From Search Engine to Answer Engine

Dekang Lin

singulariti.io

who is the mother of Frank Zappa

百度一下

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The Mothers of Invention - Wikipedia, the free encyclopedia

The Mothers of Invention were an American rock band from California that served as the backing musicians for Frank Z...

History　　Personnel　　Discography

en.wikipedia.org/wiki/... ▾ - 百度快照 - 翻译此页

Amazon.com: Frank Zappa & the Mothers of Invention: Songs, ...

查看此网页的中文翻译，请点击 翻译此页

Stay Up To Date E-mail me when there are new releases by Frank Zappa & the Mothers of Invention.Customers Also Bought Items By Frank Zappa & the ...

www.amazon.com/Frank-Z... ▾ - 百度快照 - 77%好评

Google

who is the mother of Frank Zappa

About 383,000 results (0.60 seconds)

Frank Zappa / **Mother**

Rose Marie Colimore

More about Rose Marie Colimore

Feedback

The Mothers of Invention - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/The_**Mothers**_of_Invention ▾ Wikipedia ▾

IBM Watson

- Won Jeopardy! against the best human players.
- Generated renewed interests in question-answering

Question Answering: three approaches

- Question-to-Question
  - Map user questions to questions with known answers in a database of question-answer pairs.
- With structured knowledge base
  - Translate users' questions to knowledge base retrieval queries
- With unstructured text
  - Use IR to identify top documents/passages
  - Extract answers from the retrieved text

Question to Question: an example

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QA with Structured Knowledge Base

- Knowledge base: a collection of triples: (E_{subj}, Rel, E_{obj})
  - Any relation can be decomposed into a set of triples
  - Examples
    - ("Pulp Fiction /m/0f4_l", DirectedBy, "Quentin Tarantino /m/0693l")
    - ("Jay Leno /m/046lt", Spouse, Internal_ID:Marriage1234)
    - (Internal_ID:Marriage1234, From, "11/30/1980")
    - (Internal_ID:Marriage1234, TypeOfUnion, "Marriage")
- Knowledge bases can be accessed through formal query language
  - E.g. SQL, Lambda calculus,
  - However, user queries are in natural language

Semantic Parsing

- Translate user queries/questions into database retrieval query
- Example:
    - "Who was Tom Cruise's wife in 2007?"
    - $\lambda x. \exists e. \text{Marriage}(x, e) \land \text{Spouse}(e, \text{TomCruise}) \land \text{Year}(\text{MarriageFrom}(e)) <= 2007 \land \text{Year}(\text{MarriageTo}(e)) >= 2007$

Who was Tom Cruise's wife in 2007

All   News   Images   Videos   Shopping   More ▾   Search tools

About 9,540,000 results (1.44 seconds)

Tom Cruise / Spouse (2007)

Katie Holmes

m. 2006–2012

Movies and TV shows and overview

Feedback

Who was Tom Cruise's wife in 2007

🔍

Web   Images   Videos   Maps   News   Explore

3,720,000 RESULTS   Any time ▾

Including results for *who was tom **cruise** wife in 2007*.
Do you want results only for Who was Tom Cruise's wife in 2007?

Tom Cruise - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/Tom_Cruise ▾
Cruise met his second **wife**, ... Rathbun claims that **wife** Nicole Kidman was wiretapped on **Tom Cruise's** ... October 17, **2007**. ^ a b "**Tom Cruise's** Irish ...
Early life · Career · Relationships · Scientology · Legacy · Litigation

Tom Cruise on "Valkyrie" Set - Photo 1 - Pictures - CBS News
www.cbsnews.com/pictures/tom-cruise-on-valkyrie-set ▾
Tom Cruise on "Valkyrie" Set. Facebook; Twitter; ... **2007**. Suri and **Cruise's wife**, ... **2007**. **Tom Cruise** stars in the film, ...

