and Tony Blair is now recycling it in his desperate bid to win back women voters."	0.111
11	She said the Conservatives would announce their proposals closer to the General Election.	0.125
12	Liberal Democrat spokeswoman for women Sandra Gidley said: "While mothers would welcome any extra maternity pay the Liberal Democrats feel this money is being misdirected."	0.143
13	She said her party would boost maternity pay in the first six months to allow more women to stay at home in that time.	0.167
14	Ms Hewitt also stressed the plans would be paid for by taxpayers, not employers.	0.200
15	But David Frost, director general of the British Chambers of Commerce, warned that many small firms could be "crippled" by the move.	0.250
16	"While the majority of any salary costs may be covered by the government's statutory pay, recruitment costs, advertising costs, retraining costs and the strain on the company will not be," he said.	0.333
17	Further details of the government's plans will be outlined on Monday.	0.500
18	New mothers are currently entitled to 90% of average earnings for the first six weeks after giving birth, followed by £102.80 a week until the baby is six months old.	1.000

Function scores are as expected, the first and last sentences have the highest scores. The lowest score for this function is for sentences in the middle of the article.

F4: Term Weight

Measure the term occurrences in a sentence

$$F4(\text{Sentence, article}) = \Sigma (\text{term occurrences in the sentence}) / \Sigma (\text{term occurrences in the article})$$

Term Weight (F4)

		Sentence	F4
0		Maternity pay for new mothers is to rise by £1,400 as part of new proposals announced by the Trade and Industry Secretary Patricia Hewitt.	0.174
1		It would mean paid leave would be increased to nine months by 2007, Ms Hewitt told GMTV's Sunday programme.	0.229
2		Other plans include letting maternity pay be given to fathers and extending rights to parents of older children.	0.209
3		The Tories dismissed the maternity pay plan as "desperate", while the Liberal Democrats said it was misdirected.	0.195
4		Ms Hewitt said: "We have already doubled the length of maternity pay, it was 13 weeks when we were elected, we have already taken it up to 26 weeks.	0.213
5		"We are going to extend the pay to nine months by 2007 and the aim is to get it right up to the full 12 months by the end of the next Parliament."	0.239
6		She said new mothers were already entitled to 12 months leave, but that many women could not take it as only six of those months were paid.	0.231
7		"We have made a firm commitment.	0.417
8		We will definitely extend the maternity pay, from the six months where it now is to nine months, that's the extra £1,400."	0.183
9		She said ministers would consult on other proposals that could see fathers being allowed to take some of their partner's maternity pay or leave period, or extending the rights of flexible working to carers or parents of older children.	0.258
10		The Shadow Secretary of State for the Family, Theresa May, said: "These plans were announced by Gordon Brown in his pre-budget review in December and Tony Blair is now recycling it in his desperate bid to win back women voters."	0.268
11		She said the Conservatives would announce their proposals closer to the General Election.	0.165
12		Liberal Democrat spokeswoman for women Sandra Gidley said: "While mothers would welcome any extra maternity pay the Liberal Democrats feel this money is being misdirected."	0.229
13		She said her party would boost maternity pay in the first six months to allow more women to stay at home in that time.	0.190
14		Ms Hewitt also stressed the plans would be paid for by taxpayers, not employers.	0.173
15		But David Frost, director general of the British Chambers of Commerce, warned that many small firms could be "crippled" by the move.	0.259
16		"While the majority of any salary costs may be covered by the government's statutory pay, recruitment costs, advertising costs, retraining costs and the strain on the company will not be," he said.	0.271
17		Further details of the government's plans will be outlined on Monday.	0.162
18		New mothers are currently entitled to 90% of average earnings for the first six weeks after giving birth, followed by £102.80 a week until the baby is six months old.	0.228

Function scores are as expected, the sentences whose words do not have a high occurrence in the text will have a higher score.

F5: Proper Noun

Measure the occurrences of proper nouns in a sentence

$$F5(\text{Sentence}) = (\text{number of proper nouns in the sentence}) / (\text{total number of words in the sentence})$$

Proper Nouns (F5)

