# Learning “Learning to Rank”

Sophie Watson

@sophwats

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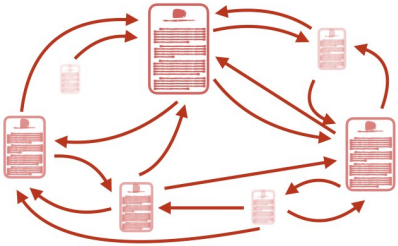
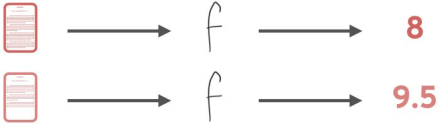


dmlc
XGBoost

$f = (\sim, \sim, \sim, \sim, \cdots, \sim, \sim)$



$q = (\sim\ \sim\ \sim\sim)$ **query**

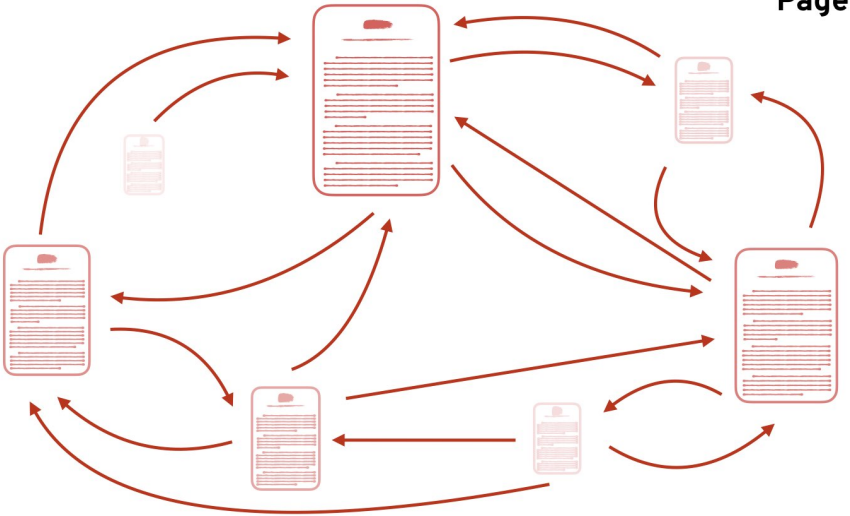
