**CSIT 5930 Search Engines and Applications**

Fall 2021 Homework 2 Report

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# C) Query Result

## "embedding":

document\_id: 95

similarity: 0.4820251213721229

document\_vector\_norm: 61.40281956231339

unique\_word\_number: 42

top5\_word\_weight: {'entiti': 33.55698831542607, 'repres': 3.796271422928588, 'aspect': 4.080064388929179, 'singl': 4.018663844265036, 'fgs2ee': 19.207252689972385}

document\_id: 277

similarity: 0.3582389148652805

document\_vector\_norm: 41.31000335801765

unique\_word\_number: 37

top5\_word\_weight: {'set': 4.788345958714484, 'deep': 3.8487388428227236, 'contextu': 11.96674950261295, 'e': 5.252692842972551, 'simpler': 12.037327688530072}

document\_id: 213

similarity: 0.3490256403079279

document\_vector\_norm: 50.880562572999686

unique\_word\_number: 51

top5\_word\_weight: {'convers': 12.532084770852283, 'contain': 3.9031866268451, 'mani': 2.8893808273200694, 'type': 3.6967357493776736, 'pr': 25.810879034958578}

document\_id: 202

similarity: 0.324401756864846

document\_vector\_norm: 72.99023738504802

unique\_word\_number: 60

top5\_word\_weight: {'goal': 4.796271422928588, 'knowledg': 5.751411780845986, 'graph': 6.160128777858358, 'kge': 9.603626344986193, 'conv': 28.810879034958578}

document\_id: 294

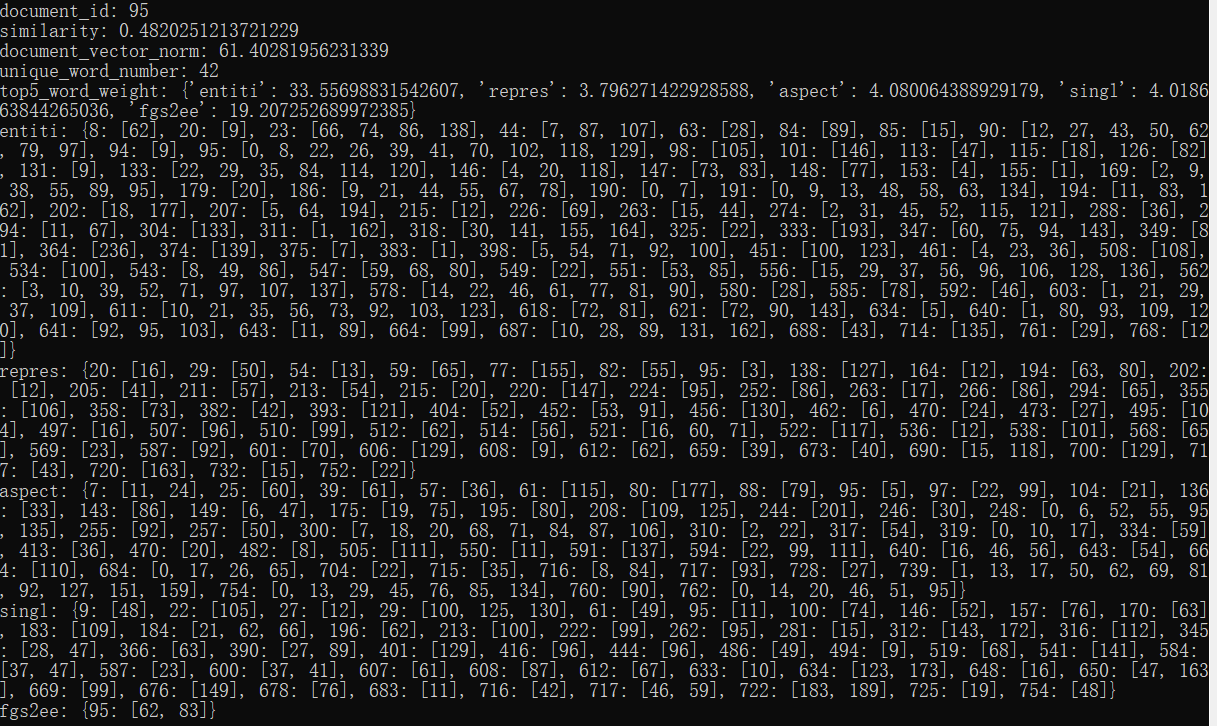
similarity: 0.3166646502029884

document\_vector\_norm: 74.77361690518207

unique\_word\_number: 45

top5\_word\_weight: {'knowledg': 2.875705890422993, 'graph': 3.080064388929179, 'kg': 56.149310754120286, 'learn': 2.8079080002996553, 'compress': 20.388814268785765}

The first document top5 keyword about corresponding postings lists is as follows, where for stem word “entit” document 8 contains it and in the position 62 of document 8. Because it is so big, so I will put it in the appendix, and only display one of them:



