CS 6322: Information Retrieval

**Homework 2**

**Program Description:**

First, the whole Cranfield text collection will be put into memory, and python code will run through each document in the collection. The xml - DOM (Document Object Model) API is used to parse the SGML documents in the collection because they are all in SGML format. This retrieves the document's text just, ignoring the tags. Regex (regular expressions) are used to eliminate punctuation and any numeric data from the page. After eliminating the punctuation and numeric, the text is divided by space and saved in a tokens list.

**Lemmatization**: After tokenizing the documents in the Cranfield collection, the tokens were filtered by eliminating stop words from the stopwords file. The NLTK WordNet Lemmatizer is used for lemmatization in the next stage.

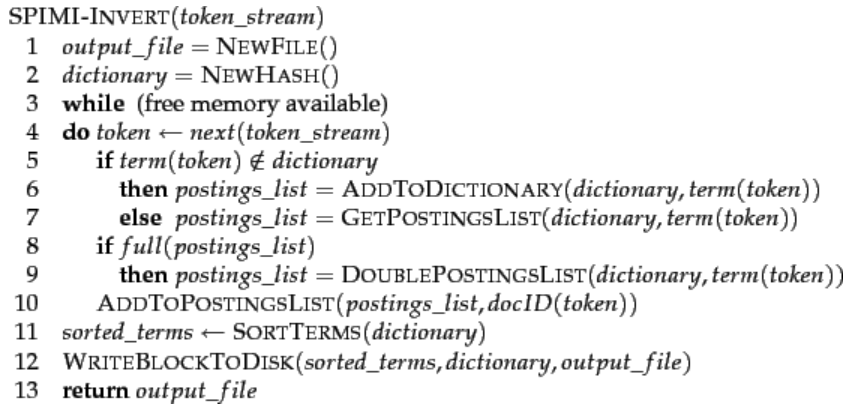
**Stemming**: An open-source porter stemmer for stemming the tokens produced by the program, similar to lemmatization.   https://tartarus.org/martin/PorterStemmer/ is the URL. This file, porter stemmer tartarus.py, should be placed in the same folder as main.py.

**Uncompressed versions of indexing**:

By Iterating documents, producing terms and term frequency maps for each document, and ultimately adding a tuple of term, documentID, tf, max tf, and document length ordered by documentID in posting\_list\_info creates a global list (posting\_list\_info). The posting list is saved in the lexicographic order of terms present in it. The approach is same for both versions of uncompressed indexing; the only difference is whether the words are lemmatized or stemmed. This is managed by two methods: one for creating a posting list of lemmatized phrases and another for generating a posting list of stemmed terms. These files are named "index\_version1\_uncompressed" and "index\_version2\_uncompressed," respectively, and are located in the same directory as main.py.

**Compressed versions of indexing:**

A single pass in memory indexing approach is applied to compress the index versions. Instead of termID, it uses terms, then writes the dictionary for each block to disk, and then starts a new dictionary for the next block. As long as there is enough disk space, SPIMI can index collections of any size. The following is the pseudocode for SPIMI:



**Blocked compression**:

To create compressed version 1 of indexing, the code uses blocked compression. For all of the terms in posting\_list\_info, a single block is first written to the file in the format of a concatenated string of term length and actual term string. The terms are then written in df, gamma code (binary string), and index pointer format (which is after every 4 terms in blocked compression). The document ids of each phrase are used to create a gap list. This is a list of the differences between the document ids stored in each term's posting list for each term. After that, the gaplist is iterated to generate a gamma code for all of the gap ids combined.

**Front coding compression:**

In front coding compression, a front coding string is produced for each 8 phrases in the dictionary by locating a common prefix and appending the remaining part from each term with <>. The terms are then written in df, delta code, and index pointer format (which is placed after every 8 terms in front coding). A delta code is created for each term and written to the file, similar to the gap list logic of blocked compression.

Following methods are used for delta and gamma code generation:

**def unary\_code**(self, num):

unary = ""

m = 0

while m<num:

unary+=str(1)

m+=1

unary = unary+str(0)

return unary

**def gamma\_code**(self, number):

my\_obj = Main()

binary\_number = str(bin(number))

offset = binary\_number[3:]

offset\_length = len(offset)

length = my\_obj.unary\_code(offset\_length)

gamma\_code = str(length) + str(offset)

return gamma\_code

**def delta\_code**(self, number):

my\_obj = Main()

binary\_number = str(bin(number))

offset = binary\_number[3:]

offbin = binary\_number[2:]

gammacode = my\_obj.gamma\_code(len(offbin))

delta\_code = gammacode + offset

return delta\_code

**Additional details and output of program**:

1) the elapsed time ("wall-clock time") required to build any version of your index, 2 points per index

time taken for building version 1 uncompressed index 11.809221506118774

time taken for building version 1 compressed index 0.3141441345214844

time taken for building version 2 uncompressed index 4.1828484535217285

time taken for building version 2 compressed index 0.3679814338684082

2) the size of the index Version 1 uncompressed (in bytes): 1836966

3) the size of the index version 1 compressed (in bytes) :822661

4) the size of the index version 2 uncompressed (in bytes) :1765313

5) the size of the index version 1 compressed (in bytes) 695004

6) number of postings in index version1: 7631

number of postings in index version2: 5797

7) the df, tf, and inverted list length (in bytes) for the terms: "Reynolds", "NASA", "Prandtl", "flow", "pressure", "boundary", "shock"