Tom Cruise's wife 🔍

3,560,000 RESULTS   Any time ▾

Tom Cruise - Wife

Katie Holmes
m. 2006 - 2012

Nicole Kidman
m. 1990 - 2001

Mimi Rogers
m. 1987 - 1990

Semantic Parsing

- Grammar induction with supervised examples
  - Too costly for create training data
  - Not enough precision for users
- Manually constructed rules
- Distant supervision

Manually Constructed Rules

- Example:
  - ?(Who is|was) $PERSON 's wife ?(in $YEAR)"
    - λx. ∃ e.Marriage(x, e) ∧ Spouse(e,$PERSON) ∧ Year(MarriageFrom (e))<=$YEAR∧Year(MarriageTo(e))>=$YEAR
- The good: predictable, precise
- The bad: costly, low coverage
  - But bearable with very high query traffic
- Rule-based NLP has been dead for a long time in academia, but is very much alive in industry.

Indiana Jones vs Swordman

Semantic Parsing

- Grammar induction with supervised examples
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Distant Supervision

- Instead of manually label examples, extract examples from an unlabeled corpus with a heuristic rule.
- Supervised learning with the extracted (weakly-labeled) examples.

Mappings between KB and NL Text

- Relations in KB and NL text are specified differently
  - infidelity.participant vs. "cheated on"
  - marriage.spouse vs "wife"
- Connection can be established through aliases of entities
  - KB entities have canonical names and aliases in natural language

Distant Supervision

- Goal:
    - Given a KB relation (e.g, Marriage.Spouse), find natural language text that expresses relation?
- Heuristic (assumption):
    - If two entities in a KB relation co-occur in the same sentence (passage), their relation is the same as the KB relation.
- Extract training examples using the heuristic for supervised training.

Distant Supervision: An Example

- KB instance:
  - ("冯小刚", Marriage.Spouse, "徐帆")
- Text containing both entities:
  - 1999年，徐帆与导演冯小刚结婚。
  - 冯小刚发表长微博，深情表白妻子徐帆。
  - 据悉，这篇文章是14年前冯小刚写给妻子的，当时给徐帆看完，她笑得合不拢嘴。
  - 冯小刚和现任老婆徐帆为什么不生子内幕.

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Distant Supervision: An Example

- KB instance:
  - ("李连杰", Marriage.Spouse, "利智")
- Text containing both entities:
  - 李连杰在接受媒体采访时透露，这几年全身心的投入到慈善
    他也坦言财产全部由妻子利智打理
  - 提到李连杰的妻子，在多数人印象中会第一时间想到利智，
  - 时过境迁，李连杰和利智结婚十多年了，育有一对女儿。
  - 大家都知道功夫巨星李连杰，谈到李连杰的老婆大家就会想到利智。
  - 相信很多朋友都知道，影坛巨星李连杰与利智结婚后，自2000年起相继的
    生育有两个女儿

Distant Supervision: example

- KB instance:
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  - 相信很多朋友都知道，影坛巨星李连杰与利智结婚后，自2000年起相继的 生育有两个女儿

Distant Supervision: source of natural language text

- [Cai & Yates 2013]:
  - Snippets from top search results
- [Yao & van Durme 2014]:
  - Sentences from ClueWeb

Question Answering: three approaches

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Question Answering with Unstructured Text

Google

what enzyme breaks down starch | 什么酶可以分解淀粉

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About 211,000 results (0.75 seconds)

Amylase

Salivary Amylase. Chewing breaks food into small molecules that combine with saliva secreted by the salivary glands in the mouth. Along with mucin and buffers, saliva contains the **enzyme salivary amylase**, which acts on the starch in food and breaks it down to **maltose**.

What Enzymes Are Used to Break Down Carbohydrates ...
healthyeating.sfgate.com/**enzymes**-used-**break-down-carbohydrates**-2211.h...

˅ More about Amylase

About this result • Feedback

annual rainfall of beijing

About 216,000 results (0.40 seconds)

December.
Rainfall/ Precipitation in Beijing, China. Beijing receives on average **576.9 mm** (22.7 in) of rainfall per year, or 48.1 mm (1.9 in) per month. On average there are 66 days per year with more than 0.1 mm (0.004 in) of rainfall (precipitation) or 5.5 days with a quantity of rain, sleet, snow etc. per month.