**documents**

$q = (\sim\ \sim\ \sim\sim)$ **query**

**documents**

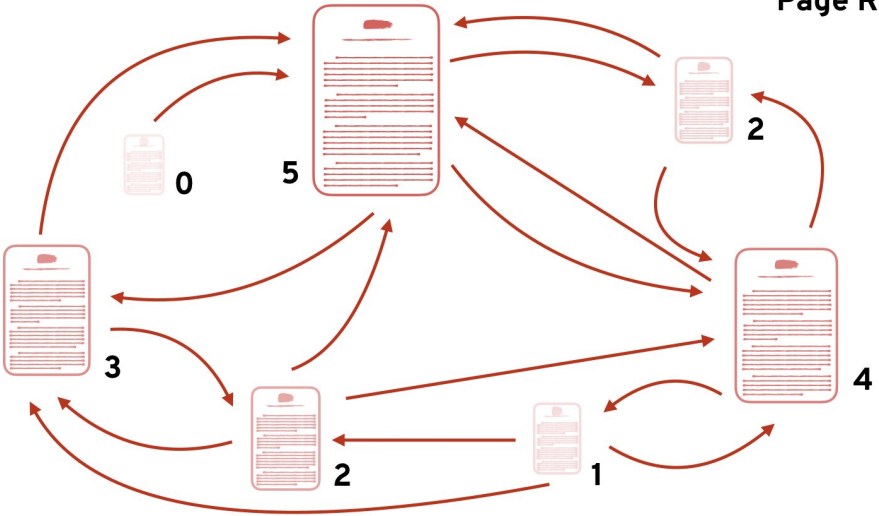
q = (~ ~ ~~~) **query**

# Page Rank

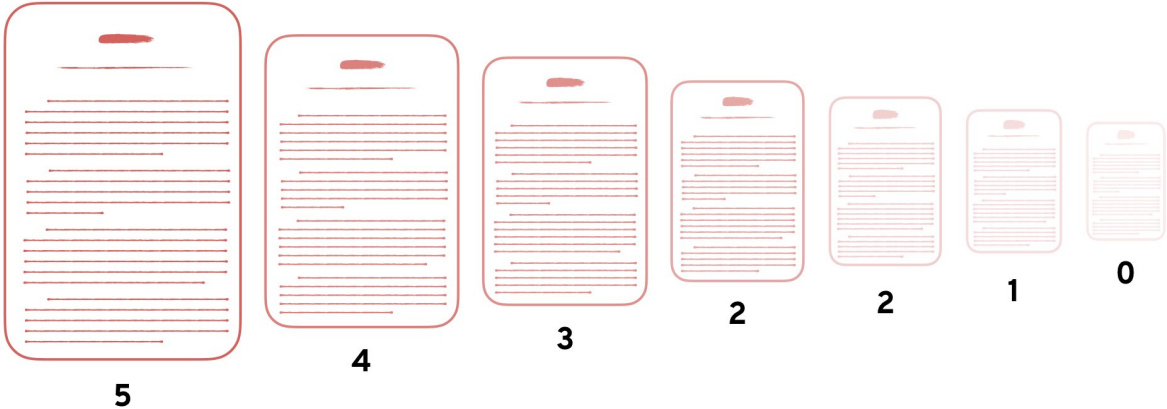


q = (~ ~ ~~~) query

# Page Rank



q = (~ ~ ~~~) **query**

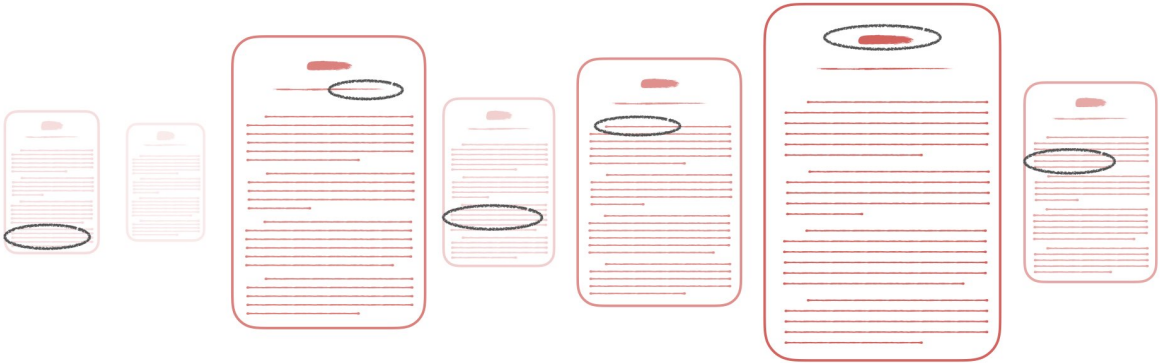


q = ( ) **query**

# Full Text Search

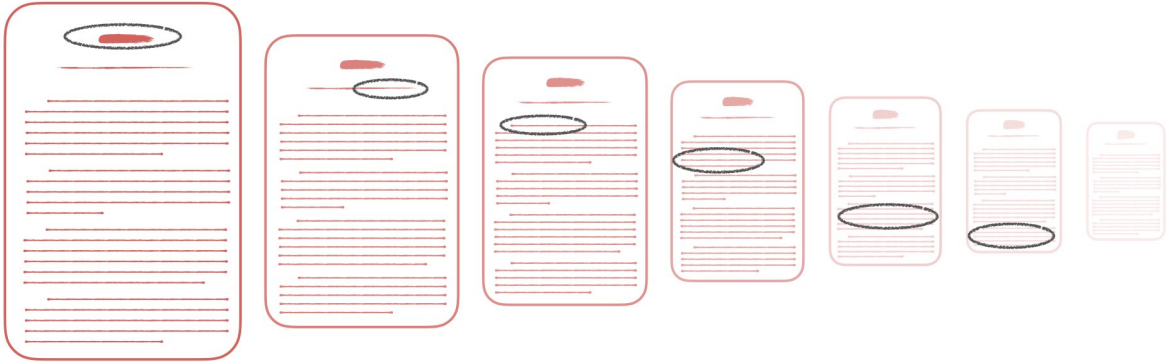