Index version1 :

|  |  |  |  |
| --- | --- | --- | --- |
| term | df | Inverted list length (bytes) | tf |
| 'flow' | 658 | 6032 | 1592 |
| 'boundary' | 380 | 3528 | 750 |
| 'shock' | 212 | 2016 | 552 |
| 'pressure' | 509 | 4688 | 1157 |
| 'reynolds' | 190 | 1816 | 355 |
| 'prandtl' | 49 | 552 | 65 |
| 'nasa' | 7 | 144 | 7 |

Index version2 :

|  |  |  |  |
| --- | --- | --- | --- |
| term | df | Inverted list length (bytes) | tf |
| 'flow' | 660 | 6048 | 1598 |
| 'shock' | 212 | 2016 | 552 |
| 'prandtl' | 53 | 584 | 70 |
| 'nasa' | 7 | 144 | 7 |

[('flow', 660, 6048, 1598), ('prandtl', 53, 584, 70), ('shock', 213, 2024, 553), ('nasa', 7, 144, 7)]

8) first 3 posting list of nasa (df,tf,doclen,maxtf) :

[(7, 1, 407, 19), (7, 1, 142, 6), (7, 1, 194, 6)]

9) the dictionary term from index 1 with the largest df (2 points) and the dictionary term with the lowest df (2 points) – if more than one list them all!!!

