IT458: Information Retrieval
Lab Assignment 3
Best Match Models

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Roll No.: 181IT113

Part 1: Original formulas:

BM1 Formula

Part 1: Original BM Formulas

```
N = 100
# the query list is created to contain only words that is present in the corpus
def BM1Original(queryList, doc):
    rankBM1 = 0.0
    for i in range(len(queryList)):
        num = N - calculateFreqWord(queryList[i]) + 0.5
        den = calculateFreqWord(queryList[i]) + 0.5
        rankBM1 += math.log(num/den)
    return rankBM1
```

```
q = "squads for centralised international superpower link Washington news for today eat healthy"
```

```
[(0, 50.815824336585365), (1, 50.815824336585365), (2, 50.815824336585365), (3, 50.815824336585365), (4, 50.815824336585365),
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5), (98, 50.815824336585365), (99, 50.815824336585365)]
```

```
q = "Washington is the capital of America. Eat healthy and stay happy. Victory of Americans."
```

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9, 37.991989776461836), (50, 37.991989776461836), (51, 37.991989776461836), (52, 37.991989776461836), (53, 37.991989776461836),
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6), (59, 37.991989776461836), (60, 37.991989776461836), (61, 37.991989776461836), (62, 37.991989776461836), (63, 37.99198977646
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7.991989776461836), (84, 37.991989776461836), (85, 37.991989776461836), (86, 37.991989776461836), (87, 37.991989776461836), (8
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(93, 37.991989776461836), (94, 37.991989776461836), (95, 37.991989776461836), (96, 37.991989776461836), (97, 37.99198977646183
6), (98, 37.991989776461836), (99, 37.991989776461836)]
```

BM11 Formula

```
def BM11Original(queryList, doc):
    rankBM11 = 0.0
    for i in range(len(queryList)):
        num = N - calculateFreqWord(queryList[i]) + 0.5
        den = calculateFreqWord(queryList[i]) + 0.5
        rankBM11 += calculateFij2(queryList[i], doc)*calculateFiq(queryList[i], queryList)*math.log(num/den)
    return rankBM11
```

```
q = "Washington is the capital of America. Eat healthy and stay happy. Victory of Americans."
```

```
[(71, 97.5061693854191), (34, 96.64131399311364), (11, 95.18669882321959), (18, 93.45954774496863), (93, 90.73312343470442), (1
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88.36242657137375), (84, 86.62729671158715), (13, 86.49465308353408), (92, 86.43879686590813), (26, 85.86681997385725), (91, 8
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8182987234046), (42, 83.32743340014811), (70, 82.7468590337659), (15, 82.14072898713061), (87, 82.03113724419964), (37, 81.1691
0175366363), (85, 81.16910175366363), (5, 80.86962672921098), (32, 80.71411590467426), (73, 80.51282148320391), (21, 80.3342453
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456), (43, 78.8173211226616), (62, 78.18077700523128), (36, 78.07136700080311), (63, 77.8596167864594), (96, 77.8292401583634
3), (60, 77.78984218769698), (57, 77.7261415965953), (80, 77.40498137782343), (59, 76.8723689539074), (39, 76.51874118993616),
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4), (88, 64.59889596558489), (7, 64.40739764203062), (23, 64.17591127465752), (24, 63.73975363060208), (27, 63.08473174859123),
(52, 60.361839026109884), (90, 59.15598892344239), (14, 58.802361159471154), (41, 58.24013135078561), (81, 57.7415957041998895),
(45, 57.39164622752684), (82, 49.928489093863824), (56, 45.69001874269349), (76, 39.52961100246379), (86, 33.028262308792186),
(54, 31.755746639177218), (67, 31.755746639177218), (68, 29.635452375548283)]
```

```
q = "squads for centralised international superpower link Washington news for today eat healthy"
```

```
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(73, 0.0), (74, 0.0), (75, 0.0), (76, 0.0), (80, 0.0), (83, 0.0), (84, 0.0), (85, 0.0), (87, 0.0), (88, 0.0), (89, 0.0), (91,
0.0), (94, 0.0), (96, 0.0), (97, 0.0), (98, 0.0)]
```

BM15 Formula