**documents**

# Full Text Search



q = ( ) query

# Full Text Search



# Feature Engineering

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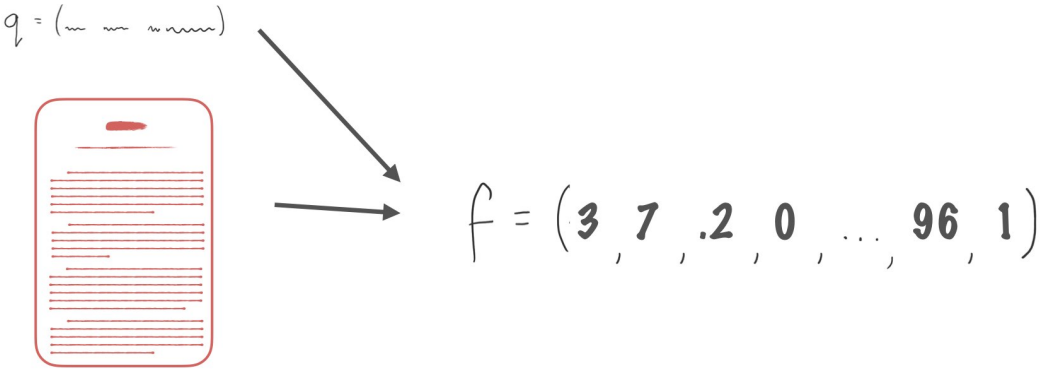
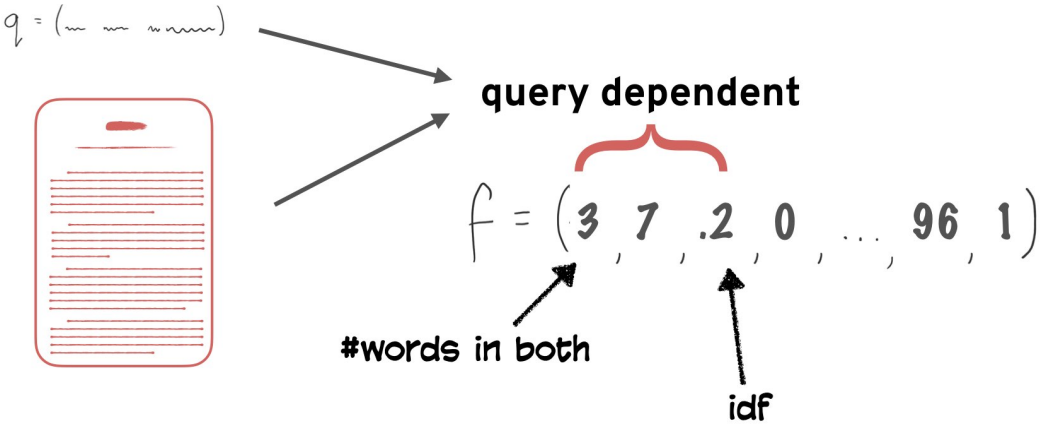
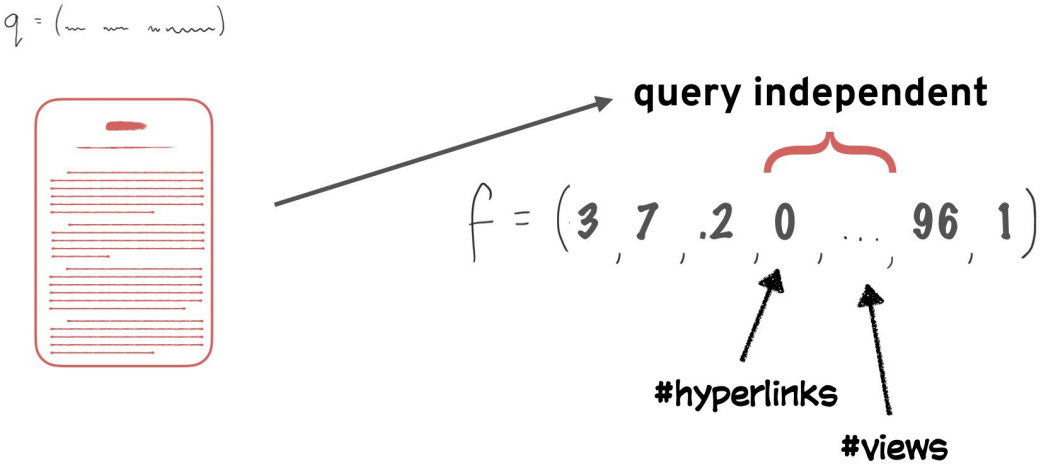
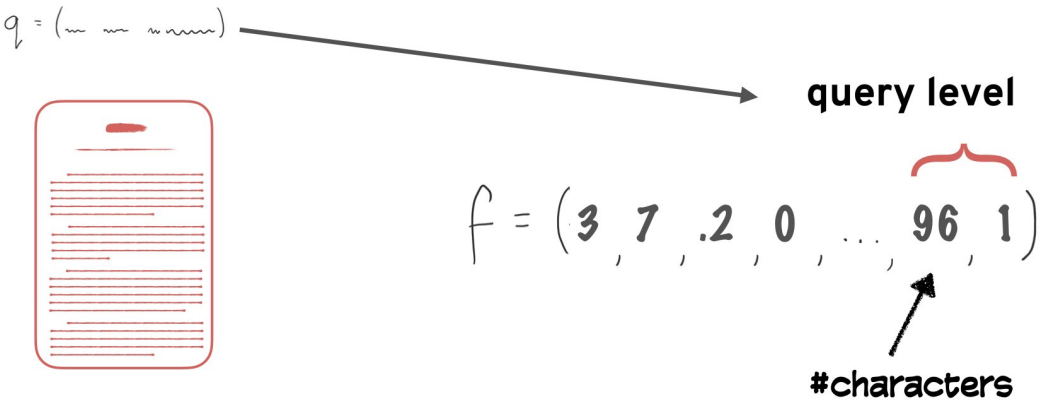