## language model

document\_id: 349

similarity: 0.19612002895805933

document\_vector\_norm: 42.5887289290885

unique\_word\_number: 55

top5\_word\_weight: {'languag': 9.519987327696157, 'pretrain': 4.318224126123944, 'ubiquit': 6.796271422928588, 'natur': 4.160128777858358, 'crawl': 12.563396500197658}

document\_id: 394

similarity: 0.18553895022622924

document\_vector\_norm: 37.57034165218137

unique\_word\_number: 56

top5\_word\_weight: {'languag': 8.329988911734137, 'multilingu': 13.423029984123676, 'neural': 1.6320827910354199, 'machin': 2.7209832956243507, 'interlingua': 9.603626344986193}

document\_id: 654

similarity: 0.1655873409808997

document\_vector\_norm: 43.728610126026325

unique\_word\_number: 41

top5\_word\_weight: {'languag': 8.329988911734137, 'present': 4.5996911936181775, 'method': 2.7400133364529795, 'combin': 7.0323270074717055, 'commun': 18.236928902510954}

document\_id: 473

similarity: 0.16025334997240523

document\_vector\_norm: 43.692004711304065

unique\_word\_number: 49

top5\_word\_weight: {'languag': 9.519987327696157, 'technolog': 11.8063732536902, 'contribut': 4.9031866268451, 'promot': 6.796271422928588, '7000': 9.603626344986193}

document\_id: 411

similarity: 0.15261037513941306

document\_vector\_norm: 34.852664624418125

unique\_word\_number: 41

top5\_word\_weight: {'languag': 7.139990495772118, 'train': 4.383326819149983, 'multilingu': 4.4743433280412255, 'machin': 2.7209832956243507, 'mt': 12.037327688530072}

## state of the art

document\_id: 262

similarity: 0.12856840120221483

document\_vector\_norm: 33.90418454789961

unique\_word\_number: 36

top5\_word\_weight: {'state': 2.9797683578740073, 'art': 3.1847981791258757, 'advanc': 4.355698831542607, 'pre': 6.067541473310488, 'classif': 13.272896504495774}

document\_id: 290

similarity: 0.1259927882712182

document\_vector\_norm: 42.383576808584216

unique\_word\_number: 45

top5\_word\_weight: {'state': 5.959536715748015, 'art': 1.5923990895629379, 'recent': 2.34623850229354, 'propos': 2.5763775224599392, 'dialogu': 23.58720601808818}

document\_id: 329

similarity: 0.11614787536688266

document\_vector\_norm: 37.5298023112283

unique\_word\_number: 46

top5\_word\_weight: {'state': 2.9797683578740073, 'art': 3.1847981791258757, 'new': 5.751377453408921, 'larg': 2.2907433897018366, 'nli': 13.592542845857176}

document\_id: 432

similarity: 0.11364277812116204

document\_vector\_norm: 84.07092823153519

unique\_word\_number: 59

top5\_word\_weight: {'state': 11.91907343149603, 'recent': 2.34623850229354, 'work': 1.8689167247603538, 'dialogu': 15.724804012058787, 'dst': 50.971887750691806}

document\_id: 750

similarity: 0.11263014348647667

document\_vector\_norm: 58.052933252877395

unique\_word\_number: 68

top5\_word\_weight: {'state': 4.469652536811011, 'art': 4.777197268688814, 'transfer': 3.6728890074233056, 'learn': 2.8079080002996553, 'aggress': 16.03732768853007}

## Natural Language Processing

document\_id: 349

similarity: 0.22074908840054522

document\_vector\_norm: 42.5887289290885

unique\_word\_number: 54

top5\_word\_weight: {'natur': 4.160128777858358, 'languag': 9.519987327696157, 'process': 2.603626344986192, 'pretrain': 4.318224126123944, 'crawl': 12.563396500197658}

document\_id: 481

similarity: 0.20417351082513727

document\_vector\_norm: 27.7406941729261

unique\_word\_number: 32

top5\_word\_weight: {'natur': 6.240193166787538, 'languag': 3.569995247886059, 'paper': 1.2682359902922669, 'trace': 7.603626344986192, 'bind': 9.603626344986193}

document\_id: 490

similarity: 0.172185749151089

document\_vector\_norm: 23.685014222810334

unique\_word\_number: 21

top5\_word\_weight: {'languag': 2.379996831924039, 'process': 2.603626344986192, 'given': 3.127892914019794, 'complex': 3.6967357493776736, 'possibl': 8.563396500197658}

document\_id: 679

similarity: 0.1720082383451278

document\_vector\_norm: 65.85632149372202

unique\_word\_number: 52

top5\_word\_weight: {'natur': 12.480386333575076, 'languag': 7.139990495772118, 'studi': 2.394172979357242, 'semant': 7.879039264458827, 'feedback': 29.126793000395317}

document\_id: 760

similarity: 0.16556814780499457

document\_vector\_norm: 45.11373732479097

unique\_word\_number: 54

top5\_word\_weight: {'natur': 4.160128777858358, 'languag': 3.569995247886059, 'process': 5.207252689972384, 'nlp': 12.257870135512642, 'person': 11.032327007471705}

# d) Other Data Structure

## abstracts\_list

This is the list of all the papers abstracts after tokenize, for instance, the first document (is the first element of the list as well) will display in this way:

['this', 'paper', 'focuses', 'on', 'generating', 'multi', 'hop', 'reasoning', 'questions', 'from', 'the', 'raw', 'text', 'in', 'a', 'low', 'resource', 'circumstance', 'such', 'questions', 'have', 'to', 'be', 'syntactically', 'valid', 'and', 'need', 'to', 'logically', 'correlate', 'with', 'the', 'answers', 'by', 'deducing', 'over', 'multiple', 'relations', 'on', 'several', 'sentences', 'in', 'the', 'text', 'specifically', 'we', 'first', 'build', 'a', 'multi', 'hop', 'generation', 'model', 'and', 'guide', 'it', 'to', 'satisfy', 'the', 'logical', 'rationality', 'by', 'the', 'reasoning', 'chain', 'extracted', 'from', 'a', 'given', 'text', 'since', 'the', 'labeled', 'data', 'is', 'limited', 'and', 'insufficient', 'for', 'training', 'we', 'propose', 'to', 'learn', 'the', 'model', 'with', 'the', 'help', 'of', 'a', 'large', 'scale', 'of', 'unlabeled', 'data', 'that', 'is', 'much', 'easier', 'to', 'obtain', 'such', 'data', 'contains', 'rich', 'expressive', 'forms', 'of', 'the', 'questions', 'with', 'structural', 'patterns', 'on', 'syntax', 'and', 'semantics', 'these', 'patterns', 'can', 'be', 'estimated', 'by', 'the', 'neural', 'hidden', 'semi', 'markov', 'model', 'using', 'latent', 'variables', 'with', 'latent', 'patterns', 'as', 'a', 'prior', 'we', 'can', 'regularize', 'the', 'generation', 'model', 'and', 'produce', 'the', 'optimal', 'results', 'experimental', 'results', 'on', 'the', 'hotpotqa', 'data', 'set', 'demonstrate', 'the', 'effectiveness', 'of', 'our', 'model', 'moreover', 'we', 'apply', 'the', 'generated', 'results', 'to', 'the', 'task', 'of', 'machine', 'reading', 'comprehension', 'and', 'achieve', 'significant', 'performance', 'improvements']

This data structure will help me deal with phase, for example, if I have a “English Teacher” phase query, I need to find the whole word which is contained by the abstracts. I can just compare word by word to judge.

## query\_weight

This is the query weight to help me calculate weight for convenience, which is a ordered dictionary. For example, if my query is ‘a tree of "language model" apple tree’, it will be transfer in this form as follows:

OrderedDict([('tree', 2), ('appl', 1), ('language model', 1)])

When I calculate numerator of cosine similarity, I need to multiply document weight by query weight element by element, it really helps to record the weight.

## unique\_word

This is a **dictionary(dict())** in one document, form like {‘english’: 2, ‘graph’: 1}, which record the occur times of one word, if one number of one word is 1, means that it is unique, and will be marked as unique.

# e) Design Proposal

If there is no updating, in order to accelerate the computing speed, I will record a few information about these papers.

1. Record all weights of all documents in advance.
2. Record all idf of all stem in advance
3. Record all tf of all stem in every document

So, the only I need to do is to process the phase query, and other words’ idf and tf have already been computed.

1. In the meanwhile, because it is static, so I can cache the idf and tf of previous phase query to accelerate query efficiency.

# Tricks to Improve

1. I make a lot of Pruning to accelerate it. Such as:
   1. When I calculate document weight, if one document doesn’t have any word or phase of the query, I will skip it.
   2. When I calculate numerator of cosine similarity, if it only calculates word or phase in the query, because others will be 0, skip a lot of multiply.
2. I use the ordered dictionary to record word weight and phase weight, and then merge them into query weight, and calculate numerator of cosine similarity.

# Appendix:

## "embedding":

document\_id: 95

similarity: 0.4820251213721229

document\_vector\_norm: 61.40281956231339

unique\_word\_number: 42

top5\_word\_weight: {'entiti': 33.55698831542607, 'repres': 3.796271422928588, 'aspect': 4.080064388929179, 'singl': 4.018663844265036, 'fgs2ee': 19.207252689972385}