```
def BM15Original(queryList, doc):
    rankBM15 = 0.0
    for i in range(len(queryList)):
        num = N - calculateFreqWord(queryList[i]) + 0.5
        den = calculateFreqWord(queryList[i]) + 0.5
        rankBM15 += calculateFij1(queryList[i], doc)*calculateFiq(queryList[i], queryList)*math.log(num/den)
    return rankBM15
```

```
q = "squads for centralised international superpower link Washington news for today eat healthy"
```

```
[(92, 96.79948013758724), (11, 63.235061382565135), (40, 53.94449098155432), (81, 53.94449098155432), (13, 43.3559952047171
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(88, 0.0), (89, 0.0), (91, 0.0), (94, 0.0), (96, 0.0), (97, 0.0), (98, 0.0)]
```

```
q = "Washington is the capital of America. Eat healthy and stay happy. Victory of Americans."
```

```
[(71, 97.5061693854191), (34, 96.64131399311364), (11, 95.18669882321959), (18, 93.45954774496863), (93, 90.73312343470442), (1
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8182987234046), (42, 83.32743340014811), (70, 82.7468590337659), (15, 82.14072898713061), (87, 82.03113724419964), (37, 81.1691
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(58, 76.27850267603567), (2, 76.09295028680171), (30, 75.95036620792936), (83, 75.2846871141945), (74, 75.16648644611949), (6,
75.15571139225077), (10, 75.00324887411395), (55, 74.67855706755921), (65, 74.4022921179804), (66, 74.29469771793083), (69, 74.
29469771793082), (33, 74.00336056477084), (3, 72.73225830685121), (51, 72.73084489515588), (4, 72.30786020422852), (1, 72.02494
385076943), (48, 71.88235977189711), (31, 71.67131608679821), (89, 71.67131608679821), (0, 71.50085217166013), (28, 71.21668067
816222), (35, 71.21668067816222), (53, 70.61055063152693), (61, 70.05340266142815), (29, 69.5916015931301), (77, 68.64024614228
701), (78, 68.31908592351513), (49, 67.56872120790143), (16, 66.47754168183513), (40, 66.37208028035661), (47, 66.3720802803566
1), (22, 66.01328918482739), (20, 65.87141163519985), (97, 65.87141163519985), (19, 65.65966142085614), (50, 65.6596614208561
4), (88, 64.59889596558489), (7, 64.40739764203062), (23, 64.17591127465752), (24, 63.73975363060208), (27, 63.08473174859123),
(52, 60.361839026109884), (90, 59.15598892344239), (14, 58.802361159471154), (41, 58.24013135078561), (81, 57.741595704199895),
(45, 57.39164622752684), (82, 49.928489093863824), (56, 45.69001874269349), (76, 39.52961100246379), (86, 33.028262308792186),
(54, 31.755746639177218), (67, 31.755746639177218), (68, 29.635452375548283)]
```

Part 2: Simplified formulas:

BM11 Formula

```
def BM11Simplified(queryList, doc):
    rankBM11 = 0.0
    for i in range(len(queryList)):
        num = N - calculateFreqWord(queryList[i]) + 0.5
        den = calculateFreqWord(queryList[i]) + 0.5
        temp = ((K1 + 1)*freqWordDoc(queryList[i], doc))/((K1*len(doc))/avgDocLen() + freqWordDoc(queryList[i], doc))
        rankBM11 += (temp*math.log(num/den))
    return rankBM11
```

```
q = "squads for centralised international superpower link Washington news for today eat healthy"
```