q = ( )
f = (3, 7, .2, 0, ..., 96, 1)


q = ( )
query dependent
f = (3, 7, .2, 0, ..., 96, 1)
#words in both
idf


q = ( )
query independent
f = (3, 7, .2, 0, ..., 96, 1)
#hyperlinks
#views


q = ( )
query level
f = (3, 7, .2, 0, ..., 96, 1)
#characters

# Established Methods

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# Pointwise Ranking

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# Pointwise Ranking

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# Pointwise Ranking

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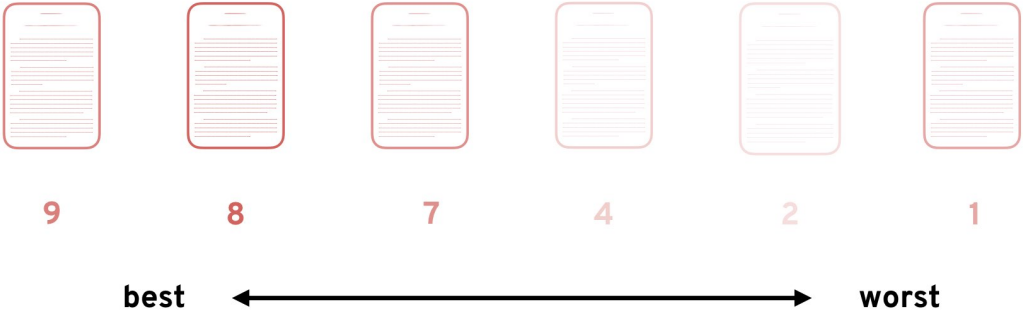
# Pointwise Ranking