entiti: {8: [62], 20: [9], 23: [66, 74, 86, 138], 44: [7, 87, 107], 63: [28], 84: [89], 85: [15], 90: [12, 27, 43, 50, 62, 79, 97], 94: [9], 95: [0, 8, 22, 26, 39, 41, 70, 102, 118, 129], 98: [105], 101: [146], 113: [47], 115: [18], 126: [82], 131: [9], 133: [22, 29, 35, 84, 114, 120], 146: [4, 20, 118], 147: [73, 83], 148: [77], 153: [4], 155: [1], 169: [2, 9, 38, 55, 89, 95], 179: [20], 186: [9, 21, 44, 55, 67, 78], 190: [0, 7], 191: [0, 9, 13, 48, 58, 63, 134], 194: [11, 83, 162], 202: [18, 177], 207: [5, 64, 194], 215: [12], 226: [69], 263: [15, 44], 274: [2, 31, 45, 52, 115, 121], 288: [36], 294: [11, 67], 304: [133], 311: [1, 162], 318: [30, 141, 155, 164], 325: [22], 333: [193], 347: [60, 75, 94, 143], 349: [81], 364: [236], 374: [139], 375: [7], 383: [1], 398: [5, 54, 71, 92, 100], 451: [100, 123], 461: [4, 23, 36], 508: [108], 534: [100], 543: [8, 49, 86], 547: [59, 68, 80], 549: [22], 551: [53, 85], 556: [15, 29, 37, 56, 96, 106, 128, 136], 562: [3, 10, 39, 52, 71, 97, 107, 137], 578: [14, 22, 46, 61, 77, 81, 90], 580: [28], 585: [78], 592: [46], 603: [1, 21, 29, 37, 109], 611: [10, 21, 35, 56, 73, 92, 103, 123], 618: [72, 81], 621: [72, 90, 143], 634: [5], 640: [1, 80, 93, 109, 120], 641: [92, 95, 103], 643: [11, 89], 664: [99], 687: [10, 28, 89, 131, 162], 688: [43], 714: [135], 761: [29], 768: [12]}

repres: {20: [16], 29: [50], 54: [13], 59: [65], 77: [155], 82: [55], 95: [3], 138: [127], 164: [12], 194: [63, 80], 202: [12], 205: [41], 211: [57], 213: [54], 215: [20], 220: [147], 224: [95], 252: [86], 263: [17], 266: [86], 294: [65], 355: [106], 358: [73], 382: [42], 393: [121], 404: [52], 452: [53, 91], 456: [130], 462: [6], 470: [24], 473: [27], 495: [104], 497: [16], 507: [96], 510: [99], 512: [62], 514: [56], 521: [16, 60, 71], 522: [117], 536: [12], 538: [101], 568: [65], 569: [23], 587: [92], 601: [70], 606: [129], 608: [9], 612: [62], 659: [39], 673: [40], 690: [15, 118], 700: [129], 717: [43], 720: [163], 732: [15], 752: [22]}

aspect: {7: [11, 24], 25: [60], 39: [61], 57: [36], 61: [115], 80: [177], 88: [79], 95: [5], 97: [22, 99], 104: [21], 136: [33], 143: [86], 149: [6, 47], 175: [19, 75], 195: [80], 208: [109, 125], 244: [201], 246: [30], 248: [0, 6, 52, 55, 95, 135], 255: [92], 257: [50], 300: [7, 18, 20, 68, 71, 84, 87, 106], 310: [2, 22], 317: [54], 319: [0, 10, 17], 334: [59], 413: [36], 470: [20], 482: [8], 505: [111], 550: [11], 591: [137], 594: [22, 99, 111], 640: [16, 46, 56], 643: [54], 664: [110], 684: [0, 17, 26, 65], 704: [22], 715: [35], 716: [8, 84], 717: [93], 728: [27], 739: [1, 13, 17, 50, 62, 69, 81, 92, 127, 151, 159], 754: [0, 13, 29, 45, 76, 85, 134], 760: [90], 762: [0, 14, 20, 46, 51, 95]}

singl: {9: [48], 22: [105], 27: [12], 29: [100, 125, 130], 61: [49], 95: [11], 100: [74], 146: [52], 157: [76], 170: [63], 183: [109], 184: [21, 62, 66], 196: [62], 213: [100], 222: [99], 262: [95], 281: [15], 312: [143, 172], 316: [112], 345: [28, 47], 366: [63], 390: [27, 89], 401: [129], 416: [96], 444: [96], 486: [49], 494: [9], 519: [68], 541: [141], 584: [37, 47], 587: [23], 600: [37, 41], 607: [61], 608: [87], 612: [67], 633: [10], 634: [123, 173], 648: [16], 650: [47, 163], 669: [99], 676: [149], 678: [76], 683: [11], 716: [42], 717: [46, 59], 722: [183, 189], 725: [19], 754: [48]}

fgs2ee: {95: [62, 83]}

document\_id: 277

similarity: 0.3582389148652805

document\_vector\_norm: 41.31000335801765

unique\_word\_number: 37

top5\_word\_weight: {'set': 4.788345958714484, 'deep': 3.8487388428227236, 'contextu': 11.96674950261295, 'e': 5.252692842972551, 'simpler': 12.037327688530072}