```
[(92, 24.299299796289993), (11, 16.08965714363263), (40, 13.692689980171842), (81, 13.692689980171842), (13, 11.185846762817018), (57, 11.185846762817018), (6, 10.786352235573554), (9, 10.786352235573554), (32, 10.786352235573554), (53, 10.786352235573554), (59, 10.786352235573554), (70, 10.786352235573554), (2, 10.067262086535317), (4, 10.067262086535317), (19, 10.067262086535317), (20, 10.067262086535317), (36, 10.067262086535317), (45, 10.067262086535317), (47, 10.067262086535317), (48, 10.067262086535317), (60, 10.067262086535317), (64, 10.067262086535317), (0, 8.389385072112765), (1, 8.389385072112765), (3, 8.389385072112765), (7, 8.389385072112765), (8, 8.389385072112765), (10, 8.389385072112765), (23, 8.389385072112765), (29, 8.389385072112765), (30, 8.389385072112765), (31, 8.389385072112765), (37, 8.389385072112765), (38, 8.389385072112765), (41, 8.389385072112765), (44, 8.389385072112765), (51, 8.389385072112765), (54, 8.389385072112765), (56, 8.389385072112765), (58, 8.389385072112765), (62, 8.389385072112765), (66, 8.389385072112765), (67, 8.389385072112765), (68, 8.389385072112765), (69, 8.389385072112765), (71, 8.389385072112765), (72, 8.389385072112765), (77, 8.389385072112765), (78, 8.389385072112765), (79, 8.389385072112765), (86, 8.389385072112765), (93, 8.389385072112765), (95, 8.389385072112765), (99, 8.389385072112765), (27, 5.303304908059076), (34, 5.303304908059076), (82, 5.303304908059076), (90, 5.303304908059076), (5, 0.0), (12, 0.0), (14, 0.0), (15, 0.0), (16, 0.0), (17, 0.0), (18, 0.0), (21, 0.0), (22, 0.0), (24, 0.0), (25, 0.0), (26, 0.0), (28, 0.0), (33, 0.0), (35, 0.0), (39, 0.0), (42, 0.0), (43, 0.0), (46, 0.0), (49, 0.0), (50, 0.0), (52, 0.0), (55, 0.0), (61, 0.0), (63, 0.0), (65, 0.0), (73, 0.0), (74, 0.0), (75, 0.0), (76, 0.0), (80, 0.0), (83, 0.0), (84, 0.0), (85, 0.0), (87, 0.0), (88, 0.0), (89, 0.0), (91, 0.0), (94, 0.0), (96, 0.0), (97, 0.0), (98, 0.0)]
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q = "Washington is the capital of America. Eat healthy and stay happy. Victory of Americans."
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[(71, 24.710369517751119), (34, 24.506426921241918), (11, 24.429105399839955), (18, 24.3316480655729), (93, 24.157421184634174), (12, 24.085250007834812), (79, 24.045646301750875), (64, 24.0034283627492), (8, 23.955593852973816), (46, 23.925895947254443), (44, 23.870988045602765), (75, 23.825323898437905), (13, 23.776085499538140), (25, 23.543861845152737), (32, 23.263309102966040), (38, 23.179577755731730), (72, 23.162526160056704), (66, 22.72741236552405), (69, 22.72741236552405), (61, 22.463410737380640), (65, 19.612618962509472), (84, 19.547179209786997), (92, 19.538505321168188), (26, 19.491860713453118), (91, 19.491860713453118), (94, 19.377900868851860), (42, 19.375484571308050), (98, 19.369984056574170), (70, 19.345249873836770), (17, 19.332679725327810), (15, 19.314023874809056), (87, 19.301570649006333), (37, 19.241830152267040), (85, 19.241830152267040), (73, 19.221832830060563), (95, 19.200705715639030), (5, 19.199832694381946), (21, 19.188947609830150), (99, 19.188947609830150), (9, 19.142852087455907), (43, 19.088101156453067), (36, 19.072022382344265), (62, 19.057704833728020), (63, 19.050895267922733), (60, 19.037569020862925), (57, 19.035152723319115), (80, 19.028343157513827), (30, 18.951021636111868), (59, 18.934171845035845), (2, 18.924945981686747), (39, 18.917120249360817), (96, 18.887667493194870), (83, 18.885342275602817), (55, 18.854116276575100), (6, 18.828449451616713), (58, 18.808460081027), (33, 18.786020618522237), (74, 18.733673691474287), (10, 18.726305964537420), (51, 18.711115394664084), (3, 18.671829438095127), (48, 18.665019872289840), (4, 18.652288944914740), (1, 18.638944217864722), (31, 18.621892622189694), (28, 18.599340511780788), (35, 18.599340511780788), (53, 18.568114512753073), (0, 18.526558700915686), (29, 18.426685069104820), (77, 18.358589411051960), (78, 18.351779845246668), (40, 18.186778827657004), (49, 18.107523680491838), (16, 18.054575247357885), (20, 18.023349248330170), (97, 18.023349248330170), (22, 18.019273729583666), (19, 18.002222133908640), (50, 18.002222133908640), (88, 17.948444024472018), (7, 17.900345688625630), (23, 17.889617574722674), (27, 17.836669141588720), (52, 17.527822382807027), (41, 17.424107457464974), (45, 17.378011935090730), (24, 14.614992093952100), (82, 14.455361350363908), (90, 14.348917760534329), (14, 14.331866164859305), (81, 14.278088055422684), (56, 14.074025665267875), (76, 9.486887775559890), (86, 8.988626862977963), (54, 8.913721639119810), (67, 8.913721639119810), (68, 8.770720757208800)]
```

BM15 Formula