# Pointwise Ranking

| query | feature vector |
| --- | --- |



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# Pointwise Ranking

| score | query | feature vector |
|---|---|---|



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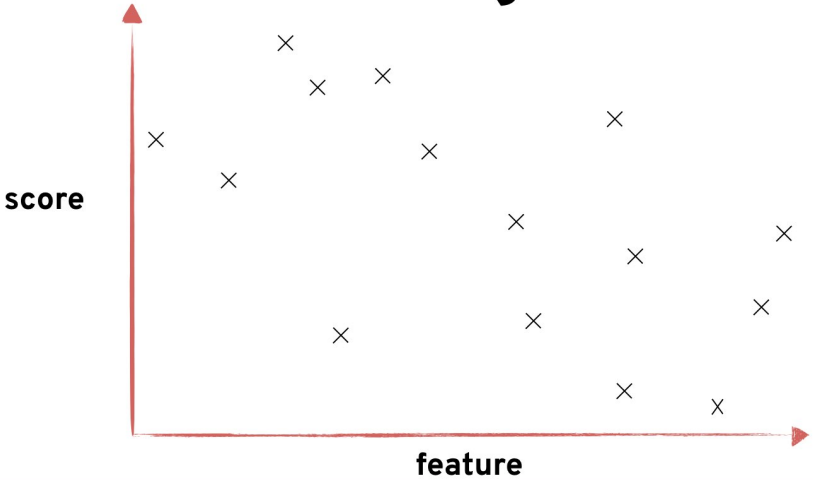
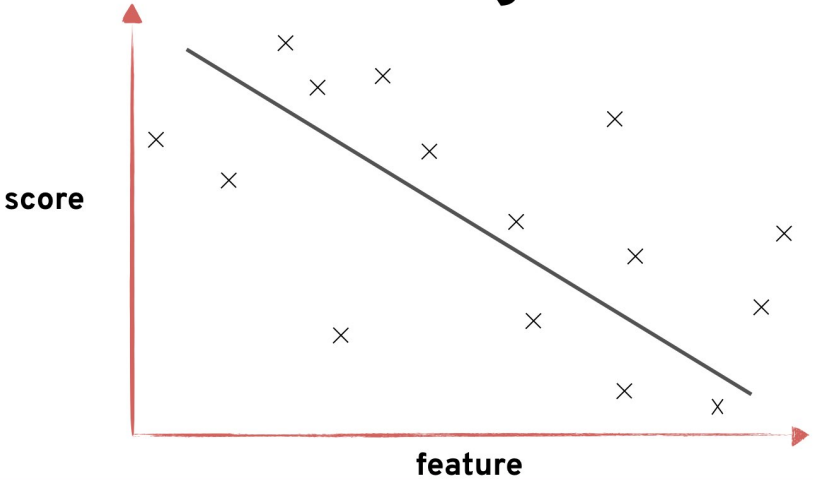
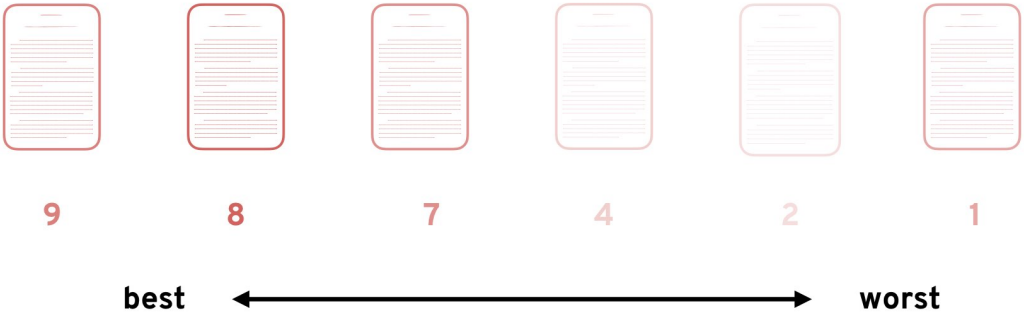
# Pointwise Ranking