	Sentence	F5
0	Maternity pay for new mothers is to rise by £1,400 as part of new proposals announced by the Trade and Industry Secretary Patricia Hewitt.	0.250
1	It would mean paid leave would be increased to nine months by 2007, Ms Hewitt told GMTV's Sunday programme.	0.211
2	Other plans include letting maternity pay be given to fathers and extending rights to parents of older children.	0.000
3	The Tories dismissed the maternity pay plan as "desperate", while the Liberal Democrats said it was misdirected.	0.176
4	Ms Hewitt said: "We have already doubled the length of maternity pay, it was 13 weeks when we were elected, we have already taken it up to 26 weeks.	0.069
5	"We are going to extend the pay to nine months by 2007 and the aim is to get it right up to the full 12 months by the end of the next Parliament."	0.000
6	She said new mothers were already entitled to 12 months leave, but that many women could not take it as only six of those months were paid.	0.000
7	"We have made a firm commitment.	0.000
8	We will definitely extend the maternity pay, from the six months where it now is to nine months, that's the extra £1,400."	0.000
9	She said ministers would consult on other proposals that could see fathers being allowed to take some of their partner's maternity pay or leave period, or extending the rights of flexible working to carers or parents of older children.	0.000
10	The Shadow Secretary of State for the Family, Theresa May, said: "These plans were announced by Gordon Brown in his pre-budget review in December and Tony Blair is now recycling it in his desperate bid to win back women voters."	0.275
11	She said the Conservatives would announce their proposals closer to the General Election.	0.231
12	Liberal Democrat spokeswoman for women Sandra Gidley said: "While mothers would welcome any extra maternity pay the Liberal Democrats feel this money is being misdirected."	0.240
13	She said her party would boost maternity pay in the first six months to allow more women to stay at home in that time.	0.000
14	Ms Hewitt also stressed the plans would be paid for by taxpayers, not employers.	0.143
15	But David Frost, director general of the British Chambers of Commerce, warned that many small firms could be "crippled" by the move.	0.136
16	"While the majority of any salary costs may be covered by the government's statutory pay, recruitment costs, advertising costs, retraining costs and the strain on the company will not be," he said.	0.000
17	Further details of the government's plans will be outlined on Monday.	0.091
18	New mothers are currently entitled to 90% of average earnings for the first six weeks after giving birth, followed by £102.80 a week until the baby is six months old.	0.033

Function scores are as expected. Sentences with more proper nouns have a higher score, and sentences with no proper nouns have a score of 0.

F6: Numeric Data

Measure the occurrences of numeric data in a sentence

$$F6(\text{Sentence}) = (\text{number of numerical terms in the sentence}) / (\text{total number of words in the sentence})$$

Numerical Data (F6)

		Sentence	F6
0	Maternity pay for new mothers is to rise by £1,400 as part of new proposals announced by the Trade and Industry Secretary Patricia Hewitt.		0.042
1	It would mean paid leave would be increased to nine months by 2007, Ms Hewitt told GMTV's Sunday programme.		0.053
2	Other plans include letting maternity pay be given to fathers and extending rights to parents of older children.		0.000
3	The Tories dismissed the maternity pay plan as "desperate", while the Liberal Democrats said it was misdirected.		0.000
4	Ms Hewitt said: "We have already doubled the length of maternity pay, it was 13 weeks when we were elected, we have already taken it up to 26 weeks.		0.069
5	"We are going to extend the pay to nine months by 2007 and the aim is to get it right up to the full 12 months by the end of the next Parliament."		0.061
6	She said new mothers were already entitled to 12 months leave, but that many women could not take it as only six of those months were paid.		0.037
7	"We have made a firm commitment.		0.000
8	We will definitely extend the maternity pay, from the six months where it now is to nine months, that's the extra £1,400."		0.045
9	She said ministers would consult on other proposals that could see fathers being allowed to take some of their partner's maternity pay or leave period, or extending the rights of flexible working to carers or parents of older children.		0.000
10	The Shadow Secretary of State for the Family, Theresa May, said: "These plans were announced by Gordon Brown in his pre-budget review in December and Tony Blair is now recycling it in his desperate bid to win back women voters."		0.000
11	She said the Conservatives would announce their proposals closer to the General Election.		0.000
12	Liberal Democrat spokeswoman for women Sandra Gidley said: "While mothers would welcome any extra maternity pay the Liberal Democrats feel this money is being misdirected."		0.000
13	She said her party would boost maternity pay in the first six months to allow more women to stay at home in that time.		0.000
14	Ms Hewitt also stressed the plans would be paid for by taxpayers, not employers.		0.000
15	But David Frost, director general of the British Chambers of Commerce, warned that many small firms could be "crippled" by the move.		0.000
16	"While the majority of any salary costs may be covered by the government's statutory pay, recruitment costs, advertising costs, retraining costs and the strain on the company will not be," he said.		0.000
17	Further details of the government's plans will be outlined on Monday.		0.000
18	New mothers are currently entitled to 90% of average earnings for the first six weeks after giving birth, followed by £102.80 a week until the baby is six months old.		0.067

Function scores are as expected. Sentences with more numbers have a higher score, and sentences with no numbers have a score of 0.

F Score

Goal: Can we predict which sentences from any given article will be important to summarize the entire article?

