type candidate answer type coercion j. w. murdock d. a. ferrucci d. c. gondek

question explicitly indicate type answer require popular approach answer question develop recognizer identify instance common answer type e.g. country animal food consider answer list strategy poorly suit answer question jeopardy!i television quiz jeopardy question extremely broad range type answer frequently occur type cover small fraction answer present alternative approach deal answer type generate candidate answer regard type candidate employ variety source strategy judge candidate desire type source strategy provide set type coercion score candidate answer use score preference answer evidence have right type question answer system significantly accurate type coercion type coercion component combine jeopardy question bin 1902 panama country explicitly indicate correct answer country answer question important able distinguish candidate answer country open domain question answer qa system e.g. 1–4 adopt type generate approach analyze incoming question expect answer type map fixed set know type restrict candidate answer retrieve corpus match answer type type specific recognizer identify candidate type generate approach suffer problem restrict answer type fixed typically small set concept make qa system brittle narrow applicability scope closed typing approach work set question cover broad range topic answer type jeopardy extremely diverse express variety lexical expression e.g. bscarefest refer horror movie vague e.g. bform meaningless e.g. bit question ask type answer cover fixed set type qa system fail generate answer use catchall type e.g. bother rest system typically suited performance question answer type outside fixed type system significantly bad answer type type system system type appropriate type generate approach highly dependent precision recall typing component component act candidate selection filter answer reject consider regardless evidence support watson use generate type framework approach implication typing component part technology underlie watson deepqa deepqa search candidate generation component use type information identify candidate answer 5 result candidate answer generate attempt determine candidate instance type question ask instead reason type

answer perform

candidate instance type question ask instead reason type answer perform later deepqa architecture portion deepqa architecture royalty free permission computer base information service system permission republish portion paper obtain editor j. w. murdock et al 7 1 candidate answer evaluate hypothesis evidence scoring subset hypothesis evidence scoring focus determine candidate answer satisfie answer type requirement question type coercion tycor result tycor component treat distinct feature statistical classifier feature component classifier generate confidence

score answer deepqa final merging term btype coercion different meaning context programming language btype coercion refer idea force value datum type change different compatible datum type put context data type require 6 example programming language expression 0.5 þ 7 require compiler interpreter convert integer i.e. 7 floating point number i.e. 7.0 add floating point number implicit change type call type coercion

pustejovsky 7 describe similar phenomenon linguistic speaker noun semantic type imply different compatible semantic type put context semantic type require example word bbook sentence bbob finished book refer physical object sentence coerce interpretation bbook activity i.e. imply activity read book pustejovsky paper involve force particular semantic type interpretation instance bcoercion paper involve force interpretation answer question base type answer question ask example question ask bwhat novel win pulitzer 1937 respondent assert bgone wind respondent implicitly force specific interpretation bgone wind i.e. novel possible answer coerce type example interpretation bmargaret mitchell refer novel valid answer question tycor component attempt coerce consistent interpretation candidate answer desire type extent component able deepqa treat result evidence answer correct watson include numerous tycor component employ different source typing information different logic

fit logical framework describe paper input tycor lexical answer type lat question ask identifie deepqa question analysis module 8 lat text string indicate type answer seek e.g. bactor bcountry candidate answer deepqa candidate generation module 5 output tycor component numerical score indicate extent component conclude candidate answer instance type indicate lat unlike qa system watson use answer type result bhard filter discard answer conclude desire type instead tycor score distinct feature deepqa statistical answer rank algorithm assign confidence value candidate answer rank answer accord confidence value 9 correct answer training datum likely evidence instance desire type result deepqa statistical answer rank algorithm tend prefer answer high tycor score answer low tycor score preference absolute answer little evidence desire type select final answer overwhelming evidence answer satisfie requirement question particularly candidate answer little tycor evidence single fixed set type tycor component instead tycor component responsible interpret lat extent need tycor component fixed list structured type able process component useful able map lat type tycor component instance tag type form text string component compute lat consistent