```
def BM15Simplified(queryList, doc):
    rankBM15 = 0.0
    for i in range(len(queryList)):
        num = N - calculateFreqWord(queryList[i]) + 0.5
        den = calculateFreqWord(queryList[i]) + 0.5
        temp = (K1+1)*freqWordDoc(queryList[i], doc)/(K1+freqWordDoc(queryList[i], doc))
        rankBM15 += (temp*math.log(num/den))
    return rankBM15
```

```
q = "squads for centralised international superpower link Washington news for today eat healthy"
```

```
[(92, 24.299299796289993), (11, 16.08965714363263), (40, 13.692689980171842), (81, 13.692689980171842), (13, 11.185846762817018), (57, 11.185846762817018), (6, 10.786352235573554), (9, 10.786352235573554), (32, 10.786352235573554), (53, 10.786352235573554), (59, 10.786352235573554), (70, 10.786352235573554), (2, 10.067262086535317), (4, 10.067262086535317), (19, 10.067262086535317), (20, 10.067262086535317), (36, 10.067262086535317), (45, 10.067262086535317), (47, 10.067262086535317), (48, 10.067262086535317), (60, 10.067262086535317), (64, 10.067262086535317), (0, 8.389385072112765), (1, 8.389385072112765), (3, 8.389385072112765), (7, 8.389385072112765), (8, 8.389385072112765), (10, 8.389385072112765), (23, 8.389385072112765), (29, 8.389385072112765), (30, 8.389385072112765), (31, 8.389385072112765), (37, 8.389385072112765), (38, 8.389385072112765), (41, 8.389385072112765), (44, 8.389385072112765), (51, 8.389385072112765), (54, 8.389385072112765), (56, 8.389385072112765), (58, 8.389385072112765), (62, 8.389385072112765), (66, 8.389385072112765), (67, 8.389385072112765), (68, 8.389385072112765), (69, 8.389385072112765), (71, 8.389385072112765), (72, 8.389385072112765), (77, 8.389385072112765), (78, 8.389385072112765), (79, 8.389385072112765), (86, 8.389385072112765), (93, 8.389385072112765), (95, 8.389385072112765), (99, 8.389385072112765), (27, 5.303304908059076), (34, 5.303304908059076), (82, 5.303304908059076), (90, 5.303304908059076), (5, 0.0), (12, 0.0), (14, 0.0), (15, 0.0), (16, 0.0), (17, 0.0), (18, 0.0), (21, 0.0), (22, 0.0), (24, 0.0), (25, 0.0), (26, 0.0), (28, 0.0), (33, 0.0), (35, 0.0), (39, 0.0), (42, 0.0), (43, 0.0), (46, 0.0), (49, 0.0), (50, 0.0), (52, 0.0), (55, 0.0), (61, 0.0), (63, 0.0), (65, 0.0), (73, 0.0), (74, 0.0), (75, 0.0), (76, 0.0), (80, 0.0), (83, 0.0), (84, 0.0), (85, 0.0), (87, 0.0), (88, 0.0), (89, 0.0), (91, 0.0), (94, 0.0), (96, 0.0), (97, 0.0), (98, 0.0)]
```