- Subgoal: Can we determine which functions will be most useful to predict a sentence's importance.

$$\text{F score} = (W1 \times F1 + W2 \times F2 + W3 \times F3 + W4 \times F4 + W5 \times F5 + W6 \times F6) / (W1 + W2 + W3 + W4 + W5 + W6)$$

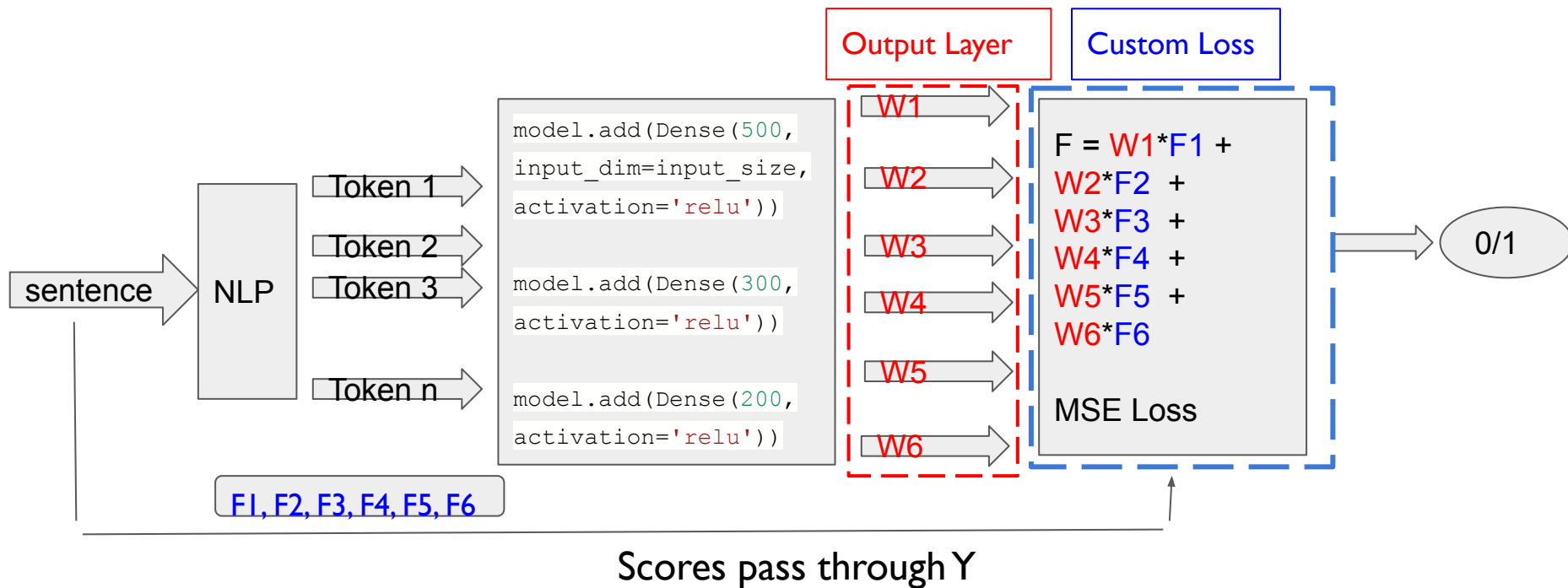
Intuitive Guess: $20 \times F1 + 10 \times F2 + 10 \times F3 + 10 \times F4 + 15 \times F5 + 5 \times F6$

Determining a sentence's relative importance

	Sentence	F
0	Maternity pay for new mothers is to rise by £1,400 as part of new proposals announced by the Trade and Industry Secretary Patricia Hewitt.	0.481
1	It would mean paid leave would be increased to nine months by 2007, Ms Hewitt told GMTV's Sunday programme.	0.221
2	Other plans include letting maternity pay be given to fathers and extending rights to parents of older children.	0.313
3	The Tories dismissed the maternity pay plan as "desperate", while the Liberal Democrats said it was misdirected.	0.276
4	Ms Hewitt said: "We have already doubled the length of maternity pay, it was 13 weeks when we were elected, we have already taken it up to 26 weeks.	0.297
5	"We are going to extend the pay to nine months by 2007 and the aim is to get it right up to the full 12 months by the end of the next Parliament."	0.237
6	She said new mothers were already entitled to 12 months leave, but that many women could not take it as only six of those months were paid.	0.152
7	"We have made a firm commitment.	0.099
8	We will definitely extend the maternity pay, from the six months where it now is to nine months, that's the extra £1,400."	0.238
9	She said ministers would consult on other proposals that could see fathers being allowed to take some of their partner's maternity pay or leave period, or extending the rights of flexible working to carers or parents of older children.	0.305
10	The Shadow Secretary of State for the Family, Theresa May, said: "These plans were announced by Gordon Brown in his pre-budget review in December and Tony Blair is now recycling it in his desperate bid to win back women voters."	0.313
11	She said the Conservatives would announce their proposals closer to the General Election.	0.137
12	Liberal Democrat spokeswoman for women Sandra Gidley said: "While mothers would welcome any extra maternity pay the Liberal Democrats feel this money is being misdirected."	0.308
13	She said her party would boost maternity pay in the first six months to allow more women to stay at home in that time.	0.251
14	Ms Hewitt also stressed the plans would be paid for by taxpayers, not employers.	0.191
15	But David Frost, director general of the British Chambers of Commerce, warned that many small firms could be "crippled" by the move.	0.180
16	"While the majority of any salary costs may be covered by the government's statutory pay, recruitment costs, advertising costs, retraining costs and the strain on the company will not be," he said.	0.258
17	Further details of the government's plans will be outlined on Monday.	0.211
18	New mothers are currently entitled to 90% of average earnings for the first six weeks after giving birth, followed by £102.80 a week until the baby is six months old.	0.294

Here is an example of an article with each sentence given an individual F score from our combined weighted functions. The best sentence is in red and the worst sentence is in green.