# Pointwise Ranking




9
8
7
4
2
1
best
worst

best ⟷ worst

# Pairwise Ranking

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# Pairwise Ranking

Rank Net

# Pairwise Ranking

Rank Net

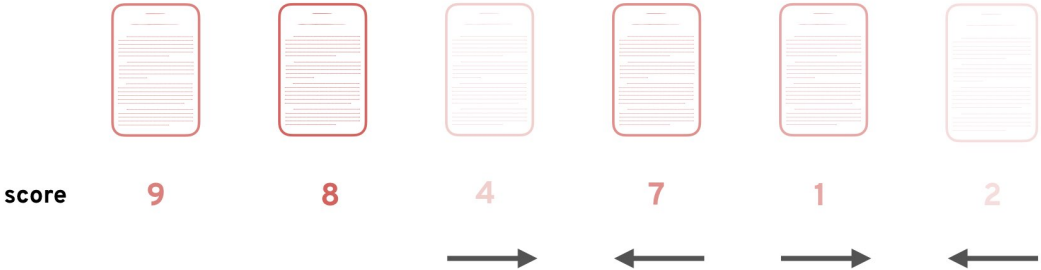
# RankNet

score 9 8 7 4 2 1

# RankNet

| score | 9 | 8 | 4 | 7 | 1 | 2 |
|---|---|---|---|---|---|---|

# RankNet



# Normalised Discounted Cumulative Gain

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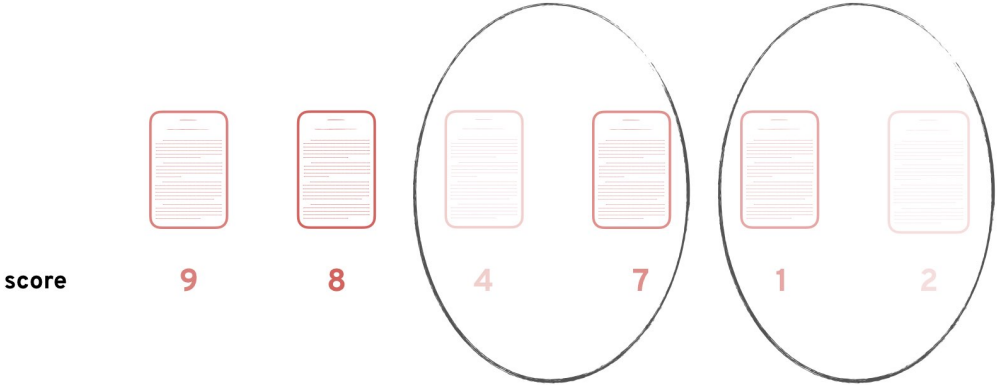
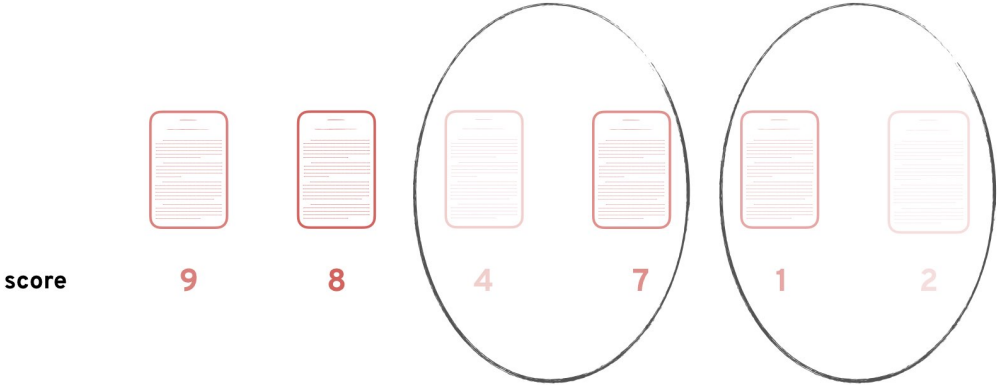

score
9
8
4
7
1
2


score
9
8
4
7
1
2

# ~~Normalised~~ Discounted Cumulative Gain

$$\sum_{\text{docs} \in \text{testing set}} \frac{\text{true score}}{\log_2 \text{predicted rank} + 1}$$