set: {0: [156], 11: [46], 16: [45], 20: [46], 21: [14, 19, 37, 54, 77, 135], 25: [103], 28: [31], 29: [58], 30: [134], 41: [11], 50: [51], 51: [168], 72: [2, 56], 76: [6, 13, 93, 129], 78: [130], 82: [87, 94], 84: [80], 86: [35, 81, 131], 89: [111], 114: [52], 126: [118], 128: [123], 129: [89], 132: [29], 145: [66, 189], 153: [8, 15, 61], 154: [103], 159: [8, 189], 165: [92], 168: [22], 170: [4, 48, 78, 133], 176: [76], 190: [54], 191: [1, 10, 42, 49, 64, 95], 196: [84], 200: [154], 201: [142], 207: [47, 58, 149], 212: [12], 216: [62, 111], 220: [64, 94, 172], 222: [67], 237: [24], 244: [127, 135], 250: [102], 251: [18, 92], 260: [108], 270: [107], 277: [3, 40], 284: [22], 285: [87], 291: [61], 294: [52], 297: [226], 299: [85], 303: [205], 308: [88], 314: [14, 21], 322: [78, 118], 324: [90], 327: [7], 329: [54], 331: [14], 332: [26, 231], 333: [86, 118, 128], 334: [114, 132, 144, 171], 336: [63, 69], 348: [127], 355: [99, 134], 358: [85], 359: [136], 363: [121], 365: [132], 370: [71], 379: [131], 380: [14], 389: [73], 396: [60], 403: [39], 411: [20, 89, 102], 416: [98], 417: [154], 422: [58], 426: [133], 427: [49], 432: [13, 175], 440: [61], 447: [81], 448: [42, 54, 90], 449: [85, 90, 102], 450: [67], 454: [77], 459: [113], 472: [89], 482: [50], 483: [32, 89, 123, 230], 487: [16, 38, 76, 142], 490: [30, 55], 494: [35], 507: [43], 514: [55, 65, 74, 106, 124], 515: [18], 527: [64], 531: [184], 532: [174], 534: [64], 545: [145], 550: [30, 109], 558: [141], 566: [86], 569: [29], 574: [62], 578: [21], 585: [57], 586: [82], 587: [106], 592: [18, 135, 147], 598: [61], 602: [155], 607: [105], 614: [61, 67, 108], 618: [48], 621: [37, 83], 637: [137], 638: [68], 645: [86], 651: [49], 654: [136], 656: [4], 672: [76, 79], 678: [47], 680: [116], 689: [45, 94, 186], 694: [63], 699: [92], 700: [55, 58], 704: [95], 708: [68], 709: [104], 722: [187], 724: [124, 154], 727: [119], 728: [56], 763: [12], 764: [125, 150], 765: [200], 770: [32, 141], 777: [58, 68, 91]}

deep: {6: [20], 8: [0], 9: [2], 24: [103], 43: [61], 52: [99], 56: [35], 64: [12, 36], 90: [101], 107: [60], 115: [24, 125], 119: [0, 143], 152: [130], 168: [46, 166], 172: [111], 178: [56], 199: [79], 228: [0, 30], 233: [78], 239: [22], 270: [26], 277: [6], 279: [6, 94, 129], 299: [4], 307: [34, 88, 139, 166, 177], 309: [10], 323: [67, 139, 158, 180], 342: [24], 357: [10, 28], 388: [20], 442: [75], 447: [121], 481: [74], 495: [55], 526: [4], 539: [6], 542: [3, 144], 544: [1, 83, 106], 546: [9], 549: [122], 564: [1, 33], 566: [0], 586: [84], 595: [116], 598: [25], 600: [6, 70, 114], 605: [38, 65], 614: [11], 667: [1], 668: [1], 680: [5], 688: [69], 720: [1], 772: [82]}

contextu: {19: [66], 74: [102], 95: [53, 81], 98: [100], 103: [3, 26], 163: [16], 164: [14], 178: [3], 189: [53], 194: [145], 224: [94], 226: [18], 231: [64], 233: [79], 238: [43], 240: [57, 66, 88, 91, 114, 130, 148], 247: [30], 251: [0, 62, 75], 265: [0, 18], 269: [49], 276: [3, 56, 77, 92], 277: [7, 60, 86], 281: [126], 300: [60, 75], 303: [167], 315: [16], 318: [127], 330: [16], 336: [112], 370: [6, 32, 97], 381: [62], 386: [84], 438: [19, 107], 461: [51, 100, 134], 472: [52], 497: [88, 108], 499: [77], 578: [70], 599: [63, 85], 605: [27, 54], 623: [10], 632: [19, 69, 96], 670: [55], 676: [104, 127], 697: [86], 722: [30], 739: [115], 760: [99], 767: [152]}

e: {6: [133, 192], 13: [103], 16: [75], 19: [39, 84], 25: [22], 30: [58], 35: [96, 101], 59: [57], 60: [6], 61: [134, 155], 63: [23, 70], 72: [132], 75: [109], 79: [23], 84: [107], 87: [10], 98: [20], 107: [13], 108: [115], 114: [16], 119: [99], 122: [136], 127: [89], 144: [79], 147: [43, 56], 157: [67], 160: [60], 165: [12], 166: [11, 17], 168: [7], 174: [88], 179: [89], 183: [9], 189: [18, 44], 196: [22], 199: [49, 60, 117], 200: [127], 201: [112], 208: [67, 136], 209: [39], 213: [7], 217: [22], 223: [111], 240: [30], 244: [141, 149, 158], 245: [179], 250: [35], 251: [2, 27], 252: [48], 262: [34], 263: [12, 28], 269: [83], 272: [38, 48], 277: [9, 22], 281: [10], 285: [30], 300: [59], 302: [17], 312: [167], 319: [9], 324: [36, 47], 332: [34], 339: [32], 344: [55], 370: [9], 373: [59], 379: [68], 380: [13], 384: [101], 387: [133], 390: [12, 39], 392: [102], 398: [17], 404: [137], 429: [15], 437: [30, 58], 447: [116], 451: [43], 457: [129], 459: [143, 181], 462: [49], 467: [37], 483: [34], 486: [42], 498: [107], 503: [73, 112], 510: [24], 512: [34], 519: [21, 54], 528: [15], 529: [41], 534: [86], 538: [170], 546: [44], 558: [99], 563: [2, 25], 573: [12, 54], 583: [122], 587: [123], 591: [105], 593: [102], 598: [68], 609: [3], 615: [13, 87], 619: [157], 625: [19, 119], 632: [15], 637: [31], 664: [12], 668: [26], 670: [68], 672: [49], 674: [115], 682: [19], 696: [33], 706: [42], 709: [4], 710: [92], 714: [120], 720: [20], 724: [77], 739: [117], 745: [7], 747: [128], 756: [26], 759: [30, 122]}