Structure of our Baseline Neural Network



Target Dataframe

y_train	F1	F2	F3	F4	F5	F6
False	0.00	1.000000	0.166667	0.750000	0.0	0.000000
True	0.00	0.933333	0.200000	0.560000	0.0	0.071429
False	0.00	0.733333	0.250000	0.647059	0.0	0.000000
False	0.00	0.733333	0.333333	0.785714	0.0	0.000000
True	0.00	0.733333	0.500000	0.500000	0.0	0.090909
...
True	0.25	0.272727	0.200000	0.300000	0.0	0.000000
False	0.25	0.727273	0.250000	0.432432	0.0	0.062500
True	0.25	0.681818	0.333333	0.333333	0.0	0.066667
False	0.00	0.500000	0.500000	0.323529	0.0	0.000000
True	0.00	0.272727	1.000000	0.315789	0.0	0.000000

Custom Loss

$$\text{F score} = (W1 \times F1 + W2 \times F2 + W3 \times F3 + W4 \times F4 + W5 \times F5 + W6 \times F6)$$

$$F1 = y_true[\text{column}2]$$

$$F2 = y_true[\text{column}3]$$

$$F3 = y_true[\text{column}4]$$

$$F4 = y_true[\text{column}5]$$

$$F5 = y_true[\text{column}6]$$

$$F6 = y_true[\text{column}7]$$

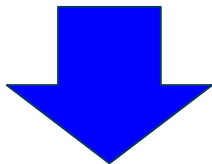
$$\text{target} = y_true[\text{column}1]$$

$$\text{MSE Loss} = \sum (F - \text{target})^2 / (\text{Number of inputs})$$

$$\text{Logistic Loss} = \sum -\text{target} \cdot \log(F) - (1 - \text{target}) \cdot \log(1 - F) / (\text{Number of inputs})$$

Add custom precision, recall, F1 measure

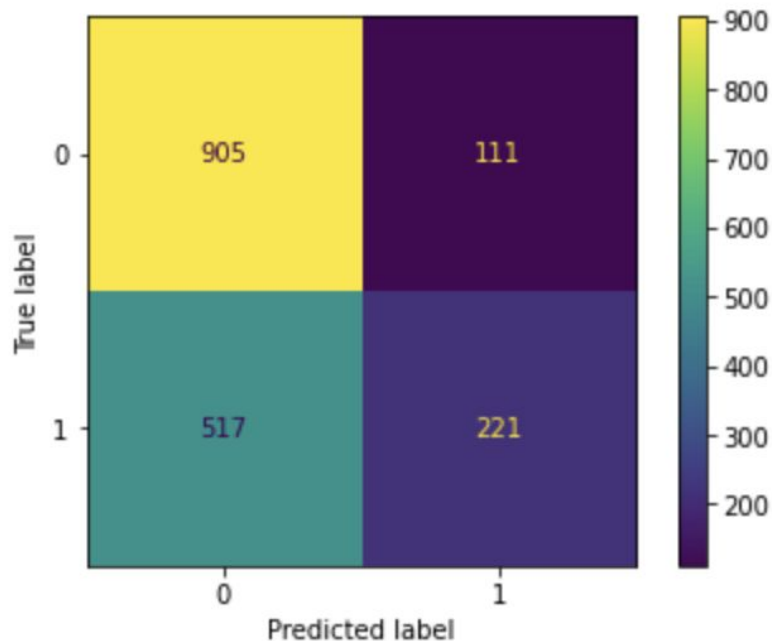
T = 0.5	Loss	Accuracy	Precision	Recall	F1
Training	0.0857	84.87%	98.20%	64.78%	77.92%
Testing	0.2775	64.10%	64.13%	29.74%	39.21%