instance tag type form text string component compute lat consistent know type candidate answer match lat type linguistically e.g. dictionary resource identify synonym paper begin discussion answer typing jeopardy explain paper fit deepqa architecture describe share logical framework tycor provide brief description tycor component finally paper present evaluation result related work future work conclusion answer type jeopardy attempt build qa system capable rival expert human performance answer open domain question start type generate approach generate candidate answer simply early analysis domain question tv quiz jeopardy find approach problematic j. w. murdock et al human language remarkably rich come assign type nearly word type particularly question invent 1500 speed game maneuver involve piece color first known airmail service take place paris 1870 conveyance answer bhot air balloon 2003 oriole first sacker elect baseball hall fame answer beddie murray freddy krueger introduce 1984 scarefest answer ba nightmare

elm street hit electron phosphor give electromagnetic energy form answer blight whitney patent revolutionize garment industry answer bthe cotton gin variability highlight intrinsic problem type generate approach i.e. reliably predict type question ask instance analyze 20,000 past jeopardy question observe long tail type figure 1 type system name entity detector large state art qa system 100 type cover half question roughly 5,000 different type word 20,000 question half occur few time question set roughly 12 occur continue evaluate hidden datum find 12 number roughly constant new type introduce rate question average addition 15 question explicitly assert lat observation lead conclude need open flexible type treat property question answer combine word instead finde candidate right type want find candidate way judge right type examine context answer type question furthermore need accommodate source type instance datum collectively reflect descriptive diversity tycor deepqa architecture tycor capability fit deepqa architecture 10 question analysisvdeepqa question analysis include subcomponent classify extract relevant information question 8 kind information extract question analysis lat i.e. word question indicate type answer seek lat recognition easy map semantic type imperfect lat detection f1 measure 0.8 evaluate 3,500 randomly select question 8 lat detection include confidence measure factor tycor score candidate generationvcandidate generation deepqa employ wide variety strategy include identify candidate text structure source 5 case candidate generation result disambiguated entity e.g. wikipedia url distribution 30 frequent lexical answer type 20,000 jeopardy question j. w. murdock et al 7 3 identifie example candidate answer find wikipedia document anchor text hypertext link candidate generation use target link provide disambiguation entity input tycor include candidate answer disambiguation result available plus lat identifie question analysis hypothesis evidence scoringvthe tycor component subset hypothesis- evidence scoring component hypothesis-evidence scoring phase different algorithm source evaluate evidence candidate answer final answer merging rankingvan overall determination final answer combine

answer final answer merging rankingvan overall determination final answer combine score score algorithm answer way weigh score appropriate context give question 9 tycor score feature component tycor logical framework tycor answer score component input lat candidate answer return score indicate strength evidence possible coerce interpretation candidate answer instance consistent interpretation lat language distinguish instantiation e.g. bsecretariat horse subclassing e.g. ba pony horse tycor component allow tycor give answer high score interpret subclass instance lat lat tycor component perform step illustrate figure 2 describe detail tycor component combine score lat produce score candidate answer step involve source e.g. knowledge base determine source indicate answer desire type involve map candidate answer lat instance type source consult source claim instance correspond candidate answer consistent type correspond lat specifically step entity disambiguation matching edm)vedm find entity typing source correspond candidate answer edm account polysemy refer entity synonymy entity multiple name source require special edm implementation exploit property source example dbpedia 11 encode useful naming information entity identifier id edm implementation typically try use context answer purely structured source context difficult exploit type retrieval tr)vtr retrieve type entity identifie edm tycors structured source step exercise primary function source simple unstructured source require parsing 12 semantic processing 13 natural language predicate disambiguation matching pdm)vpdm identifie type correspond lat find source algorithm edm type lookup require special treatment source encode type instance differently tycors use unstructured information source pdm step simply return lat pdm strongly high level architecture tycor component involve core step example yago tycor give candidate bdifficulty swallowing lexical answer type lat bmanifestation edm map candidate dbpedia entity bdysphagia tr obtain wordnet type bsymptom dbpedia instance pdm map lat wordnet concept bcondition final tr step find hyponymy relation bsymptom bcondition

produce positive tycor score j. w. murdock et al correspond notion word sense disambiguation