Bigger contribution from start of list

# Normalised Discounted Cumulative Gain

score 9 8 4 7 1 2

$$\text{nDCG} = \frac{\text{discounted cumulative gain}}{\text{optimal discounted cumulative gain}}$$

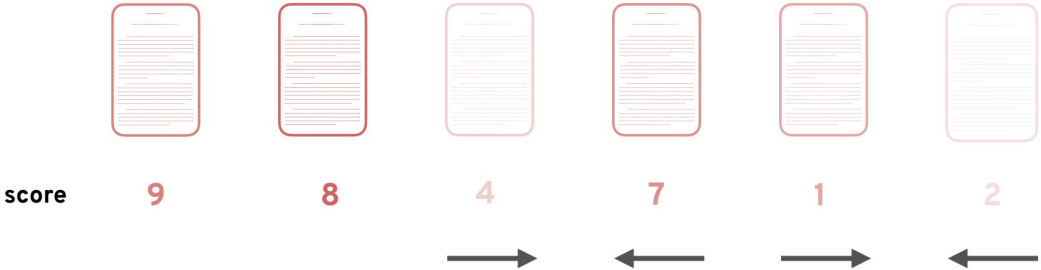
nDCG = 1 is perfect!

nDCG = 0 means it couldn't be worse!

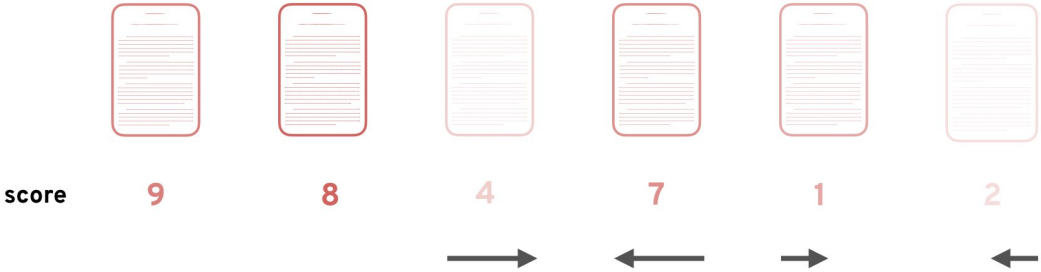
# Normalised Discounted Cumulative Gain

$$\text{nDCG@4} = \frac{\text{discounted cumulative gain for top 4}}{\text{optimal discounted cumulative gain for top 4}}$$

# RankNet



# LambdaRank



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# Listwise Algorithms

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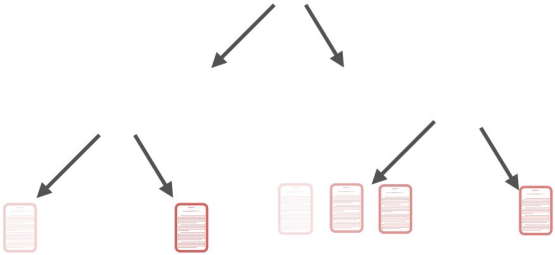
# Listwise Ranking