**dictionary terms from index version1 with largest df**: ['to']

**dictionary terms from index version1 with smallest df**: ['boundarylayercontrol', 'libby', 'emitting', 'wassermann', 'ensuing', 'contaminates', 'persist', 'rake', 'lacquer', 'totalhead', 'hastening', 'detection', 'phosphorescent', 'polytechnic', 'brooklyn', 'dominating', 'alleviating', 'attacking', 'acrothermoelasticity', 'boxwing', 'pointfunction', 'ackerets', 'determinant', 'wherever', 'analyseseg', 'panelsis', 'aerodynamicthermoelastic', 'controlsurface', 'collectively', 'raise', 'flatness', 'elemental', 'postulate', 'company', 'wheel', 'pointednose', 'reverts', 'generalizednewtonian', 'md1', 'lees', 'superiority', 'hardware', 'studiesdash', 'aero', 'maslen', 'slipping', 'sci', 'catalytic', 'sakurai', 'lin', 'va', 'inviscidviscous', 'realization', 'notednamely', 'aerodynamieist', 'einbinder', 'sedov', 'inquire', 'wideflanged', 'builtup', 'ibeam', 'multicellular', 'undamped', 'ballistictype', 'accrue', 'maximumacceleration', 'seeding', 'constantarea', 'provision', 'seeded', 'poiscuille', 'justify', 'electrode', 'nontrivial', 'possessing', 'unfamiliar', 'happen', 'magnifiedschlieren', 'singleelement', 'supplystream', 'ask', 'enginemount', 'vibrated', 'studiesexperimental', 'gyroscopic', 'gyroscope', 'tical', 'undergoes', 'enginepropeller', 'eter', 'walltoambient', 'transitionreversal', 'nominally', 'characteristies', 'conceivably', 'contemplated', 'sparkschlieren', 'thermaltomomentum', 'lengthtodepth', 'matric', 'slopecompatibility', 'shocked', 'veiocity', 'surfacetemperature', 'inferred', 'inappropriate', 'entitled', 'wallcooling', 'sixthdegree', 'seventhdegree', 'locating', 'k05', 'k20', 'attainment', 'onetenth', 'picard', 'conformaltransformation', 'oftenused', 'slendertail', 'viscid', 'semivertexangle', 'rameter', 'talbot', 'refracts', 'attenuating', 'acoustically', 'analyzer', 'recur', 'capsule', 'diverse', 'crest', 'dragdivergence', 'thermalboundarylayer', 'rayleightollmien', '11m', 'sign', 'powerplants', 'forwardfuselage', 'wallpressure', 'unduly', 'forwardfuselagesection', 'presentday', 'convert', 'senior', 'convected', 'unpowered', 'offset', 'precessiontype', 'examines', 'backup', 'aircraftenginepropeller', 'powerplant', 'airspeed', 'microinches', '15x10', 'finish', 'spot', 'granulartype', 'transitiontriggering', 'rotate', 'corollary', 'irbm', 'nondecomposing', 'meltingtype', 'opaque', 'threeyear', 'july', 'forecasting', 'igc', 'proton', 'detectable', 'igy', 'terrestrial', 'geophysical', 'hazard', 'mev', 'efficacious', 'widen', 'expansioncontrolled', 'observables', 'conductioncontrolled', 'trailsie', 'aerialground', 'volumetric', 'liquidmetal', 'grashof', 'parallelplate', 'depression', 'layerfree', 'supersonicwake', 'bluntbase', 'freeshear', 'thicken', 'rely', 'spanning', 'protrusion', 'floorpressure', 'protect', 'grober', 'capacitance', 'stonecypher', 'heatinput', 'urgent', 'cutting', 'wingfuselageshell', 'desk', 'subroutine', 'planeload', 'hopelessly', 'minimumsize', 'opportunely', 'intersectiontype', 'determinate', 'organization', 'mediumsized', 'zeroth', 'differentiates', 'derivable', 'torda', 'roghness', 'heightthickness', 'reanalyze', 'reanalysis', 'bluntbased', 'boundarylayershockwave', 'fage', 'friedman', 'england', 'townend', 'late', 'simmons', 'tried', 'windstream', 'crew', 'passenger', 'occasionally', 'unbalanced', 'intimately', 'shorten', 'mounting', 'preponderance', 'psychological', 'physiological', 'ratecontrolling', 'rategoverning', 'nondimensionalized', 'atommolecule', 'noschmidt', 'heimel', 'premixed', 'butler', 'analyzable', 'potter', 'extinction', 'inductance', 'ceulers', 's2', 's1', 'balancing', 'protein', 'sedimentation', 'ultracentrifuge', 'sixfigure', 'isotope', 'gridnor', 'rod', 'inserting', 'sheara', 'danger', 'weakly', 'dismissed', 'promised', 'strongshock', 'lucid', 'elegant', 'lacking', 'programming', 'choleski', 'hartreewomersley', 'surrounded', 'conduct', 'masked', 'filtering', 'turned', 'signal', 'scanning', 'signaltonoise', 'additive', 'lyon', 'convect', 