respect specific source type alignmentvthe result pdm tr step compare determine degree match source contain formal type taxonomy include check taxonomy subsumption disjointness etc source type natural language text alignment require determine text lat text retrieve type answer consistent challenging natural language processing nlp task use parsing 12 depend resource wordnet 14 finde synonym hypernym etc note edm skip candidate generation able produce disambiguated candidate answer specified unique id tycor able use example wiki category tycor describe later type associate specific wikipedia entry wiki category tycor skip edm encounter candidate answer generate know edm pdm tr return multiple result example start candidate string bgone wind lat bbook edm tie candidate variety entity movie novel confidence entity confidence score factor tycor score similarly candidate multiple type find tr lat bbook correspond type publish work phenomenon graph theory type alignment attempt align type retrieve tr entity identifie edm type identifie pdm refer tycor bcoerce candidate answer lat commit early single interpretation edm pdm tr stage example instead first disambiguate bgone wind decide instance type want remain open variety possibility edm consider type possibility type alignment step able bforce particular interpretation candidate lat identify interpretation well fit base conclusion interpretation step constitute logical framework i.e. conceptually tycor component follow progression step subset tycor component share common implementation step example tycor source describe section provide type information entity define wikipedia url tycor component use source share common edm implementation

future work intend formalize refine framework section future work tycor component find evidence candidate answer desire type indicate neutral result i.e. support refute answer addition tycor component able identify specific evidence answer desire type tycor component able identify negative evidence describe section logic identify negative evidence generally different logic identify positive evidence priori reason believe model treat strong negative tycor score bad strong positive tycor score good consequently tycor represent positive

negative score distinct feature use deepqa answer ranking 9 tycor component consider negative typing evidence feature final model feature constrain framework tycor component feature nonzero value candidate answer possible different tycor component produce conflicting score e.g. produce positive evidence produce negative evidence generally speak negative typing evidence reduce confidence answer remove answer invalidate error possible evidence watson override negative typing evidence incorrect tycor source strategy watson use suite different tycor component score candidate answer type evidence tycor component share algorithm use different source use different algorithm source algorithm mainly involve different approach tycor step appropriate source eye accurately account error step notably edm alignment produce meaningful score tycor component defined set structure type example tycor component sort give yago great ontology)vmany candidate answer domain title wikipedia article entity dbpedia i.e. link open data source automatically compile wikipedia infoboxe i.e. information box article template entity article dbpedia type represent resource description framework rdf yago 15 i.e. semi automatically construct type taxonomy base wordnet corpus analysis wikipedia addition manually add roughly 200 disjointness constraint e.g. ba person j. w. murdock et al 7 5 country high level concept taxonomy special purpose reasoner check subsumption disjointness yago tycor produce negative evidence candidate match type disjoint type match lat gendervthis tycor apply question ask person specified gender score evidence candidate answer appropriate gender custom source datum mine article

people determine pronoun unambiguously commonly refer person gender tycor produce negative evidence lat indicate gender answer find closed latvcertain lats identify type enumerable list instance country u.s. state u.s. president list available tycor component capable produce negative type score candidate answer list course describe confidence perfect matching issue possibility lat nonstandard way example mythical country gondor closed list conceivably answer country lat question list believe complete obvious interpretation lat closed

lat tycor assert negative evidence candidate answer know lat answer list lexicalvoccasionally lats specify lexical constraint answer e.g. verb phrase first lexical tycor use special purpose algorithm base lat score constraint lexical tycor able produce negative evidence type e.g. conclude answer contain blank space consistent name entity detection ned)vtycor use rule base name entity detector originally design classical type generate qa system 16 name entity detector recognize instance 100 structured type 100 lat name entity detector identifie zero structured type correspond lat annotate candidate answer zero structured type instantiate ned tycor determine structured type detector find lat consistent structured type detector find candidate answer wordnetvwordnet tycor component assist type alignment phase contain limited information know entity famous scientist geographic geopolitical entity high coverage biological taxonomy wordnet tycor use hyponym instance link wordnet match candidate answer string lat tycor component high precision tycor component type arbitrary natural language text type alignment tycors require process natural language align term correspond position syntactic structure type recognize deepqa parsing predicate argument structure 12 term align determine consistent variety source wikipedia redirect wordnet example tycor component sort give wiki categoryvwikipedia article frequently tag explicit category form natural language text category store dbpedia wiki category tycor use category name entity type wiki category use category structure e.g. subcategory add wiki listvwikipedia web source contain list thing associate way blist argentinean nobel prize winners collect list use

associate way blist argentinean nobel prize winners collect list use text follow blist type instance list wiki introvby convention first sentence