simpler: {72: [112], 128: [29], 159: [85, 95], 196: [29], 209: [110], 277: [28, 56], 291: [96], 445: [24], 588: [14], 643: [40], 669: [138], 765: [186]}

document\_id: 213

similarity: 0.3490256403079279

document\_vector\_norm: 50.880562572999686

unique\_word\_number: 51

top5\_word\_weight: {'convers': 12.532084770852283, 'contain': 3.9031866268451, 'mani': 2.8893808273200694, 'type': 3.6967357493776736, 'pr': 25.810879034958578}

convers: {6: [34], 10: [70], 15: [64], 39: [32, 39, 69, 110, 162], 46: [2, 80], 52: [13, 27, 86], 60: [14, 26, 51, 84, 101, 107, 124, 160, 204, 215], 69: [33, 41], 89: [31, 37, 119], 113: [13], 121: [5], 136: [121], 145: [14, 98], 149: [10, 18, 51, 145], 170: [12, 36, 71], 204: [53], 213: [1, 21, 31], 218: [6], 226: [13], 239: [16, 52], 246: [55], 275: [5, 22, 41, 51, 60, 80, 134], 355: [98, 132], 371: [3, 71], 374: [6, 86, 94], 397: [3], 401: [8, 72, 139], 423: [16], 428: [7, 109], 441: [19], 478: [180], 496: [1, 23, 28, 62], 504: [11, 44], 521: [12, 48], 535: [67, 90, 109, 116], 555: [2, 39, 89, 152, 172, 196], 650: [12, 53, 66, 126, 155], 659: [1, 17, 29, 33, 42, 85, 94, 112], 693: [3, 51, 147], 707: [4, 18, 30, 54, 100], 732: [5], 751: [67], 759: [6, 24]}

contain: {0: [104], 29: [33], 92: [148], 93: [60], 102: [42], 119: [76, 117], 135: [30], 136: [40], 138: [78], 139: [58], 148: [67], 153: [17], 156: [67], 167: [151], 213: [2], 218: [42], 227: [34, 48], 232: [52], 234: [37], 242: [65], 274: [86], 275: [57, 81], 277: [93], 324: [117, 178], 331: [109], 345: [12, 57], 390: [44], 410: [85], 416: [60], 446: [17], 451: [183], 455: [102], 458: [9], 475: [65], 523: [86], 535: [112], 538: [64], 556: [19], 560: [94], 589: [19], 598: [10, 145], 599: [75], 634: [72], 637: [26], 660: [22], 668: [41], 676: [10, 26, 47], 681: [3], 684: [21], 690: [82], 700: [74], 750: [109, 187]}

mani: {2: [0], 16: [80], 20: [24], 28: [13], 69: [79], 72: [1], 91: [6, 13, 25], 92: [71], 94: [60], 105: [43], 117: [14, 73, 91], 128: [49], 141: [97], 161: [1], 170: [142], 182: [93], 191: [26], 199: [46], 205: [28], 213: [3], 214: [0], 215: [1, 47], 242: [140], 244: [12], 245: [1], 251: [108], 256: [12], 265: [26], 269: [65], 274: [8], 278: [23], 280: [1], 285: [13], 289: [19], 294: [21, 49], 320: [196], 324: [0, 28], 332: [25], 338: [145, 153], 339: [3], 351: [18], 352: [80], 357: [117], 358: [29], 359: [4], 364: [0], 376: [16], 378: [14], 379: [126, 128, 130], 381: [9], 383: [8], 405: [8], 406: [21], 411: [96, 98], 428: [4], 447: [38], 456: [29], 465: [127], 474: [122], 478: [0], 482: [146], 489: [11, 68], 494: [5], 500: [9], 508: [95], 511: [0], 535: [14, 36, 113], 537: [15], 549: [27], 550: [10], 551: [10], 553: [10, 62], 554: [9], 558: [128], 559: [82], 566: [11], 573: [9], 580: [26], 589: [0, 126], 595: [18], 600: [13], 610: [43], 631: [12], 657: [21], 661: [76], 663: [43], 673: [80], 682: [11], 684: [27], 694: [10], 699: [5], 704: [19, 36], 705: [156], 709: [11, 32], 717: [99], 718: [70], 724: [39], 748: [4], 750: [12], 753: [1], 764: [35], 766: [19], 768: [0], 771: [19], 777: [18]}