Rainfall in Beijing, China Average Precipitation and Wet Days
www.**beijing**.climatemps.com/**precipitation**.php

About this result • Feedback

how much does a mac air weigh

Web   Images   News   Videos   More ▾   Search tools

About 906,000 results (0.30 seconds)

2.96 pounds

The 13" Macbook Air weighs **2.96 pounds** and the 13" Macbook Pro weighs **3.57 pounds**. However, with the 15" Macbook Pro weighing in at 4.46 pounds, the 13" Pro is much more comparable to the 13" Air than it is the 15" Pro.

Why I Sold My 13" Air for a Macbook Pro Retina Display
briangardner.com/**macbook**-pro-retina-display/

Feedback

Apple - MacBook Air - Technical Specifications
https://www.apple.com/hk/en/**macbook-air**/specs.html ▾
View the technical specifications for MacBook Air, see what comes in the box, ...
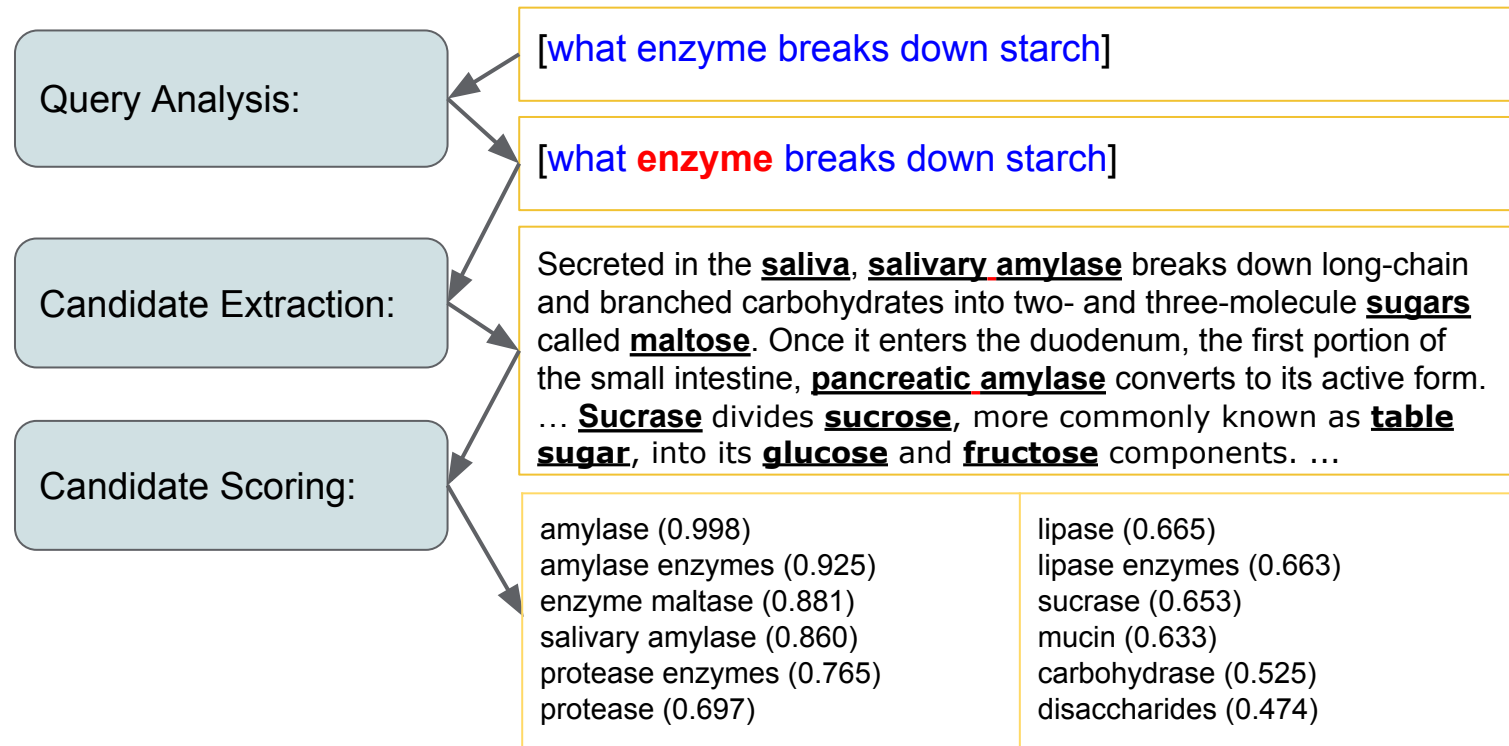
Query Analysis: Find the Focus Words in a Query