wikipedia article identifie type entity describe article e.g. btom hanks american actor producer writer director bthe lion panthera leo big cat genus panthera wiki intro tycor utilize special source mine intro passage variety syntactic identityvidentity tycor use candidate answer text source typing information example identity tycor recognize bthe chu river river look text

answer prior knowledge entity passagevmany candidate answer occur passage text find primary search 5 support evidence retrieval 17 occasionally passage assert candidate type e.g. bchristian bale first actor batman justice passage tycor use pattern base relation detection 13 identify assertion entity type attempt match assert type lat prismaticvprismatic 18 repository corpus statistic prismatic tycor measure frequency candidate answer directly assert instance lat type assertion detection pattern passage tycor j. w. murdock et al step tycor logical framework differently implement tycor strategy example consider question ask bemperor candidate answer bnapoleon tycor strategy handle different step framework edmvtycor strategy use wikipedia derive source e.g. wiki list wiki category yago try determine dbpedia entry bnapoleon refer find dbpedia napoleon strong match find variety match dbpedia napoleon_%28card_game%29

assign low score wordnet tycor look bnapoleon find different word sense passage tycor identifie occurrence napoleon support passage step tycors ned identity tycor simply candidate string bnapoleon declare entity trvthose tycor strategy identify formal entity e.g. dbpedia url wordnet synset set synonym edm generally able look type entity structured source example yago tycor able find formal yago type dbpedia entity identifie edm similarly wordnet tycor find synset synset napoleon instance hyponym case wordnet label primary sense bnapoleon instance primary sense bemperor ned tycor get structured type name entity detector e.g. label bnapoleon reference politicalleader tycors produce type stage entry formal ontology simply text string example wiki list provide type bfrench monarch dbpedia napoleon page wikipedia label blist french monarch entry link http://en.wikipedia.org/wiki/napoleon_i_of_france wikipedia redirect http://en.wikipedia.org/wiki/napoleon tycor strategy produce text string type defer issue make sense type type pdmvtycor strategy use formal type look type step example wordnet look lat bemperor identifie synset word yago tycor find formal type yago ontology correspond string bemperor ned tycor examine ned result question determine lat question label name entity type case bemperor mark nominal

reference politicalleader tr tycors implement pdm simply return input string defer work make sense type alignmentvfor tycors wordnet yago ned produce formal type type hierarchy tr pdm type alignment process involve align type hierarchy i.e. check subsumption disjointness etc example wordnet tycor check entity type tr hyponym question desire type pdm contrast strategy simply produce text string tr pdm need determine extent know entity type tr imply desire answer type pdm example wiki list try determine conclude bfrench monarch bemperor parse e.g. finde bmonarch headword bfrench monarch match term resource wordnet wikipedia redirect strategy use single configurable implementation capability use variety different configuration provide different tradeoff precision recall evaluate tycor mechanism compare effectiveness qa system tycor component experiment report

tycor mechanism compare effectiveness qa system tycor component experiment report perform set 3,508 previously unseen jeopardy question figure 3 show line graph compare system tycor strategy versus system bar graph show impact effective individual tycor strategy horizontal axis line graph show percentage question answer preference give question confidence answer high example 70 point axis show system perform attempt answer 70 confident refer value precision@70 vertical axis line graph indicate fraction question correctly answer example line complete watson system tycor component show precision 0.875 70 question answer 70 question watson confident answer answer 87.5 question correctly contrast watson system tycor answer 81.5 question correctly 70

confident difference i.e. 6.0 precision@70 statistically significant great impact overall accuracy i.e. precision@100 4.9 great impact 70 100 suggest tycor useful assess confidence watson answer select answer watson able use confidence score decide question attempt answer benefit tycor j. w. murdock et al 7 7 bar graph show impact accuracy 12 interesting tycor component define impact accuracy difference accuracy qa system tycor component accuracy system specified tycor component accuracy percentage question correctly answer first 12 bar