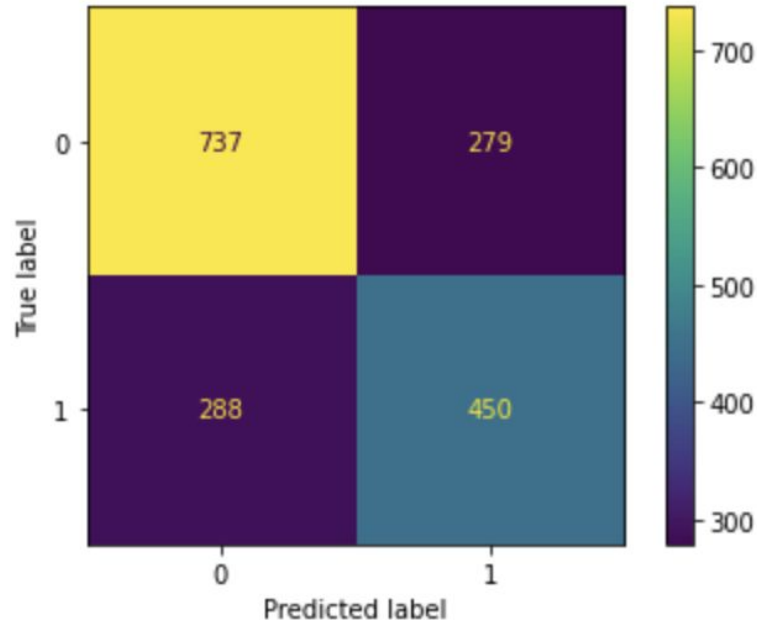
Reduced prediction
threshold from 0.5 to 0.2

T = 0.2	Loss	Accuracy	Precision	Recall	F1
Training	0.0856	97.05%	95.59%	97.43%	96.48%
Testing	0.2638	67.56%	61.90%	60.43%	60.11%

Reduce threshold of prediction



Reduced prediction threshold from 0.5 to 0.2



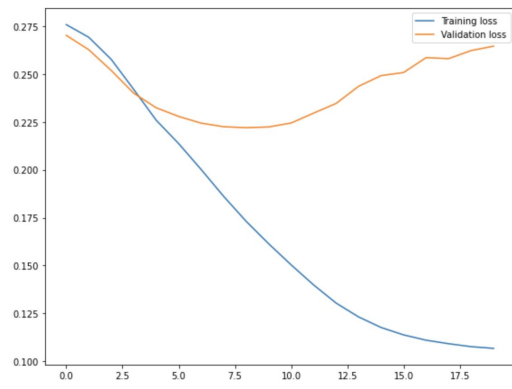
Grid Search

Grid Search Parameters				
Parameters	Internal Layer Activation	Neurons in hidden layers	Learning Rate	Batch Size
Variation 1	relu	20	0.1	200
Variation 2	relu6	50	0.01	500
Variation 3	swish	80	0.001	800

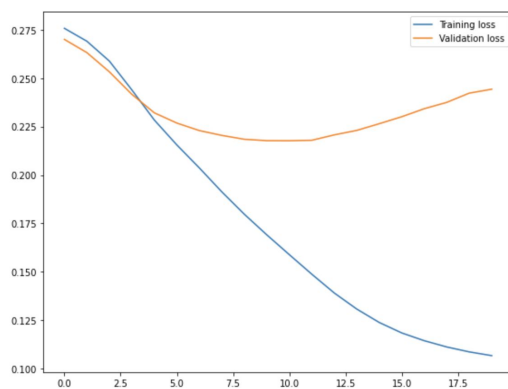
Best Metric	Internal Layer Activation	Neurons in Hidden Layer	Learning Rate	Batch Size	Loss	Accuracy	Precision	Recall	F1
Accuracy	relu6	50	0.01	800	0.2505	68.55%	62.08%	65.10%	62.74%
Precision	relu6	80	0.001	200	0.2603	67.92%	62.69%	61.09%	60.67%
Recall	relu	50	0.1	800	0.2660	46.88%	43.94%	96.35%	60.18%
F1	relu6	20	0.001	800	0.2307	66.93%	58.96%	74.03%	65.06%
Loss	relu	20	0.001	800	0.2287	65.63%	57.34%	75.67%	64.67%