- The focus words are words in a query that specify the type of the answer that the user is looking for.
- A query is answer-seeking if and only if such focus words are found

Focus Words: Examples

- Explicit questions
  - what **enzyme** breaks down starch?
  - 2014 ebola outbreak happened in what **african countries**
  - **how much** does a macbook air **weigh**
  - what is the **melting point** of paraffin wax
  - **what** do hedgehogs **eat**
- Implicit questions
  - fastest **animal**
  - **annual rainfall** of beijing
- Non-question:
  - when in rome rotten

Finding Focus Words in Explicit Questions

- Explicit questions have wh-words

- Pattern matching rules works well
  - Wh-word itself: when/where/who
  - The first noun phrase after which/what
    - what **enzyme** breaks down starch?
    - 2014 ebola outbreak happened in what **african countries**
    - what is the **melting point** of paraffin wax

Implicit Questions

- Use explicit questions to obtain training examples for implicit questions:

Pattern: (what|who) (is|was|are|were) the Attribute of Entity
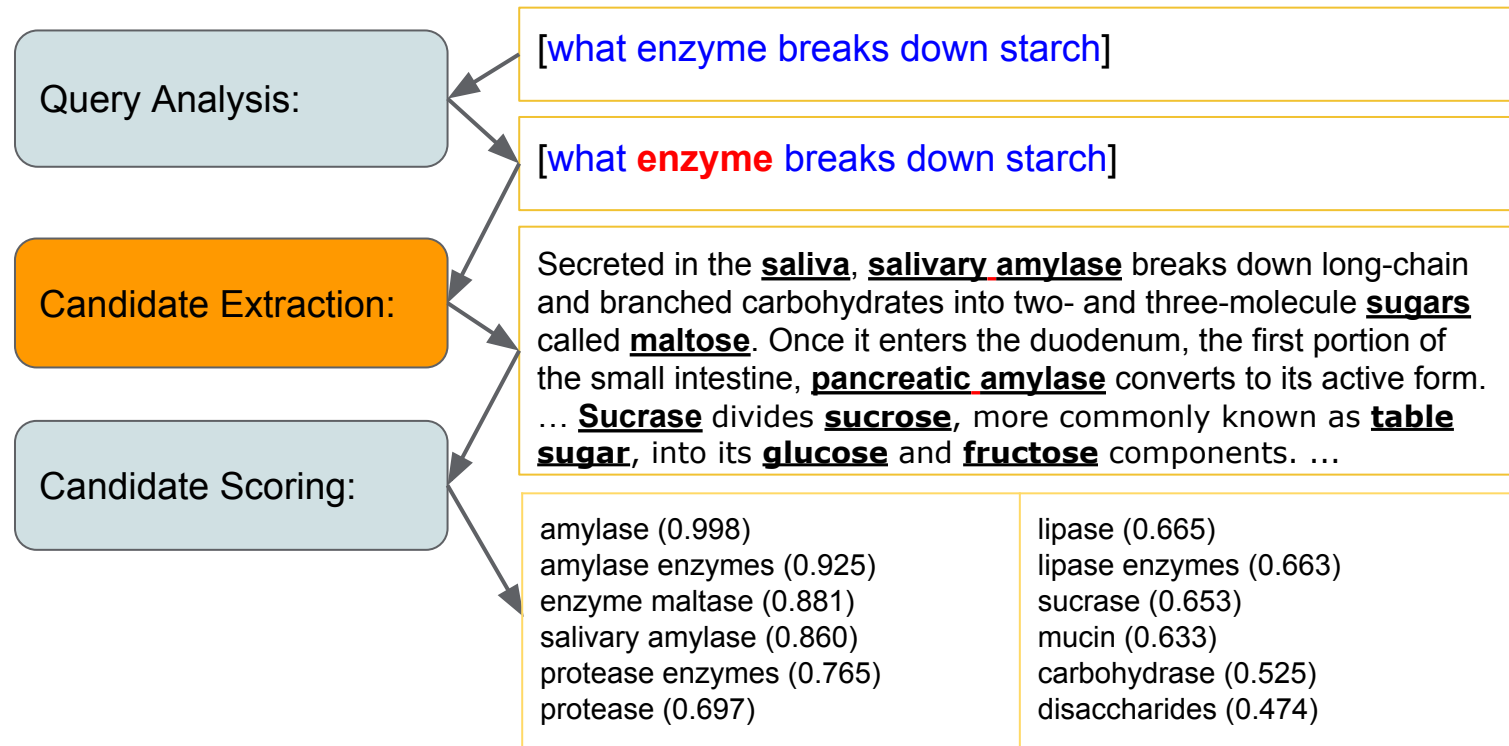
    [what is the fastest animal]