impact individual tycor component final bar show impact tycor component individual component show vary impact accuracy 3 impact accuracy 4.9 difference visible graph compare rightmost point line tycor tycor measure statistical significance accuracy mcnemar test correction continuity 19 consider p g 05 significant standard difference lexical tycor tycor statistically significant surprising lexical tycor highly specialized component address small number unusual lat tycors show significant impact versus tycor tycor show significant impact versus tycors precision@70 amenable mcnemar test reflect mean set independent observation e.g. raise confidence answer question cause question drop 70 high confidence consequently use fisher randomization test 20 assess significance metric concern result ablate tycor watson system impact tycor blunt existence score component watson explicitly focus tycor implicitly correlate answer have correct type example passage term match algorithm 17 count frequency candidate answer co occur retrieve passage term question lat question term match count passage term match case expect answer instance lat frequently co occur lat text expect signal passage term match feature overlap signal tycor component produce blunt measure impact ablation study consequently evaluate tycor component watson answer score baseline system 10 deepqa evaluation 13 17 21

baseline include deepqa question analysis 8 plus search candidate generation 5 deep shallow evidence scoring ned tycor answer ranking watson impact type coercion complete watson qa system j. w. murdock et al answer score baseline system use statistical answer ranking technique watson system restricted set feature work watson search candidate generation feature e.g. rank score keyword search engine passage answer find feature derive deep analysis support evidence start watson answer score baseline compare variant tycor tycor ned variant tycor component add baseline system tycor component add figure 4 show result tycor great impact simple configuration component show 4 impact entire set show 8 component identity tycor lexical tycor provide significant impact versus tycor tycor provide significant impact versus tycor watson answer score baseline system include signal overlap answer

typing search candidate generation algorithm use lat finde source candidate answer 5 consequently build extremely simple bultralite baseline system additional point comparison tycor ultralite system include text document search 5 search knowledge basis text passage figure 5

show effectiveness tycor configuration effect accuracy great component show 8 10 component result impact 15 component lexical tycor provide significant impact versus tycor tycor provide significant impact versus tycor note early ned tycor use ned component originally build classical type generate qa system consistently high performer competitive qa evaluation 1 comparison ned tycor performance tycor performance figure 3–5 demonstrate impact additional source strategy versus traditional qa baseline difference 2.4 watson system 4.6 watson answer score baseline system 8.5 ultralite baseline system difference significant conduct experiment completely discard candidate reject ned tycor closely approximate type generate approach comparison purpose experiment show discard candidate reject ned tycor perform worse ned tycor tycor feature worse tycor discard correct answer deepqa able select feature impact type coercion watson answer score baseline qa system j. w. murdock et al 7 9 paper differ major respect exist work answer typing qa employ diverse collection typing resource include highly precise narrow coverage hand craft resource e.g. ned close lat broad community generate resource e.g. wiki category yago resource automatically extract natural language text e.g. wiki intro prismatic diversity allow cover wide range type have high confidence type understand discard ignore answer coerce give lat instead retain answer result tycor provide distinct feature deepqa answer ranking traditional qa system e.g. 1–4 tightly integrate capability finde candidate answer answer typing string appear desire answer type consider candidate answer exist work decouple typing generation extent quartz 22 qa system use statistical mapping lats wordnet pdm collocation count candidate answer synonym map type tr 23 approach take step combine correlation base typing score type information resource wikipedia machine learning base scheme compute type validity 22 23

similar tycor approach defer type checking decision qa pipeline use collection technique resource instead rely classical ned check type match candidate expect answer type question approach type match information filter discard candidate answer instead individual tycor score combine statistically answer score deepqa answer ranking similar approach combination ned wiki category present 24 work traditional type generate approach question analysis recognize semantic answer type question revert wikipedia category 22 23 typing treat hard filter supply feature classify answer unique characteristic tycor framework separate step edm pdm type alignment etc algorithm resource use implement step complex variedvhave precision broad impact type coercion bultralite baseline qa system j. w. murdock et al scope compare exist work example use wikipedia content type inference 23 shallow heuristic search mention expect answer type wikipedia page candidate answer map exact string match page title make yes decision type validity basis finding contrast wikipedia base tycors use edm algorithm map candidate answer string wikipedia page variety resource wikipedia redirect extract synonym list link anchor datum use different kind type information express wikipedia e.g. lexical type introductory paragraph wikipedia category type match lat similarly 22 use notion complement type set approximate heuristic sibling type explicitly identified pair type yago disjoint use disjointness information evidence candidate answer type disjoint lat prismatic wiki intro passage tycor component use nlp analysis extract typing information natural language text automatic detection typing relation long study topic nlp 25–27 variety exist project attempt use relation detection sort build large scale entity type knowledge basis 28 29 prismatic wiki intro tycors follow basic approach differ prismatic run large web corpus wiki intro draw result exclusively first sentence wikipedia article result prismatic tycor

