7. (a) LMD =>

$$\sum_{t \in q} q_t \cdot \log\left(1 + \frac{f_{t,d}}{\mu} \cdot \frac{l_c}{l_t}\right) - n \log\left(1 + \frac{l_d}{\mu}\right.$$

where, $\mu = 1000$

q_t = occurence of term t in query

$f_{t,d}$ = freq of term t in document d

l_d = length of document d

l_c = total number of tokens in corpus

l_t = total number of occurences of term t in corpus

(b) LMJM $\Rightarrow \sum_{t \in q} q_t \cdot \log\left(1 + \frac{1-\lambda}{\lambda} \cdot \frac{f_{t,d}}{l_d} \cdot \frac{l_c}{l_t}\right)$

where $\lambda = 0.5$

q_t = occurence of term t in query

$f_{t,d}$ = freq of term t in document d

l_d = length of document d

l_c = total number of tokens in corpus

l_t = total number of occurences of term t in corpus.

(c) DFR

$$\Rightarrow \sum_{t \in q} q_t \cdot \frac{\left(\log\left(1 + \frac{l_t}{N}\right) + f'_{t,d} \cdot \log\left(1 + \frac{N}{l_t}\right)\right)}{\left(f'_{t,d} + 1\right)}$$

$$f'_{t,d} = f_{t,d} \cdot \log\left(1 + \frac{l_{avg}}{l_d}\right)$$

$q_t \Rightarrow$ occurrence of term t in query

l_t = total number of occurrences of term t in corpus

N = total number of documents

l_{avg} = average length of documents

l_d = length of document d

Example (DFR):

Suppose we have a corpus of 100000 previous queries and we are trying to rank them by DfR. ~~So for they have type degree~~.

Average length of query = 3.

Number of occurences of terms

"Popeye's" = 56 "Sandwich" = 254

"chicken" = 501 "Deal" = 607

∴ Scoring query "Popeye's chicken Sandwich" with DFR =>

$$\frac{\log\left(1+\frac{56}{10^5}\right)+1.\log\left(1+\frac{10^5}{56}\right)}{2}$$

$$+\ \frac{\log\left(1+\frac{501}{10^5}\right)+1.\log\left(1+\frac{10^5}{501}\right)}{2}$$

$$= 9.23$$

$LMJM_d \Rightarrow$

$q =$ "popeye's chicken sandwich"

$f_{popeye's,d} = 3$

$f_{chicken,d} = 5$ $\quad \lambda = 0.5$

$f_{sandwich,d} = 1$ $\quad M = 1000$

$l_d = 4000$

$l_c = 10^7$ $\quad l_{chicken} = 4000$

$l_{popeye's} = 600$ $\quad l_{sandwich} = 2000$

$$LMJM_d \Rightarrow 1.\log\left(1 + \frac{0.5}{0.5} \times \frac{3}{4000} \times \frac{100}{600}\right)$$

$$+ 1.\log\left(1 + \frac{0.5}{0.5} \times \frac{5}{4000} \times \frac{10^7}{4000}\right)$$

$$+ 1.\log\left(1 + \frac{0.5}{0.5} \times \frac{1}{4000} \times \frac{10^7}{2000}\right)$$

$$\Rightarrow \log(13.5) + \log(4.125) + \log(2.25)$$

$\Rightarrow$ 4.83

LMD =>

$$\log\left(1+\frac{3}{1000}\times\frac{10^7}{600}\right)+\log\left(1+\frac{5}{1000}\times\frac{10^7}{4000}\right)$$

$$+\log\left(1+\frac{1}{1000}\times\frac{10^7}{2000}\right)-3\log\left(1+\frac{4000}{1000}\right)$$

=> 3.49