Top 5 Models Validation and Test Loss

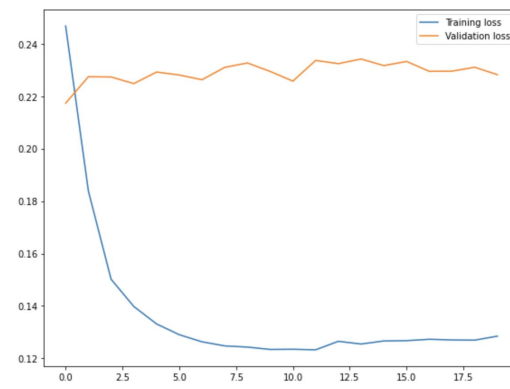
Loss Model



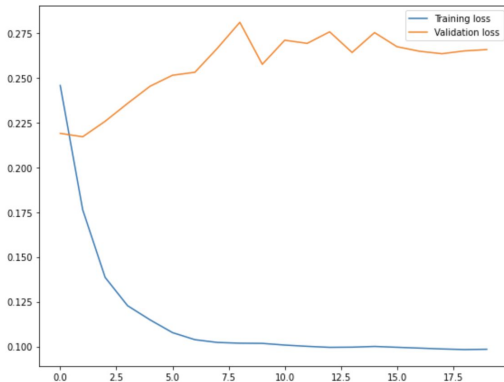
F1 Model



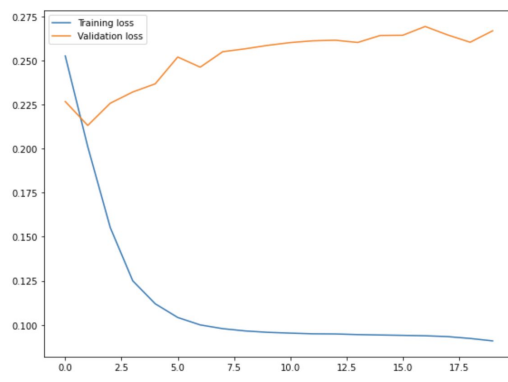
Recall Model



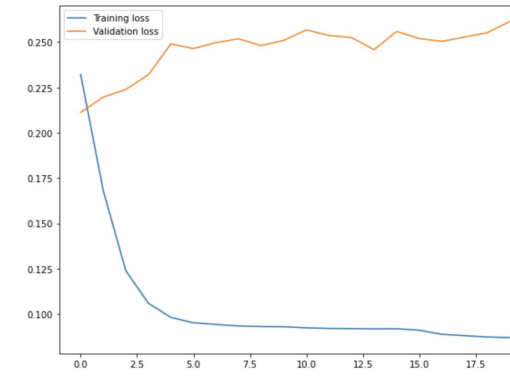
Accuracy Model



Precision Model



Baseline Model



Top 5 Models Metrics (re-run)

Loss Model

Loss	0.2646
Accuracy	63.78%
Precision	56.62%
Recall	59.79%
F1	57.17%

F1 Model

Loss	0.2443
Accuracy	66.14%
Precision	59.23%
Recall	65.40%
F1	61.43%

Recall Model

Loss	0.2282
Accuracy	64.44%
Precision	55.95%
Recall	79.16%
F1	64.94%

Accuracy Model

Loss	0.2658
Accuracy	66.63%
Precision	61.04%
Recall	59.63%
F1	59.48%

Precision Model

Loss	0.2668
Accuracy	65.09%
Precision	58.40%
Recall	60.22%
F1	58.24%

Baseline Model

Loss	0.2638
Accuracy	67.56%
Precision	61.90%
Recall	60.43%
F1	60.11%

Top 5 Models Metrics Compared to Average

Loss Model

Loss	+ 0.009
Accuracy	- 1.83%
Precision	- 2.06%
Recall	- 4.32%
F1	- 3.06%

F1 Model

Loss	- 0.0113
Accuracy	+ 0.53%
Precision	+ 0.55%
Recall	+ 1.29%
F1	+ 1.20%

Recall Model

Loss	- 0.0274
Accuracy	- 1.17%
Precision	- 2.73%
Recall	+ 15.05%
F1	+ 4.71%

Accuracy Model

Loss	+ 0.0102
Accuracy	+ 1.02%
Precision	+ 2.36%
Recall	- 4.48%
F1	- 0.75%

Precision Model

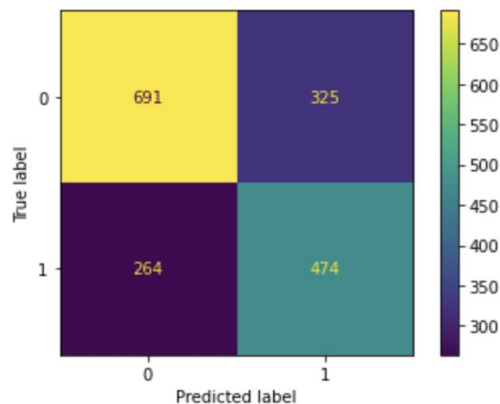
Loss	+ 0.0112
Accuracy	- 0.52%
Precision	- 0.28%
Recall	- 3.89%
F1	- 1.99%

Baseline Model

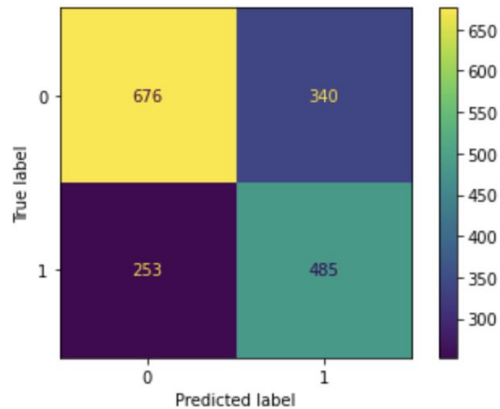
Loss	+ 0.0083
Accuracy	+ 1.95%
Precision	+ 3.22%
Recall	- 3.68%
F1	- 0.12%