type: {2: [13], 18: [84], 23: [82], 29: [88], 37: [21], 88: [70], 94: [17], 95: [90], 130: [129], 131: [134], 139: [65], 186: [22, 45, 56, 68, 79], 192: [9], 213: [4], 217: [14, 30, 46, 58, 81, 94, 99], 218: [58], 274: [122], 276: [87, 138], 292: [53], 295: [58], 314: [72], 318: [165], 332: [196], 338: [66], 347: [95], 358: [129], 367: [100, 109], 375: [31, 38, 64], 383: [25, 155], 384: [93, 96], 416: [117], 446: [33], 447: [109], 448: [58], 454: [71], 468: [86], 473: [46], 508: [32, 147], 517: [41], 523: [57, 93], 538: [94], 543: [53, 87], 562: [4, 11, 40, 48, 53, 72, 98, 108, 138], 578: [91], 580: [4], 583: [84], 597: [70], 618: [82], 626: [31], 654: [91, 127], 665: [55], 682: [41], 703: [35], 705: [135], 712: [13, 32], 717: [18], 719: [18, 50, 71, 83], 742: [93], 759: [13, 94], 773: [47]}

pr: {107: [143], 213: [26, 43, 118]}

document\_id: 202

similarity: 0.324401756864846

document\_vector\_norm: 72.99023738504802

unique\_word\_number: 60

top5\_word\_weight: {'goal': 4.796271422928588, 'knowledg': 5.751411780845986, 'graph': 6.160128777858358, 'kge': 9.603626344986193, 'conv': 28.810879034958578}

goal: {3: [60], 60: [1], 82: [76], 90: [17], 94: [19], 145: [5, 62], 177: [13], 202: [1], 255: [37], 290: [109], 385: [76], 397: [160], 401: [1], 425: [2], 432: [153], 441: [1, 27, 105], 463: [83], 491: [24], 506: [17], 533: [5], 565: [34], 633: [62], 647: [16], 654: [21], 678: [18], 693: [1], 747: [30], 772: [28]}

knowledg: {3: [4, 9], 8: [39, 54], 27: [83, 127], 29: [120], 36: [82], 37: [116], 46: [0, 18, 43, 52, 57, 62, 71, 74, 85, 88, 133], 59: [12, 43, 61, 78], 63: [48, 58, 107, 157], 69: [37], 80: [112, 187], 81: [46, 77], 89: [32, 51], 94: [0], 99: [0], 113: [25, 28, 41, 63, 80, 99, 112, 126, 143], 119: [37, 101], 120: [34, 134, 232], 127: [75], 130: [163], 131: [0], 133: [14], 136: [9], 143: [15, 105], 159: [73], 161: [87], 169: [81], 170: [27], 171: [47, 57], 183: [11], 184: [90], 186: [60], 190: [13, 40], 202: [3, 129], 205: [94, 132], 207: [51], 213: [9], 235: [70], 269: [79, 141, 159], 275: [3, 28, 39, 53, 119, 129], 288: [11], 294: [0], 296: [47, 120], 306: [23], 318: [53], 320: [2, 11, 57, 129], 333: [25], 335: [33], 342: [52, 82], 351: [43, 99, 158], 353: [61], 358: [0, 3, 18, 39, 66, 103, 133], 372: [32], 377: [120], 390: [2, 20, 56], 395: [120], 416: [108], 449: [29, 55], 451: [139], 454: [33, 61], 461: [42], 465: [3, 34], 472: [45, 63, 82], 478: [144], 485: [92], 511: [9, 144, 152], 513: [93, 105], 516: [104], 520: [70], 531: [164], 534: [13], 543: [18], 545: [104], 551: [110], 558: [48], 560: [82], 562: [0, 26, 49, 58, 66, 112], 565: [10], 594: [16, 52, 76, 85], 611: [3], 619: [67, 140], 626: [28], 634: [22], 642: [103], 645: [26, 35, 55], 650: [2], 655: [4, 57], 657: [138, 147, 154], 659: [24, 92], 660: [34, 53], 686: [99, 104], 693: [13], 702: [0, 13], 706: [5], 712: [7], 723: [62, 75, 85, 135, 162], 724: [96], 733: [47, 58], 738: [126], 743: [14, 89], 744: [130], 745: [13], 756: [79], 767: [49, 146], 768: [44], 772: [3, 86]}