    [who was the annual rainfall of beijing]

Pattern: (what|who) (is|was|are|were) Entity's Attribute

    [what is vietnam's population]

Expected Answer Type

- Expected answer type of a question specifies what phrase/text can potentially be an answer (without knowing the context).
- The expected answer type of a question depends on
  - The focus words of the question
  - The ability of recognize whether something belongs to that type

Coarse-Grain Answer Types

- A small number of types
  - PERSON, LOCATION, TIME, TEMPERATURE, …
- Advantage:

  - use a named entity recognizer to determine what phrase matches the type.

- Disadvantage:

  - mapping from the focus word in query to an answer type is non-trial
    - melting point ->TEMPERATURE
    - annual rainfall -> LENGTH
    - assistant coach -> PERSON

Fine-Grain Answer Types

- IBM Watson
  - ~5000 types
- The most extreme version of fine-grain answer types:
  - Use as many answer types as focus words
  - Trivial mapping from focus words to answer types
  - Similar types are modeled separately
    - E.g., diameter and width are treated as two different types.

Extract Answer Type Examples with Patterns

- Numerical types:
  - (has|with) (a|an) TYPE of _____
  - Example:
    - has a DIAMETER of <u>13 cm</u>

- Entity types:
  - TYPE(s), such as _____
  - Example:
    - cities such as <u>Beijing</u>