Top 5 Models Confusion matrix

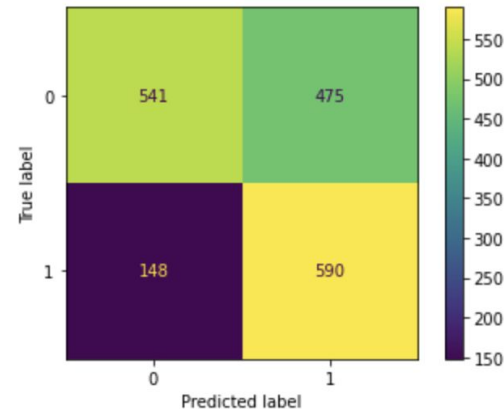
Loss Model



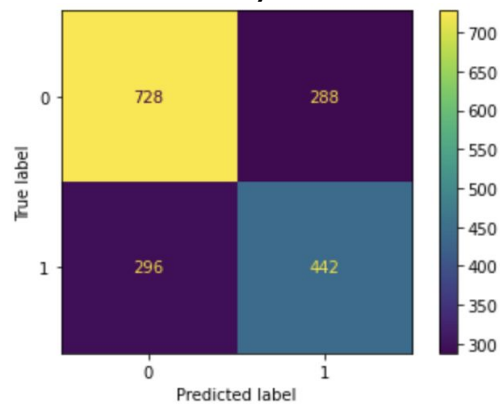
F1 Model



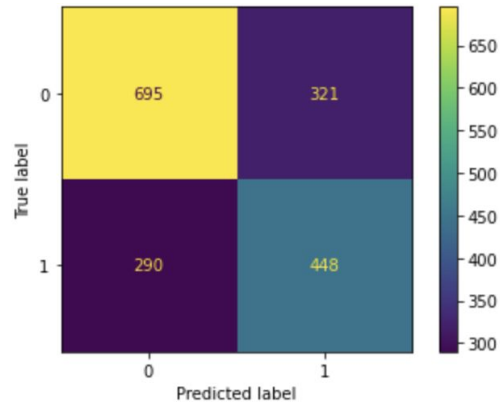
Recall Model



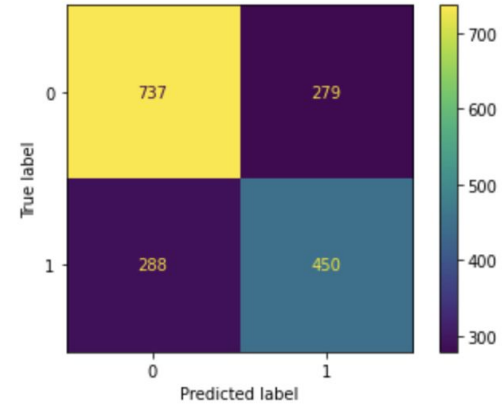
Accuracy Model



Precision Model



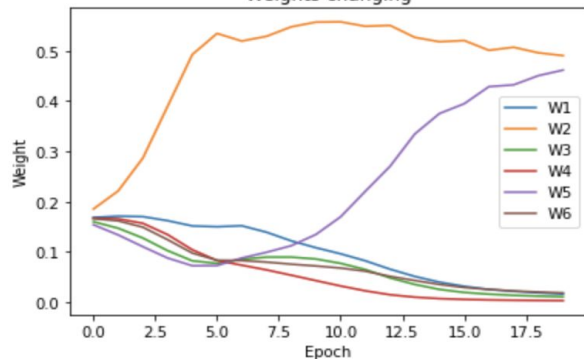
Baseline Model



Top 5 Models Weight Convergence

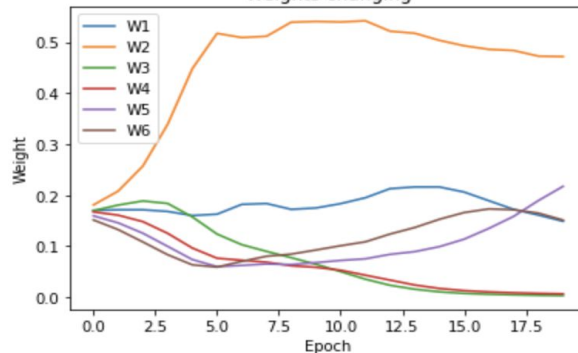
Loss Model

Weights changing



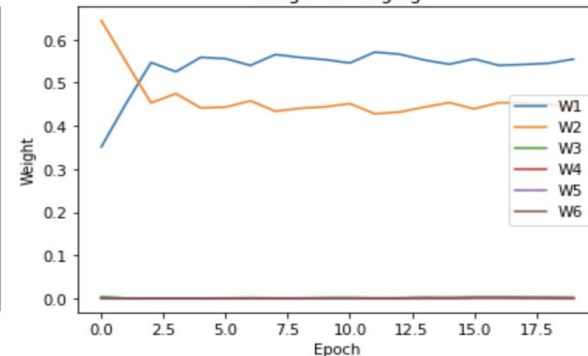
F1 Model

Weights changing



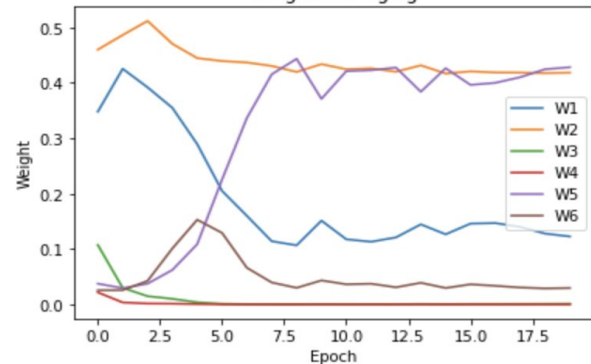
Recall Model

Weights changing



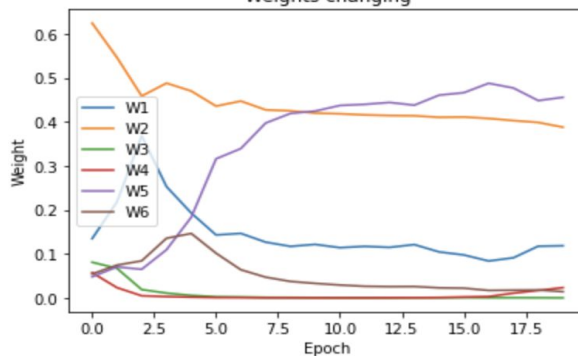
Accuracy Model

Weights changing



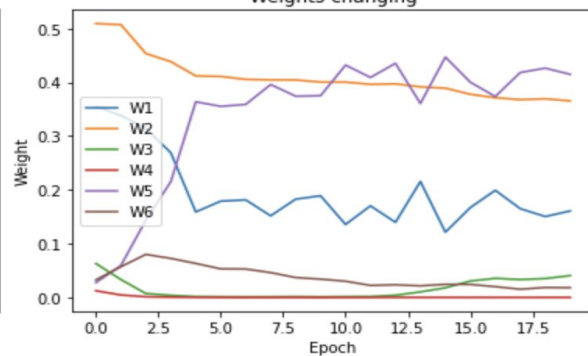
Precision Model

Weights changing



Baseline Model

Weights changing



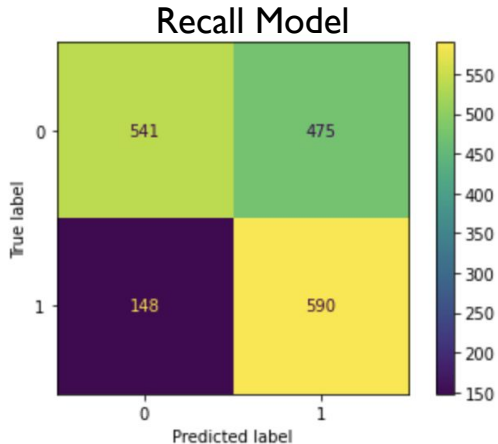
Best Weights

- From our neural network the only important functions in order of importance are:
 1. Function 2 (score is based on sentence length)
 2. Function 5 (score is based on occurrence of proper nouns)
 3. Function 1 (score is based on the number of title words in the sentence)