```
q = "Washington is the capital of America. Eat healthy and stay happy. Victory of Americans."
```

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[(71, 24.71036951775119), (34, 24.506426921241918), (11, 24.429105399839955), (18, 24.3316480655729), (93, 24.157421184634174), (12, 24.085250007834812), (79, 24.045646301750875), (64, 24.0034283627492), (8, 23.955593852973816), (46, 23.925895947254443), (44, 23.870988045602765), (75, 23.825323898437905), (13, 23.77608549953814), (25, 23.543861845152737), (32, 23.26330910296604), (38, 23.17957775573173), (72, 23.162526160056704), (66, 22.72741236552405), (69, 22.72741236552405), (61, 22.46341073738064), (65, 19.612618962509472), (84, 19.547179209786997), (92, 19.538505321168188), (26, 19.491860713453118), (91, 19.49186071345311 8), (94, 19.37790086885186), (42, 19.37548457130805), (98, 19.36998405657417), (70, 19.34524987383677), (17, 19.3326797253278 1), (15, 19.314023874809056), (87, 19.301570649006333), (37, 19.24183015226704), (85, 19.24183015226704), (73, 19.2218328300605 63), (95, 19.20070571563903), (5, 19.199832694381946), (21, 19.18894760983015), (99, 19.18894760983015), (9, 19.14285208745590 7), (43, 19.088101156453067), (36, 19.072022382344265), (62, 19.05770483372802), (63, 19.050895267922733), (60, 19.037569020862 925), (57, 19.035152723319115), (80, 19.028343157513827), (30, 18.951021636111868), (59, 18.934171845035845), (2, 18.9249459816 86747), (39, 18.917120249360817), (96, 18.88766749319487), (83, 18.885342275602817), (55, 18.8541162765751), (6, 18.82844945161 6713), (58, 18.808460081027), (33, 18.786020618522237), (74, 18.733673691474287), (10, 18.72630596453742), (51, 18.711115394664 084), (3, 18.671829438095127), (48, 18.66501987228984), (4, 18.65228894491474), (1, 18.638944217864722), (31, 18.62189262218969 4), (89, 18.621892622189694), (28, 18.599340511780788), (35, 18.599340511780788), (53, 18.568114512753073), (0, 18.526558700915 686), (29, 18.42668506910482), (77, 18.35858941105196), (78, 18.351779845246668), (40, 18.18677882765704), (47, 18.186778827657 04), (49, 18.107523680491838), (16, 18.054575247357885), (20, 18.02334924833017), (97, 18.02334924833017), (22, 18.019273729583 666), (19, 18.00222213390864), (50, 18.00222213390864), (88, 17.948444024472018), (7, 17.90034568862563), (23, 17.8896175747226 74), (27, 17.83666914158872), (52, 17.527822382807027), (41, 17.424107457464974), (45, 17.37801193509073), (24, 14.614992093952 1), (82, 14.455361350363908), (90, 14.348917760534329), (14, 14.331866164859305), (81, 14.278088055422684), (56, 14.07402566526 7875), (76, 9.486887775559 89), (86, 8.988626862977963), (54, 8.91372163911981), (67, 8.91372163911981), (68, 8.7707207572088)]
```

Part 3: BM25 formula

Part 3: BM25

```
b = 0.1
def calculateBij(word, doc):
    num = (K1 + 1)*freqWordDoc(word, doc)
    den = K1*((1-b)+ b*len(doc)/avgDocLen()) + freqWordDoc(word, doc)
    return num/den
```

```
def BM25(queryList, doc):
    rankBM25 = 0.0
    for i in range(len(queryList)):
        num = N - calculateFreqWord(queryList[i]) + 0.5
        den = calculateFreqWord(queryList[i]) + 0.5
        temp = calculateBij(queryList[i], doc)
        rankBM25 += (temp*math.log(num/den))
    return rankBM25
```

```
q = "squads for centralised international superpower link Washington news for today eat healthy"
```