'hysteretic', 'obtainment', 'pointing', 'proceeding', 'lubricant', 'substituted', 'tomotika', 'meyers', 'gorcums', 'gorcum', 'fourpole', 'stratiform', 'furnace', 'prestons', 'freejet', 'newtoniantheory', 'inconsistent', 'conicalflow', 'lockheed', 'equivalentcone', 'abbreviated', 'machnumber80', 'subtending', 'prevailing', 'boundarylayertype', 'boattails', 'appraised', 'theorythat', 'expansionturning', 'originate', 'flowvisualization', 'shortest', 'eniac', 'twentyone', 'regularity', 'coordinatetype', 'cyclessec', 'association', 'octave', 'doppler', 'monopole', 'hindered', 'understand', 'world', 'reichardts', 'temperatureie', 'casesone', 'twouniform', 'streamhave', 'hopf', 'nonplane', 'inspire', 'tribute', 'sir', 'rederive', 'geoffrey', 'finest', 'accountable', 'ludweigs', 'ludwieg', 'contoured', 'belltype', 'ed', 'expansiondeflection', 'people', 'justifiable', 'fed', 'discharging', 'think', 'chesky', 'hurd', 'confirming', 'correctness', 'tubesthe', 'utilises', 'bang', 'telemetering', 'rocketlaunched', 'tracking', 'airborne', 'rocketborne', 'nomograph', 'energyrequirement', 'shielded', 'thicknesstoradius', 'utilised', 'wingbodies', 'spillage', 'coordinated', 'descriptively', 'diamond', 'externalflow', 'dy', 'alternately', 'noslip', 'uniformstream', 'devising', 'blasiuss', 'summed', 'schubauer', 'steepest', 'fx', 'fr', 'radiates', 'timederivatives', 'occupying', 'accompany', 'immersed', 'asserted', 'frictionless', 'belong', 'goldstein', 'superposed', 'ninth', 'trochoidal', 'weitbrecht', 'shallower', 'quotation', 'triplevaluedness', 'inverts', 'singlevalued', 'trialanderror', 'historics', 'insure', 'm1', 'riolate', 'hypersonicslenderbody', 'opposition', 'retrovelocity', 'contributing', 'misalinement', 'hitting', 'liftoff', 'heliocentric', '10earthg', 'planetocentric', 'supercircular', 'fuelto', 'technologically', 'prescribing', 'atmosphererather', 'conveniently', 'titan', 'broadened', 'disregarded', 'sanger', 'egger', 'introduring', 'slowing', 'precisely', 'allen', 'uncorrected', 'schultzgrunow', 'schoenherr', 'inexpensive', 'surfaceshear', 'univeral', 'obtainec', 'kempf', 'appraoch', 'slighlty', 'nonheatconducting', 'amongst', 'concisely', 'dispersion', 'oxygenlike', 'euckenvalue', 'eucken', 'distorting', 'deexciting', 'hirschfelders', 'verifies', 'afterflow', 'identifying', 'nozzleafterbody', 'vital', 'precise', 'enlightening', 'shockboundarylayerinteraction', 'goal', 'compatible', 'propulsionsystem', 'airinduction', 'jetstream', 'interchangeable', 'e53h25', '9inch', 'halfjet', 'fullyexpanded', 'errorintegral', 'axiallysymmetrical', 'traversing', 'shadow', 'inviscidfluid', 'solides', '12inch', 'diffuse', 'utia', 'thermoaeroelastic', 'nonflammable', 'toxic', 'monatomic', 'gasmixture', 'commercially', 'proportioning', 'krypton', 'nontoxic', 'firingrange', 'xenon', 'concocted', 'accumulated', 'inasmuch', 'heighttochord', 'sizeable', 'conecylinders', 'classificaiton', 'tnis', 'oilfilm', 'literal', 'optic', 'incidental', 'numger', 'anh', 'stroboscopic', 'rearranged', 'thomas', 'diffusive', 'subcore', 'spiralling', 'admit', 'slenderairfoil', 'analyticially', 'verfied', 'duplicating', 'differed', 'lotz', '120inch', 'stingcone', '16foot', 'cowlingspinner', 'propellerresearch', 'nearmaximum', '1series', 'lip', 'shank', 'spinner', 'inletvelocity', 'vortexsheet', 'ailerontab', 'sealing', 'ailcron', 'suffix', 'constantchord', 'plunging', 'avaluated', 'stratagem', 'actural', 'replaces', 'kinked', 'enlarge', 'smoothing', 'logically', 'flutterare', 'flutternamely', 'inertial', 'monograph', 'airloads', 'airload', 'airscrew', 'flutterprevention', 'basing', 'certainty', 'afford', 'adjusting', 'preventing', 'twodimensionalairfoil', 'infiniteaspectratio', 'wingsection', 'disappeared', '64a010', 'inboard', '95percentsemispan', 'rae104', 'anisotropy', 'ohm', 'washing', 'noisefree', 'promoting', 'underneath', 'excites', 'provisional', 'singlerotating', 'fixedpitch', 'harris', 'crosscoupling', 'therefrom', 'nd', 'advancediameter', 'lever', 'manufacturing', 'maintainance', 'classic', 