- Intuitive estimated weights:
 - $20 \cdot F1 + 10 \cdot F2 + 10 \cdot F3 + 10 \cdot F4 + 15 \cdot F5 + 5 \cdot F6$

Conclusion (best model)

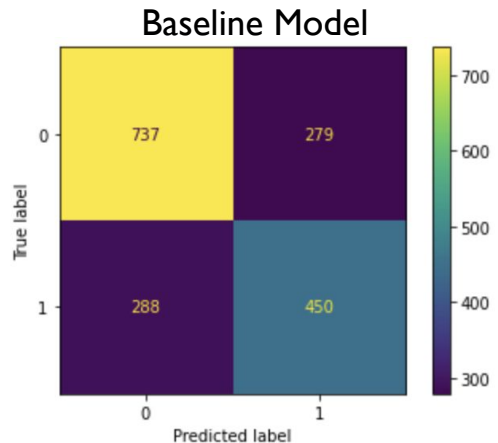
Recall Model: Best if it is important not to miss any summary sentences



Recall Model	
Loss	0.2282
Accuracy	64.44%
Precision	55.95%
Recall	79.16%
F1	64.94%

Baseline Model: Best if you need to find important sentence but want the summary to be short.

** Accuracy Model: Similar to baseline model but simple



Baseline Model	
Loss	0.2638
Accuracy	67.56%
Precision	61.90%
Recall	60.43%
F1	60.11%

Conclusion

❖ Findings

- Training metrics are very high (accuracy in the 90s), but testing data remains low around 60s so we might still be overfitting.
- Testing loss also increases slightly as training goes, but the weights do seem to converge.
- Regardless of what we do the training metrics do not change too much except recall will go from around 60% to 80%.
- We tried a very high number of neurons in each layer at first but through testing found a lower number (>100) would give us similar results and have a faster runtime.

THANK YOU