Answer Type Example: annual rainfall

- The Zatecka Basin, the driest area, has an annual rainfall of about 18 inches.
- More than 80% of the continent has an annual rainfall of less than 600 mm;
- Cuzco with a mean average temperature of 10.7°C, and highest average monthly 12.1, has an annual rainfall of 804 mm.
- along the western Ghats escarpment, has an annual rainfall of about 5600 mm which is towards the mid-range of rain stations in the area
- For example, the 'region comprising New Mexico, Arizona, Colorado, Utah, Nevada, and Wyoming has an annual rainfall of from eight to sixteen inches
- Durban has an annual rainfall of 1,009 millimeters.
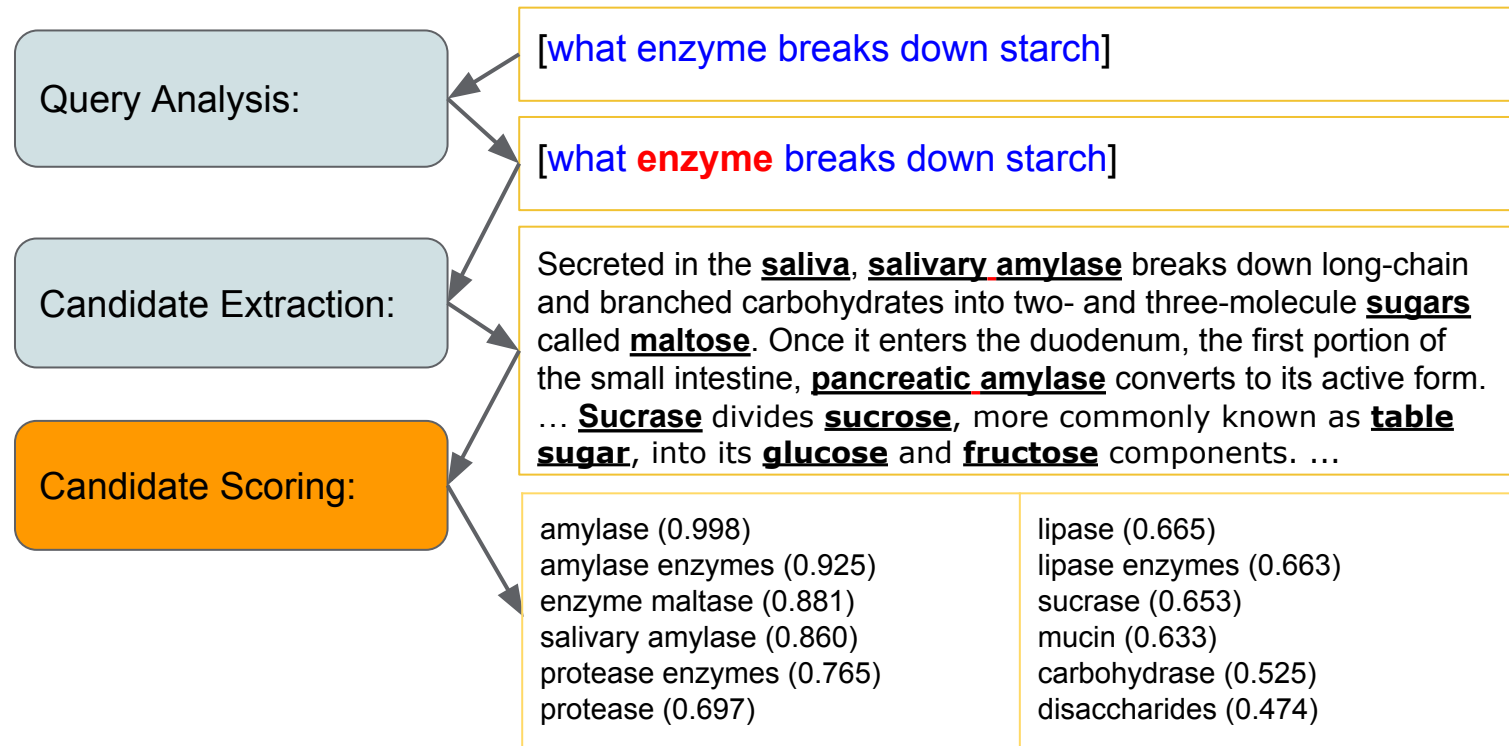
Answer Type Example: melting point

- Transcript of At room temperature, a substance with a melting point of 40 C.
- Unlike the trifluoride, gallium(III) chloride exists as dimeric molecules, Ga 2Cl 6, with a melting point of 78°C.
- Hafnium nitride, with a melting point of 3300°C
- Pure Benzene (C6H6) has a melting point of 5.5 degrees C.
- This solid material has a melting point of approximately 106°C and a relative density (RD or SG) of approximately ...