K1 = 0.5, b = 0.3

```
[(92, 24.299299796289993), (11, 16.08965714363263), (40, 13.692689980171842), (81, 13.692689980171842), (13, 11.18584676281701
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317), (20, 10.067262086535317), (36, 10.067262086535317), (45, 10.067262086535317), (47, 10.067262086535317), (48, 10.067262086
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6), (34, 5.303304908059076), (82, 5.303304908059076), (90, 5.303304908059076), (5, 0.0), (12, 0.0), (14, 0.0), (15, 0.0), (16,
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(42, 0.0), (43, 0.0), (46, 0.0), (49, 0.0), (50, 0.0), (52, 0.0), (55, 0.0), (61, 0.0), (63, 0.0), (65, 0.0), (73, 0.0), (74,
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(96, 0.0), (97, 0.0), (98, 0.0)]
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K1 = 0.7, b = 0.8

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5), (86, 8.389385072112765), (93, 8.389385072112765), (95, 8.389385072112765), (99, 8.389385072112765), (27, 5.30330490805907
6), (34, 5.303304908059076), (82, 5.303304908059076), (90, 5.303304908059076), (5, 0.0), (12, 0.0), (14, 0.0), (15, 0.0), (16,
0.0), (17, 0.0), (18, 0.0), (21, 0.0), (22, 0.0), (24, 0.0), (25, 0.0), (26, 0.0), (28, 0.0), (33, 0.0), (35, 0.0), (39, 0.0),
(42, 0.0), (43, 0.0), (46, 0.0), (49, 0.0), (50, 0.0), (52, 0.0), (55, 0.0), (61, 0.0), (63, 0.0), (65, 0.0), (73, 0.0), (74,
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(96, 0.0), (97, 0.0), (98, 0.0)]
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K1 = 0.2, b = 0.6

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[(92, 24.299299796289993), (11, 14.741363114185933), (40, 13.692689980171842), (81, 13.692689980171842), (13, 9.5878686538431
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(59, 9.438058206126858), (70, 9.438058206126858), (2, 9.152056442304833), (4, 9.152056442304833), (19, 9.152056442304833), (20,
9.152056442304833), (36, 9.152056442304833), (45, 9.152056442304833), (47, 9.152056442304833), (48, 9.152056442304833), (60, 9.
152056442304833), (64, 9.152056442304833), (0, 8.389385072112765), (1, 8.389385072112765), (3, 8.389385072112765), (7, 8.389385
072112765), (8, 8.389385072112765), (10, 8.389385072112765), (23, 8.389385072112765), (29, 8.389385072112765), (30, 8.389385072
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5), (72, 8.389385072112765), (77, 8.389385072112765), (78, 8.389385072112765), (79, 8.389385072112765), (86, 8.38938507211276
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8, 0.0)]
```

K1 = 0.2, b = 0.1

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```
q = "Washington is the capital of America. Eat healthy and stay happy. Victory of Americans."
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K1 = 0.5, b = 0.3

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K1 = 0.2, b = 0.1

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K1 = 0.7, b = 0.8

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K1 = 0.2, b = 0.6

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```

Observations

1) Comparing original and simplified formulas of the BM11 model, the ranks change greatly for both the queries.
2) In the BM15 model, similar ranks are produced for the original and simplified versions. Although the ranks don't change much, the difference in values between the highly and lower ranked documents increase. This can be observed for both the queries.
3) Four combinations of K1 and b values have been considered. Different combinations of high and low values of both K1 and b have been experimented with.
4) The top ranked documents do not vary a lot with the different K1 and b values. However, the documents in the middle of the ranking are slightly affected. Changes in the value of K1 have more effect in the change of ranking of documents.
5) The top documents are almost the same for all the three models namely BM11, BM15 and BM25.