'areamean', 'concurrently', 'suffer', 'featuring', 'interblade', 'liquidinjection', 'freevortex', 'manufacture', 'steamturbine', 'focusing', 'lowenergy', 'nozzleproviding', 'closedjet', 'overriding', 'testedbetween', 'behaved', 'straightsided', 'fourhole', 'twostage', 'inefficient', 'acr', 'l5d20', 'decelerated', 'decelerate', 'explore', 'decelerates', 'convergingdiverging', 'mum', '35inchdiameter', 'correlograms', 'diam', 'easier', 'soundattenuating', 'quieting', 'frequencyshifting', 'emerges', 'multiplenozzle', 'muffler', 'fat', 'decision', 'astronautics', 'amply', 'proposal', 'streamlining', '8x10', 'render', 'straightedged', 'display', 'ridge', 'staggered', 'aero2441', 'owen', 'maskell', 'rollup', 'wingbodytailplane', 'para5', 'maccoll', 'conicalshockexpansion', 'reversibility', 'forebodies', 'radian', 'mehtod', 'noninclined', 'evolve', 'minimises', 'quasiequilibrium', 'endorsed', 'subcommittee', 'collaboration', 'weighting', 'compressorsdash', 'enquiryto', 'measurable', 'no1', 'no2', 'squareedged', 'transfn', 'lowvelocity', 'asimplified', 'tubing', 'exploration', 'royal', 'staff', 'denser', 'educational', 'society', 'flocculent', 'noncorrosive', 'colour', 'white', 'nonirritant', 'wax', 'bluish', 'visualising', 'smell', 'bore', 'directorgeneral', 'hit', 'flapped', 'theta', 'trefitz', 'centresection', 'quickly', '2n', 'expose', 'fluctuates', 'sweptwing', 'ara', 'openarea', 'whithamwalkden', 'sqft', 'disposable', 'townsend', 'ours', 'analoguous', 'waisted', 'laufer', 'loadcarrying', 'sliderbearing', 'ev', 'affinity', 'pv', 'rt', 'richmond', '18x10', 'declassified', 'blastproducer', 'fissionthe', 'explosive', 'outwards', 'borne', 'usedand', 'home', 'expands', 'told', 'till', 'security', 'name', 'degraded', 'circulated', 'publish', 'superseded', 'releasing', 'unaccompanied', 'bomb', 'neumann', 'fredholm', 'seidel', 'solidbody', 'edpm', 'researcher', 'ostrach', 'zhukhovitskii', 'gershuni', 'attract', 'tao', 'insulatedwall', 'matting', 'coworkers', 'pyrex', 'microinch', 'ellipsecylinder', 'molten', 'evaporate', 'returning', 'weighs', 'kg', 'midcourse', 'corrective', 'exhaustpressure', 'statictototal', 'conservationofmomentum', 'took', 'hadamards', 'heaslet', 'semicircular', 'lomax', 'haag', 'child', 'korst', 'afterbodyjetnozzle', 'basetojet', 'curlingup', 'neater', 'highaspectratio', '4vortex', 'centroid', 'equalspan', 'canted', 'propelled', 'coasting', 'intentionally', 'unintentionally', 'slide', 'coarse', 'rotationallysymmetrical', 'velocitydistribution', 'advent', 'sharptip', 'ninefold', 'shrouded', 'persh', 'hypersonicflow', 'vshaped', 'unidirectional', 'unidirectionally', 'electrostatically', 'lowbeta', 'hallcurrent', 'echo', 'highbeta', 'magnetoacoustic', 'orgin', 'revealing', 'forceand', 'convectionie', 'surprising', 'mol', '500degree', 'transparent', '15000degree', 'partition', 'realistically', 'erickson', 'tangentwedgeapproximation', 'rubesins', 'karmanpohlhausens', 'collaborator', 'analogously', 'interanl', 'hpyersonic', 'thn', 'meyer', 'warning', '16series', 'fix', 'spurious', 'minimised', 'transitionfixing', 'broadening', 'theequilibriumparameters', 'processincluding', 'receives', 'lighthill1957for', 'dissociatinggas', 'postulating', 'thenewtoniantheory', 'anideal', 'flowsthat', 'tracing', 'variant', 'truncation', 'singlepoint', 'meksyn', 'shockgenerated', 'kemp', 'largethe', 'cx', 'schuh', 'repetition', 'm4', 'powerfunction', 'invoked', 'oversimplification', 'homann', 'zamm', 'thickened', 'competition', 'wavenumber', 'tetrachloride', 'methanol', 'overstability', 'atmosphereie', 'densitycan', 'howorth', 'discernible', 'massinjection', 'zeroinjection', 'mask', 'disturb', 'mil', 'undetermined', 'integrate', 'shortens', 'transpired', 'excused', 'berger', 'enjoys', 'memorial', 'terminology', 'academic', 'letude', 'enjoy', 'parietale', 'poudres', 'thesis', 'pressing', 'annex', 'serenity', 'erosive', 'usage', 'doctor', 'frustration', 'ignores', 'aerothermochemical', 'linjection', 'paris', 'nationale', 'imprimerie', 'license', 'fd', 'poetic', 'overstatement', 