Answer Type Example: sleeping pills

- There is little evidence that the newer generation sleeping pills such as Ambien or Lunesta are more effective than older sleeping pills such as Dalmane or ...
- Diphenhydramine is found in many popular over the counter sleeping pills such as Tylenol PM, Excedrin PM and Nytol.
- Sedative sleeping pills such as Ambien can nearly double the risk for car accidents among new users compared with nonusers
- A newer class of non-benzodiazepine sleeping pills such as eszopiclone or zolpidem appears to be safe to use by patients with OSA

Question Answering with Unstructured Text

Query Analysis:

[what enzyme breaks down starch]

[what **enzyme** breaks down starch]

Candidate Extraction:

Secreted in the **saliva**, **salivary amylase** breaks down long-chain and branched carbohydrates into two- and three-molecule **sugars** called **maltose**. Once it enters the duodenum, the first portion of the small intestine, **pancreatic amylase** converts to its active form. … **Sucrase** divides **sucrose**, more commonly known as **table sugar**, into its **glucose** and **fructose** components. …

Candidate Scoring:

amylase (0.998)
amylase enzymes (0.925)
enzyme maltase (0.881)
salivary amylase (0.860)
protease enzymes (0.765)
protease (0.697)

lipase (0.665)
lipase enzymes (0.663)
sucrase (0.653)
mucin (0.633)
carbohydrase (0.525)
disaccharides (0.474)

Answer Candidate Scoring

- Features
  - Answer type score
  - Proximity to query keywords
  - Popularity
  - …...

Question Answering: Product Features

- Answer context
- Robustness
- Integration with other products
- Related questions
- Fun facts

Answer Context

- Automatic question answering system is not perfect
- Allow users to assess the credibility of answers
  - The source of the answer
  - The context in which the answer appears

what chemical kills bed bugs

Pyrethrins are botanical insecticides derived from chrysanthemum flowers. **Pyrethroids** are synthetic chemical insecticides that act like **pyrethrins**. Both compounds are lethal to bed bugs and can flush bed bugs out of their hiding places and kill them.

Pesticides to Control Bed Bugs | Bed Bugs: Get Them Out ...

https://www.epa.gov/**bedbu**...   United States Environmental Protection Agency

About 11,100,000 results (0.57 seconds)

274 cm

Table Tennis Rules. 1.1 The table shall be in surface rectangular, **274 cm**. (9 ft.) in length, **152.5 cm**. (5 ft.) in width. It shall be supported so that its upper surface, termed the playing surface, shall lie in a horizontal plane **76 cm.** (**2 ft. 6** in.) above the floor.

Official Ping Pong - Table Tennis Rules | Killerspin
www.killerspin.com/spin-info-**table-tennis**-rules/

About this result • Feedback

Robustness

- Different phrasing of the same question should get the same result

what size is ping pong table

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About 10,700,000 results (0.58 seconds)

Table Tennis Rules. 1.1 The table shall be in surface rectangular, **274 cm.** (9 ft.) in length, **152.5 cm.** (5 ft.) in width. It shall be supported so that its upper surface, termed the playing surface, shall lie in a horizontal plane **76 cm.** (2 ft. 6 in.) above the floor.

Official Ping Pong - Table Tennis Rules | Killerspin
www.killerspin.com/spin-info-**table-tennis**-rules/

Integration with Other Search/Answer Products

- Image search
- Knowledge base answers

alcohol content of tsingtao beer

About 8,750 results (0.51 seconds)

Tsingtao Beer, a well-hopped standard pilsner of **4.7% abv**, is the flagship brew, accounting for most of the brewery's production.

Tsingtao Brewery - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/**Tsingtao**_Brewery   Wikipedia ▾

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alcohol content of tsingtao beer

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Tsingtao Brewery - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/**Tsingtao**_Brewery   Wikipedia ▾

About this result • Feedback

Google

origin of miniature schnauzer

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About 113,000 results (0.97 seconds)

Miniature Schnauzer / Origin

Germany

Miniature Schnauzers were originally bred to be ratters and guard dogs on farms. They were developed in the mid-to-late 19th century in **Germany** by crossbreeding the Standard Schnauzer with smaller breeds, such as the Miniature Pinscher, Affenpinscher, and perhaps the Poodle or Pomeranian.