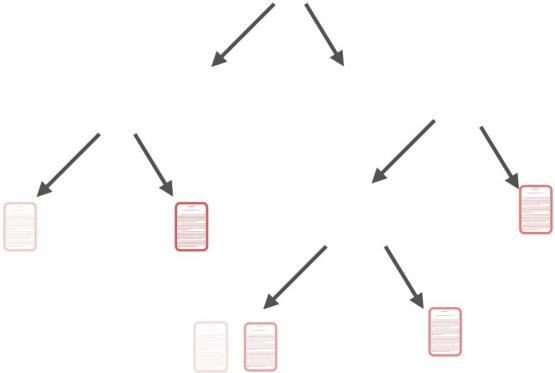
# LambdaMART

# LambdaMART

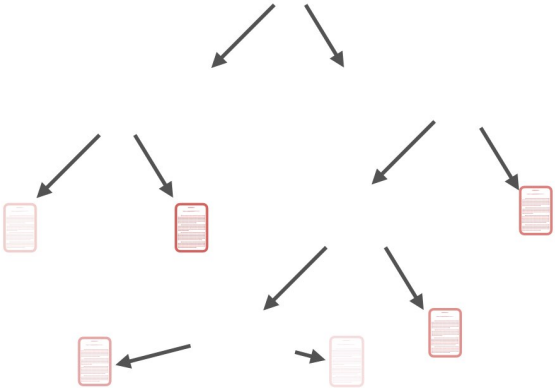
# LambdaMART



# LambdaMART



# LambdaMART



# Learning to Rank in Action

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# MSLR-WEB10K

- Open Source
- 10,000 queries
- scored from 0 to 4
- schema: relevance, query id, feature vector
- training, testing and validation data sets

2 qid:13 1:2 2:0 3:2 4:1 5:2 6:1 7:0 8:1 9:0.5 …

133:7 134:0 135:0 136:0

relevance

2 qid:13 1:2 2:0 3:2 4:1 5:2 6:1 7:0 8:1 9:0.5 …

133:7 134:0 135:0 136:0

relevance

2 qid:13 1:2 2:0 3:2 4:1 5:2 6:1 7:0 8:1 9:0.5 …

133:7 134:0 135:0 136:0

query id

relevance

features

2 qid:13 1:2 2:0 3:2 4:1 5:2 6:1 7:0 8:1 9:0.5 …

133:7 134:0 135:0 136:0

query id

```python
from sklearn.linear_model import LinearRegression
```

```python
reg = LinearRegression().fit(X, y)
```

```python
from sklearn.linear_model import LinearRegression
```

```python
reg = LinearRegression().fit(X, y)
```

```python
preds = reg.predict(X_test)
```

```python
preds
```

```
array([0.76923034, 0.29349399, 0.3523804 , ..., 0.80657282, 0.43
872805,
       0.19482099])
```

dmlc

# XGBoost

```python
import xgboost as xgb
```

```python
training_data = xgb.DMatrix('data/train_dat.txt')
testing_data = xgb.DMatrix('data/test_dat.txt')
```

```
[16:11:30] 723412x137 matrix with 98384032 entries loaded from data/train_dat.txt
[16:11:30] 6000 groups are loaded from data/train_dat.txt.group
[16:11:31] 241521x137 matrix with 32846856 entries loaded from data/test_dat.txt
[16:11:31] 2000 groups are loaded from data/test_dat.txt.group
```

eg. [7,8,5]

```python
import xgboost as xgb
```

```python
training_data = xgb.DMatrix('data/train_dat.txt')
testing_data = xgb.DMatrix('data/test_dat.txt')
```

```python
params = [('objective','rank:ndcg'),
          ('max_depth',2), ('eta',0.1), ('num_boost_round',4)]

model = xgb.train(params, training_data)

predictions = model.predict(testing_data)
```

```python
import xgboost as xgb
```

```python
training_data = xgb.DMatrix('data/train_dat.txt')
testing_data = xgb.DMatrix('data/test_dat.txt')
```

```python
params = [('objective','rank:ndcg'),
          ('max_depth',2), ('eta',0.1), ('num_boost_round',4)]

model = xgb.train(params, training_data)

predictions = model.predict(testing_data)
```

**rank:ndcg** LambdaMart (listwise)

**rank:pairwise** LambdaRank (pairwise)

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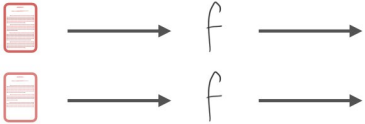
dmlc XGBoost

$f = (\sim, \sim, \sim, \sim, \cdots, \sim, \sim)$



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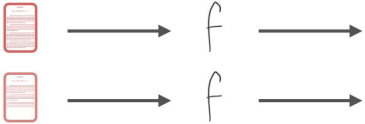
$f = (\sim, \sim, \sim, \sim, \cdots, \sim, \sim)$