'threaten', 'effusion', 'overlook', 'explored', 'stimulus', 'observing', 'bulent', 'momentumthickness', 'wilson', 'wallproperty', 'compressiblefluid', 'incompressiblefluid', 'recursion', 'isovel', 'jefferyhamel', 'jacobian', 'dorodnitsyn', 'sweatcooling', 'inject', 'protects', 'protecting', 'erature', 'sperical', 'carter', 'consideredideal', 'minimizes', 'speculartype', 'shockseparated', 'kopals', 'ogival', 'corpuscular', 'roy', 'piercy', 'repeat', 'winny', 'london', 'largeaspectratio', 'spence', 'continually', 'fictitious', 'pinkerton', 'integraldifferential', 'localize', 'insulates', 'radome', 'sixth', 'thesecond', 'companion', 'thorough', 'methodof', 'servo', 'toa', 'systemsbestimation', 'behaviorccontrolsystem', 'optimizationddesign', 'relay', 'nonslationary', 'resolve', 'polarcontrolled', 'homing', 'surfacevelocity', 'connect', 'quasispherical', 'bertrams', 'letter', 'demarcation', 'imply', 'charter', 'interestit', 'numbersespecially', 'bertram', 'machzehnder', 'giese', 'expects', 'bergdolt', 'affirmative', '14in', 'inquired', 'ratiothat', 'parameterexceeds', 'twodimensionality', 'zoom', 'blowout', 'optimal', 'afterburner', 'maneuvering', 'tsion', 'crossdrift', 'determinable', 'rott', 'crabtree', 'stewartsonillingworth', 'unspecified', 'xcoordinate', 'xtransformation', 'adjoint', 'diagonal', 'reemphasized', 'garrick', 'cg', 'constantsthey', 'semiconvergent', 'conecylinderfrustumbooster', 'conecylinderfrustum', 'conefrustum', 'tacitly', 'examinable', 'anyway', 'murray', 'obscureand', 'elliptically', 'theoryone', 'thinplate', 'dana', 'nomenclature', 'heavier', 'worthwhile', 'glauerts', 'formulate', 'drastic', 'transit', 'antisymmetrical', 'lowerlimit', 'bimolecularexchange', 'bimolecular', 'postshock', 'nearspherical', 'infiniterate', 'relativistic', 'unrelativistic', 'interstellar', 'compressional', 'observational', 'prominence', 'hoffmanteller', 'incompressibleflow', 'monoxide', 'enthalpics', 'preserving', 'nonrigorous', 'considereddashthat', 'empiricalintermediate', 'enthalpyused', 'grasshofs', 'solves', 'fore', 'concurring', 'decidedly', '2x10', '100x10', 'const', 'unpublished', 'industry', 'bagley', 'rogers', 'neighbouring', 'airjet', 'corotating', 'separationfree', 'counterrotating', 'lose', 'embraced', 'emphasising', 'impair', 'r420', 'r5906', 'cf', 'r502', 'flex', 'r5314', 'synge', 'singleand', 'doublesided', 'hitherto', 'persists', 'inducedpressure', 'intractable', 'listing', 'plied', 'nosecone', 'nosed', 'returned', 'sphericallyblunted', 'sphericalconical', 'circuit', 'dynamicanalogy', 'setup', 'variablethickness', 'gasdynamical', 'chap', 'overhang', 'inadmissable', 'wavedrag', 'centrebody', 'nullify', 'ringwings', 'nearing', 'highsupersonicspeed', 'plausibly', 'opposing', 'bodydiametermaximumspan', 'dence', 'trailingvortex', 'linevortex', 'indetermining', 'triangularwing', 'crossflowplane', 'tailbody', 'cylindricalbody', 'hirshfelder', 'jchemphys262feb1957', 're', 'tions', 'fourcomponent', 'shockwaveboundarylayer', 'humphreys', 'lindsey', 'daley', 'unseparated', 'reaffirmed', 'translatory', 'timeaverage', 'stallflutter', 'mitnaca', 'oscillator', 'experimenter', 'happened', 'assortment', 'relativedensity', 'variabledensity', '20degree', 'midspan', 'onedegreeoffreedom', 'debye', 'collisionfree', 'selfconsistent', 'boltzmann', 'dielectric', 'traversal', 'questionable', 'permeability', 'inapplicable', 'removable', 'routhhurwitz', 'liapunov', 'quadruplet', 'eulerian', 'kuttajoukowsky', 'couple', 'enhance', 'cornell', 'exploited', 'propellerdriven', 'lawspeed', 'replacement', 'seeking', 'equate', 'collocation', 'hyperbolictrigonometric', 'fewer', 'translated', 'reattaching', 'fk', 'improper', 'parabolae', 'delimited', 'interpretive', 'nonspherical', 'endpoint', 'desire', 'ux', 'succeeding', 'dudx', 'necessitate', 'gortler', 'contracting', 'planestress', 'photoelastic', 'lengthdepth', 'thermalshock', 'epoxy', 'hysol', 'potentially', 'castolite', '6000op', 'inkflow', 'vaporscreen', 'deltawing', 'normalpressure', 'diamondshaped', 'latent', 'fog', 