broad coverage statistic entity type pair e.g. statistic indicate bthe godfather assert bfilm bthe godfather assert novel contrast wiki intro datum datum precise disambiguate attach specific wikipedia url e.g. http://en.wikipedia.org/wiki/the_godfather bfilm exist research mine answer

type text close prismatic tycor respect describe early able benefit advantage post tycor result distinct feature deepqa statistical answer ranking note btycor logical framework section paper tycor component share common logical framework consist processing subtask logical framework implement common software artifact share tycors future work intend build explicit software framework formalize design fact logical architecture explicit implementation convenient early development process tycor component address dramatically different challenge different information requirement example type alignment yago tycor take pair structured type input type alignment wiki list tycor take pair lexical type input involve reason formal ontology involve nlp address careful object orient design e.g. define type alignment interface abstract input type provide different implementation input type provide different functionality require work tycor mature lack explicit implementation logical framework increasingly significant obstacle tycor research example like able rapidly test different approach combine score different step piece code different tycor implementation explicit software framework provide common code base integrate step tycor process give experience diverse range tycors

watson believe ready design implement explicit software framework key challenge paper precisely identify proper level abstraction i.e. distinguish capability datum structure share implementation specific particular tycor algorithm source reasonable large diverse set tycor component provide motivate example work future work deepqa involve wide variety concrete application area consequently flexibility rapid adaptation new technical challenge essential case involve plug new knowledge source exist logic logic require revision pluggable extensible framework tycor component subcomponent easy customize deepqa address new challenge tycor approach finde evidence give candidate answer specified lexical type i.e. type characterize natural language text deepqa include logical framework tycor variety specific instantiation assortment structured unstructured source tycor deepqa form evidence scoring perform answer generate rank tycor component provide separate score distinct feature

deepqa answer ranking tycor component instantiate logical framework compose element edm map candidate answer string entity tr identifie structured lexical type entity pdm map lat answer type type alignment determine type candidate answer j. w. murdock et al 7 11 tr consistent desire type question determine pdm tycor component significant impact accuracy qa system apply jeopardy task component complement demonstrate fact qa system well tycor component business machines corporation united states country productions inc. wikimedia foundation trustees princeton university united states country 1 j. chu carroll k. czuba p. a. duboue j. m. prager gaithersburg md 2005 online available http://www 2 h. cui k. li r. sun t.-s. chua m.-y . kan bnational university singapore trec-13 question answer main task proc trec gaithersburg md 2004 3 s. harabagiu d. moldovan c. clark m. bowden j. williams j. bensley banswer mining combine extraction technique abductive reasoning proc trec gaithersburg md 2003 4 n. schlaefer p. gieselmann g. sautter bthe ephyra 5 j. chu carroll j. fan b. k. boguraev d. carmel d. sheinwald c. welty bfinding needle haystack search

6 g. ford r. wiener modula-2 software development hoboken nj wiley 1986 7 j. pustejovsky btype coercion lexical selection semantics lexicon j. pustejovsky ed netherlands kluwer 1993 8 a. lally j. m. prager m. c. mccord b. k. boguraev s. patwardhan j. fan p. fodor j. chu carroll bquestion 9 d. c. gondek a. lally a. kalyanpur j. w. murdock p. duboue l. zhang y. pan z. m. qiu c. welty ba framework 11 c. bizer j. lehmann g. kobilarov s. auer c. becker r. cyganiak s. hellmann bdbpediava crystallization point web datum j. web semantics sci services 12 m. c. mccord j. w. murdock b. k. boguraev bdeep 13 c. wang a. kalyanpur j. fan b. k. boguraev d. c. gondek 14 g. a. miller bwordnet lexical database english 15 f. m. suchanek g. kasneci g. weikum byago core semantic knowledge unify wordnet wikipedia proc 16th int www conf banff canada 2007 16 j. m. prager e. w. brown a. coden r. radev bquestion answer predictive annotation proc 17 j. w. murdock j. fan a. lally h. shima b. k. boguraev 18 j. fan a. kalyanpur d. c. gondek d. a. ferrucci 19 j. l. fleiss statistical methods rates proportions new york wiley 1981 20 m. d. smucker j. allan b. carterette ba comparison statistical significance test information