Miniature Schnauzer Dog Breed Information, Pictures ...
dogtime.com/dog-breeds/**miniature-schnauzer**   Dogtime ▾

Destinations and points of interest

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Miniature Schnauzer Dog Breed Information, Pictures ...
dogtime.com/dog-breeds/**miniature-schnauzer**   Dogtime ▾

Capital: Berlin

Dialing code: +49

Population: 80.62 million (2013) World Bank

Chancellor: Angela Merkel

President: Joachim Gauck

Destinations

View 10+ more

Berlin   Munich   Frankfurt   Hamburg   Heidelberg   Dresden

Points of interest

View 40+ more

Brandenb... Gate   Neuschwa... Castle   Berlin Wall   Cologne Cathedral   Reichstag building   Europa-P...

Show less

Related Questions

Query: GOP

GOP (disambiguation) - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/GOP_(disambiguation) ▾ Wikipedia ▾
GOP, short for Grand Old Party, is a nickname for the Republican Party of the United
States. GOP or Gop may also refer to: ...

Republican Party (United States) - Wikipedia, the free ...
https://en.wikipedia.org/wiki/Republican_Party_(United_States) ▾ Wikipedia ▾
The Republican Party, commonly referred to as the GOP is one of the two major
contemporary political parties in the United States, the other being its historic ...

People also ask

What is the difference between republican and democratic parties?	˅
Who is the leader of the Republican Party?	˅
Are conservative and Republican the same?	˅
Why was the republican party formed?	˅

With or Without Ryan, A Convention Savior Unlikely for GOP ...
www.nbcnews.com/.../or-without-ryan-convention-savior... ▾ NBCNews.com ▾
14 hours ago - With House Speaker Paul Ryan's "count me out" declaration Tuesday, the
prospects of a "savior" candidate to emerge at the GOP convention ...

Fun Facts (I am feeling curious)

- When the google query is "fun facts" or "i am feeling curious", the search results is an interesting question and its answer (shown after some delay).

fun facts

About 194,000,000 results (0.48 seconds)

Are foxes and wolves related?

Dogs belong to the taxonomic family Canidae (canines) which is divided into two tribes: those related to wolves (Canini) and those related to foxes (Vulpini). A couple of canine species lay outside these two tribes, but hyenas are not canines.

14 of Your Dog's Wild Relatives | Mental Floss

http://m.mentalfloss.com/article.php?id=30959

ASK ANOTHER QUESTION

i'm feeling curious

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About 54,900,000 results (0.39 seconds)

When was New York the capital of America?

The city and its surroundings came under English control in 1664. New York served as the capital of the United States from 1785 until 1790. It has been the country's largest city since 1790.

New York City - Wikipedia, the free encyclopedia
http://en.m.wikipedia.org/wiki/New_York_City

ASK ANOTHER QUESTION

Lessons Learned from Web Answers

- Question answering involve a full spectrum of NLP tasks.
  - Infrastructure:
    - NER
    - POS tagging
    - parsing
  - Type inference:
    - what does yellow rose symbolize
    - what sunglasses did james bond wear in spectre
  - Relation match
    - what do cows eat? [not beef!]
  - Entity linking
  - Evidence aggregation
  - …...

What's Next: From Answer Engine to Action Engine

- Do things instead of just looking for things
- Singulariti.io:
  - Natural language/speech interface to apps.
- Examples
  - 放大微信字体
  - 发一张照片给激扬
  - 把今天的公里数上传到清华跑步群
  - 从四爷拉面叫一份牛肉面
  - 国航今天从三藩到北京的飞机正点吗

singulariti

邬霄云
创始人
谷歌资深科学家
主要从事大规模机器学习，自然语言理解

林德康
联合创始人
谷歌12年工作经验，阿尔伯塔大学教授，
自然语言领域领军人物

刘忠
联合创始人
前中概股文思海辉(Pactera)执行副总裁，
负责公司的市场和内部运营管理

宋嘉伟
联合创始人
曾任索尼公司高级架构师
技术与架构实力双S级

And You！

Singulariti官方网站