'vapour', 'pressurecorrection', 'circulararc', 'maeder', 'keune1', 'chapter', 'chester', '076power', 'proportionality', 'jmin', 'u1', 'dashn', 'erfc', 'u2u1', 'recurrence', 'u1s', 'jmjn', 'im', 'lock2', 'cocurrent', 'sextic', 'quartic', 'keulegan1', 'f40umerical', 'cussed', 'fn', 'ff', '5d', 'tabulate', 'f0', 'yy', 'analyser', 'sutton', 'relieve', 'admixture', 'doubled', 'highstagnationtemperature', 'facet', 'aerothermoelastic', 'modeling', 'stressdeflection', 'looking', 'basetype', 'incoming', 'backwardfacing', 'msvo', 'ia', 'linearizing', 'announces', 'jan', '30th', 'annual', 'etal', 'quote', 'mentioning', 'typography', 'typographical', 'unhappy', 'surely', 'confusing', 'ber', 'letting', 'magneticfield', 'firmer', 'concise', 'describable', 'slug', 'johnson', 'pr', 'computingmachine', 'approximationie', 'newtonbusemann', 'buzz', 'arithmetic', 'compete', 'traveled', 'nice', 'standardize', 'freeing', 'viewing', 'idealizing', 'afresh', 'exponentiallyficients', 'spoken', 'communication', 'coefstant', 'facilitates', 'condamped', 'laguerre', 'refine', 'puzzled', 'linearity', 'constancy', 'joule', 'serbin', 'geiger', 'edelfelt', 'gravalos', 'gordon', 'onsetofseparationeffects', 'dragrise', 'velocityie', 'redefinition', 'aeroballistics', 'navysponsored', 'quest', 'digitalcomputer', 'gravitywave', 'operates', 'focused', 'havelock', 'land', 'transportation', 'nosebluntnessinduced', 'noseafterbody', 'hise', 'chernyi', 'apogee', 'reorbit', 'grazing', 'usafsupported', 'selfsustained', 'representable', 'restoring', 'polygonal', 'longitudinalstability', 'transonictunnel', 'reactionresisted', 'resisted', 'coplanar', 'simulates', 'playing', 'platinum', 'tailinterference', 'modifies', 'sub', 'theoryeg', 'hosokawas', 'locallinearization', 'px', 'spreiters', 'roundness', 'refinementthis', 'blended', 'fpre', 'aob', 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'integrity', 'ribskin', 'traction', 'minimisation', 'kempners', 'torsioncontrol', 'undermassbalanced', 'historically', 'gridwork', 'fine', 'antielastic', 'planestrain', 'bernoullieuler', 'prime', 'gathered', 'woven', 'aligned', 'twoinch', 'prismatic', 'equilateraltriangle', 'craft', 'saundersroe', 'searching', 'hovercraft', 'press', 'assessing', 'personal', 'powering', 'maritime', 'srn1', 'service', 'economics', 'reattached', 'focus', 'convolution', 'distancetime', 'r14', 'ur', 'japan', 'imai', 'suddenfreezingof', 'rapidlyfreeze', 'm245', 'interferograms', 'attaining', 'entirety', 'unretarded', '2p', 'secondaryflow', 'whitehead', 'vy', 'basicflow', 'wedgetype', 'variabletemperature', 'streamtowall', 'combine', '23x10', '06x10', 'evaluates', 'recoverytemperature', 'foreknowledge', 'wedgeflow', 'adjoining', 'surfaceheat', 'cheng', 'classified', 'bridge', 'ting', 'caplan', 'inconsistency', '32x10', 'centerbut', 'aerodynamiccentre', '16x10', 'octagonal', 'ld', 'parasol', 'counteracting', 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'randomness', 'spacewise', 'acceptance', 'conviction', 'assure', 'acoustical', 'eye', 'highpowered', 'endeavour', 'podmounted', 'jetinduced', 'elevator', 'throw', '2024t3', 'shorter', 'discretefrequency', 'modal', 'prevalence', 'dictated', 'chain', 'schwarzs', 'wxy', 'huv', 'identity', 'edgetractions', 'multiply', 'bent', 'inclusive', 'propounded', 'twodiagram', 'edgedisplacements', 'methodeg', 'boundarycondition', 'integralequation', 'weinstein', 'connexion', 'deflexion', 'semicircle', 'closeness', 'analyzes', 'bisector', 'largedeflexion', 'laplacian', 'muller', 'transcendental', '1103a', 'fz', 'explaining', 'stored', 'rapidity', 'untenable', 'explains', 'onequarter', 'america', '0195etr', 'leggett', '0182er', 'michielsen', 'rsults', 'dvl', 'bc', 'oc', 'endshortening', 'ab', 'efflux', 'twofold', 'massbalance', 'gyration', 'canard', 'surfacetab', 'multiplying', '08a', '1fa', 'halfheights', 'branchline', 'exhaustive', 'sophisticated', 'acceptably', 'parametervariation', 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9) **dictionary terms from index version2 with largest df**: ['to']