retrieval evaluation 21 a. kalyanpur b. k. boguraev s. patwardhan j. w. murdock a. lally c. welty j. m. prager b. coppola a. fokoue nkoutche l. zhang y. pan z. m. qiu 22 s. schlobach d. ahn m. de rijke v. jijkoun bdata drive type checking open domain question answering 23 a.

grappy b. grau banswer type validation question answer system proc riaovadaptivity personalization fusion heterogeneous information paris france 2010 24 d. buscaldi p. rosso bmining knowledge wikipedia question answering task proc int conf lang resour 25 r. amsler bthe structure merriam webster pocket dictionary ph.d. dissertation univ texas austin tx 1980 26 m. chodorow r. byrd g. heidorn bextracte semantic hierarchy large line dictionary proc 23rd annu 27 m. hearst bautomatic acquisition hyponym large text 28 s. soderland a. ritter o. etzioni bwhat automatic hypernym discovery proc aaai spring symp 29 a. carlson j. betteridge b. kisiel b. settles e. r. hruschka jr. t. m. mitchell btoward architecture end language learning proc 24th aaai conf 2010 receive august 18 2011 accept publication november 18 2011 j. william murdock research center yorktown heights ny 10598 usa murdockj@us team t. j. watson research center 2001 receive ph.d. degree computer science georgia tech member ashok goel design intelligence laboratory work postdoctorate david aha u.s. naval research laboratory research interest include natural language semantic analogical reasoning knowledge base planning machine learning self aware artificial intelligence research center yorktown heights ny 10598 usa adityakal@us t. j. watson research center receive ph.d. degree computer science university maryland 2006 research interest include knowledge representation reasoning natural language processing statistical data mining machine expressive reasoner sher project scale ontology reasoning large expressive knowledge basis subsequently join algorithm team deepqa project helped design watson question answer system dr. kalyanpur 25 publication lead artificial intelligence journal conference patent relate sher deepqa chair international workshop serve w3c working groups j. w. murdock et al center yorktown heights ny 10598 usa cawelty@gmail.com

dr. welty research staff member semantic analysis integration department t. j. watson research center receive ph.d. degree computer science rensselaer 6 year professor vassar college work publish extensively area ontology natural language processing semantic web 2011 serve program chair international semantic web conference editorial board journal web semantics journal applied ontology ai magazine dr. fan research staff member semantic analysis integration department t. j. watson research center yorktown university texas austin 2006 member deepqa team develop watson question answer system defeat good human player quiz jeopardy dr. fan author coauthor dozen technical paper subject knowledge representation reasoning natural language processing machine learning member association computational linguistics david a. ferrucci deepqa watson jeopardy project t. j. watson research center 1995 lead semantic analysis integration department dr. ferrucci focus technology automatically discover meaning natural language content enable well human decision making graduate manhattan college b.s. degree biology rensselaer polytechnic institute 1994 ph.d. degree computer science specialize knowledge representation reasoning publish paper area artificial intelligence knowledge representation reasoning natural language processing automatic question answering david c. gondek com dr. gondek research staff member manager t. j. watson research center receive b.a. degree mathematic computer science dartmouth college 1998 ph.d. degree computer science brown university watson jeopardy challenge lead knowledge capture learning group semantic analysis integration district beijing 100193 china tozhanglei@qq.com dr. zhang receive ph.d. degree computer science engineering shanghai jiao tong university china 2005 research interest include knowledge representation semantic web information retrieval statistical machine learning ph.d. study work research staff member information knowledge work

semantic web technology semantic search application healthcare domain 2008 team work structure knowledge include semantic web datum help question answer deepqa project active academic community major initiator china semantic web symposium series start 2007

program committee member conference www ijcai international joint conferences artificial intelligence iswc international semantic web conference etc recently local organizer iswc 2010 master degree graduate school university tokyo research research focus type deep language analysis include machine translation sentiment analysis knowledge extraction unstructured datum j. w. murdock et al 7 13