graph: {9: [32], 26: [61], 37: [7, 14, 23, 63, 104, 120, 168], 42: [27], 45: [72, 96], 48: [97], 53: [20, 55, 77], 63: [49, 108, 158], 68: [94], 88: [3, 17, 41, 86, 107], 90: [102, 112, 117, 136], 94: [1, 6], 98: [80, 132], 99: [1], 113: [29], 123: [94], 131: [1], 133: [1, 19, 62], 138: [103, 120, 137], 147: [61], 150: [26], 161: [102], 167: [113, 124], 183: [6, 12, 24, 47, 59, 91], 198: [82, 113], 202: [4, 130], 207: [52], 233: [26, 65, 119], 247: [10, 23, 65], 271: [3], 275: [54], 279: [52, 62, 78], 288: [12], 294: [1], 300: [97, 112], 303: [77, 116, 143, 160, 165, 217], 313: [1, 9, 25, 56, 71], 320: [3, 12, 58, 105, 115, 130], 324: [151], 325: [43, 95], 328: [15, 68], 336: [9, 22, 37, 41], 337: [59, 68], 350: [23, 28, 46], 358: [4, 19], 366: [40, 84, 90], 382: [104, 128, 132, 145, 169], 385: [67], 396: [72, 83], 407: [97, 109], 416: [29, 51, 87, 121], 427: [29, 58, 83, 85, 141], 431: [0, 40, 47, 50, 65, 90], 442: [77, 95], 449: [62], 451: [69, 88, 140], 465: [4, 35], 472: [69], 495: [64, 83, 88, 92], 499: [57], 521: [24, 28, 49, 103], 526: [41], 530: [10, 26], 536: [69], 537: [4, 16, 28, 43, 49, 66, 93, 106, 121, 156], 556: [9, 32, 46, 107, 114, 121], 562: [1, 27], 601: [59, 81, 100], 603: [58], 611: [4, 63, 79], 615: [5, 10, 21, 35, 42, 93], 630: [88], 633: [129], 642: [54], 645: [64, 72, 83], 649: [100], 657: [148], 659: [25, 58, 63], 663: [82, 107], 684: [53, 92, 109, 117, 142, 153], 702: [1, 14], 710: [133], 712: [50, 64, 74], 721: [80, 85, 113], 723: [95, 110, 129], 733: [59, 84], 745: [14], 754: [100, 150], 758: [46], 761: [92], 764: [5, 23, 100, 113], 767: [60]}

kge: {202: [6]}

conv: {202: [35, 73, 111]}

document\_id: 294

similarity: 0.3166646502029884

document\_vector\_norm: 74.77361690518207

unique\_word\_number: 45

top5\_word\_weight: {'knowledg': 2.875705890422993, 'graph': 3.080064388929179, 'kg': 56.149310754120286, 'learn': 2.8079080002996553, 'compress': 20.388814268785765}

knowledg: {3: [4, 9], 8: [39, 54], 27: [83, 127], 29: [120], 36: [82], 37: [116], 46: [0, 18, 43, 52, 57, 62, 71, 74, 85, 88, 133], 59: [12, 43, 61, 78], 63: [48, 58, 107, 157], 69: [37], 80: [112, 187], 81: [46, 77], 89: [32, 51], 94: [0], 99: [0], 113: [25, 28, 41, 63, 80, 99, 112, 126, 143], 119: [37, 101], 120: [34, 134, 232], 127: [75], 130: [163], 131: [0], 133: [14], 136: [9], 143: [15, 105], 159: [73], 161: [87], 169: [81], 170: [27], 171: [47, 57], 183: [11], 184: [90], 186: [60], 190: [13, 40], 202: [3, 129], 205: [94, 132], 207: [51], 213: [9], 235: [70], 269: [79, 141, 159], 275: [3, 28, 39, 53, 119, 129], 288: [11], 294: [0], 296: [47, 120], 306: [23], 318: [53], 320: [2, 11, 57, 129], 333: [25], 335: [33], 342: [52, 82], 351: [43, 99, 158], 353: [61], 358: [0, 3, 18, 39, 66, 103, 133], 372: [32], 377: [120], 390: [2, 20, 56], 395: [120], 416: [108], 449: [29, 55], 451: [139], 454: [33, 61], 461: [42], 465: [3, 34], 472: [45, 63, 82], 478: [144], 485: [92], 511: [9, 144, 152], 513: [93, 105], 516: [104], 520: [70], 531: [164], 534: [13], 543: [18], 545: [104], 551: [110], 558: [48], 560: [82], 562: [0, 26, 49, 58, 66, 112], 565: [10], 594: [16, 52, 76, 85], 611: [3], 619: [67, 140], 626: [28], 634: [22], 642: [103], 645: [26, 35, 55], 650: [2], 655: [4, 57], 657: [138, 147, 154], 659: [24, 92], 660: [34, 53], 686: [99, 104], 693: [13], 702: [0, 13], 706: [5], 712: [7], 723: [62, 75, 85, 135, 162], 724: [96], 733: [47, 58], 738: [126], 743: [14, 89], 744: [130], 745: [13], 756: [79], 767: [49, 146], 768: [44], 772: [3, 86]}

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## language model

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unique\_word\_number: 56

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## state of the art

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unique\_word\_number: 45

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document\_id: 432

similarity: 0.11364277812116204

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unique\_word\_number: 59

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aggress: {339: [40], 737: [18], 750: [52, 141]}

## Natural Language Processing

document\_id: 349

similarity: 0.22074908840054522

document\_vector\_norm: 42.5887289290885

unique\_word\_number: 54

top5\_word\_weight: {'natur': 4.160128777858358, 'languag': 9.519987327696157, 'process': 2.603626344986192, 'pretrain': 4.318224126123944, 'crawl': 12.563396500197658}

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## Result of “knowledge graph”