**dictionary terms from index version2 with smallest df**: ['boundarylayercontrol', 'libbi', 'wassermann', 'ensu', 'hasten', 'rake', 'phosphoresc', 'lacquer', 'totalhead', 'polytechn', 'brooklyn', 'acrothermoelast', 'boxw', 'wherev', 'controlsurfac', 'analyseseg', 'pointfunct', 'panelsi', 'aerodynamicthermoelast', 'compani', 'wheel', 'generalizednewtonian', 'md1', 'pointednos', 'leess', 'hardwar', 'studiesdash', 'sci', 'aero', 'maslen', 'sakurai', 'lin', 'va', 'inviscidvisc', 'notednam', 'aerodynamieist', 'einbind', 'sedov', 'wideflang', 'builtup', 'ibeam', 'multicellular', 'undamp', 'ballistictyp', 'seed', 'maximumacceler', 'electrod', 'constantarea', 'accru', 'provis', 'poiscuil', 'nontrivi', 'unfamiliar', 'singleel', 'magnifiedschlieren', 'supplystream', 'ask', 'enginemount', 'enginepropel', 'tical', 'studiesexperiment', 'gyroscop', 'walltoambi', 'eter', 'transitionrevers', 'characteristi', 'contempl', 'sparkschlieren', 'thermaltomomentum', 'lengthtodepth', 'slopecompat', 'entitl', 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'quickact', 'hotter', 'fuse', 'silica', 'm7', 'centrelin', 'semiangl', 'kopalfor', 'rose', 'shercliff', 'wavesdash', 'soundsourc', 'measurementsdashth', 'braunschweig', 'enthalpyveloc', 'show1how', 'type1ar', 'and2how', 'theirworstvalu', 'sphericalatmospher', 'nogw533on', 'itechn', 'timeand', 'gramsc', 'kilometr', 'p2859015h20046500280013h20046', 'bracket', 'airdens', 'heightto', 'subperige', 'profileieit', 'belt', 'equatori', 'daytonight', 'thesolar', 'xrai', 'ultraviolet', 'fllayer', 'variationsh180', 'satellitessputnik', 'kallmann', 'physcal', 'effectmai', '1958octob', 'consolid', 'diurnal', '20cm', 'effectorigin', 'f2layer', 'vanguard', '352kmno', 'nighttim', 'smallless', 'polarregion', 'egat', 'hpdpdy', 'airit', 'errorssdof', 'shortlifetim', 'heighth', 'smalleccentr', 'thedens', 'declin', 'becausewith', 'supposit', 'migrat', 'warmer', 'laminarboundarylayertyp', 'spontan', 'dufour', 'multicompon', 'colder', 'soret', 'mound', 'vehiclelength', 'expenditur', 'induceddrag', 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'defi', 'conidt', 'pin', 'forcibl', 'recognis', 'heav', 'easiest', 'broke', 'semispantochord', 'ko', 'lowaspectratiow', 'notsoslend', 'supersonicairfoil', 'munk', 'sourcesink', 'a50f06', 'nielsen', 'tang', 'katzen', 'a52b06', 'a51j04', 'wingbodytail', 'unbank', 'bodyw', 'closedcontour', 'potentialth', 'calculatebi', 'velocityperimet', 'hundr', 'mildsteel', 'proposel', 'duralumin', 'ellipselik', 'unsymmetr', 'ovalshel', 'vlasov', '109placement', 'prikl', 'meh', 'drosophila', 'roughen', 'lap', 'partsnam', 'housefli', 'layeri', 'rivet', 'insect', 'mainten', 'mistak', 'synthesi', 'hypersonicsimilar', 'nosetail', 'tan', 'asid', 'kirk', 'preasymptot', 'transduc', 'decompos', 'bladesurfac', 'shockdisplac', '225x10', 'axialforc', 'd693', 'nozzleflow', 'gerard', 'rabotnov', 'shesterikov', 'hyperbolicsin', 'pressuretyp', 'herrmann', 'conespher', 'mismatch', 'nonconcurr', 'cylinderhemispher', 'closur', 'bellevil', 'kernal', 'bornel', 'mitig', 'rx', 'resolidif', 'meteorit', 'stoni', 'tx', 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'dampinginpitch', 'hemisphericallynos', 'hemisphericalnos', '2inch', 'designtyp', 'flowfield', 'obliqueshock', 'poind', 'marin', 'unimport', 'palt', 'concret', 'shanleyto', 'loada', 'librov', 'outofstraight', 'elevatedtemperatur', 'asreceiv', 'columnmateri', 'columncapac', 'isochronousstressstrain', '24st4', 'loadcapac', 'columnimperfect', 'electricresist', 'creepbend', 'oven', '16inch', 'fortythre', '40inch', 'deflectiontim', 'crook', 'lowalloi', 'straintim', 'eab', 'infinitythat', 'alloys75st6', 'constantstress', 'collapsesin', 'polycrystallin', 'rapidh', 'equicohes', 'iron', 'adjacentequilibriumposit', 'trefftz', 'curvedbeam', 'nongyroscop', 'twolob', 'uncontrol', 'fourwav', 'skirt', 'threewav', 'crinolin', 'magnifi', 'nearer', 'drape', 'wilei', 'internat', 'cambridg', 'edgeload', 'abrupt', 'stepdown', 'judici', '7c', 'pressurereynold', '7a', 'largestep', 'geckel', 'lovemeissn', 'cabin', 'multisect', 'semialgebra', 'mth', 'grossman', 'russian', 'indefinit', 'inaccess', 'lyskov', 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10)**The document id with largest max\_tf** : 673

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