Auto-completion for Question Answering Systems at Bloomberg

SIGIR Symposium on IR in Practice (SIRIP 2018)
July 9, 2018

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Outline

- Background: Question Answering Systems at Bloomberg

- Why Auto-completion for QA?

- Desiderata & Challenges

- Approaches

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QA at Bloomberg

- **Bloomberg Professional Service (The Terminal)**
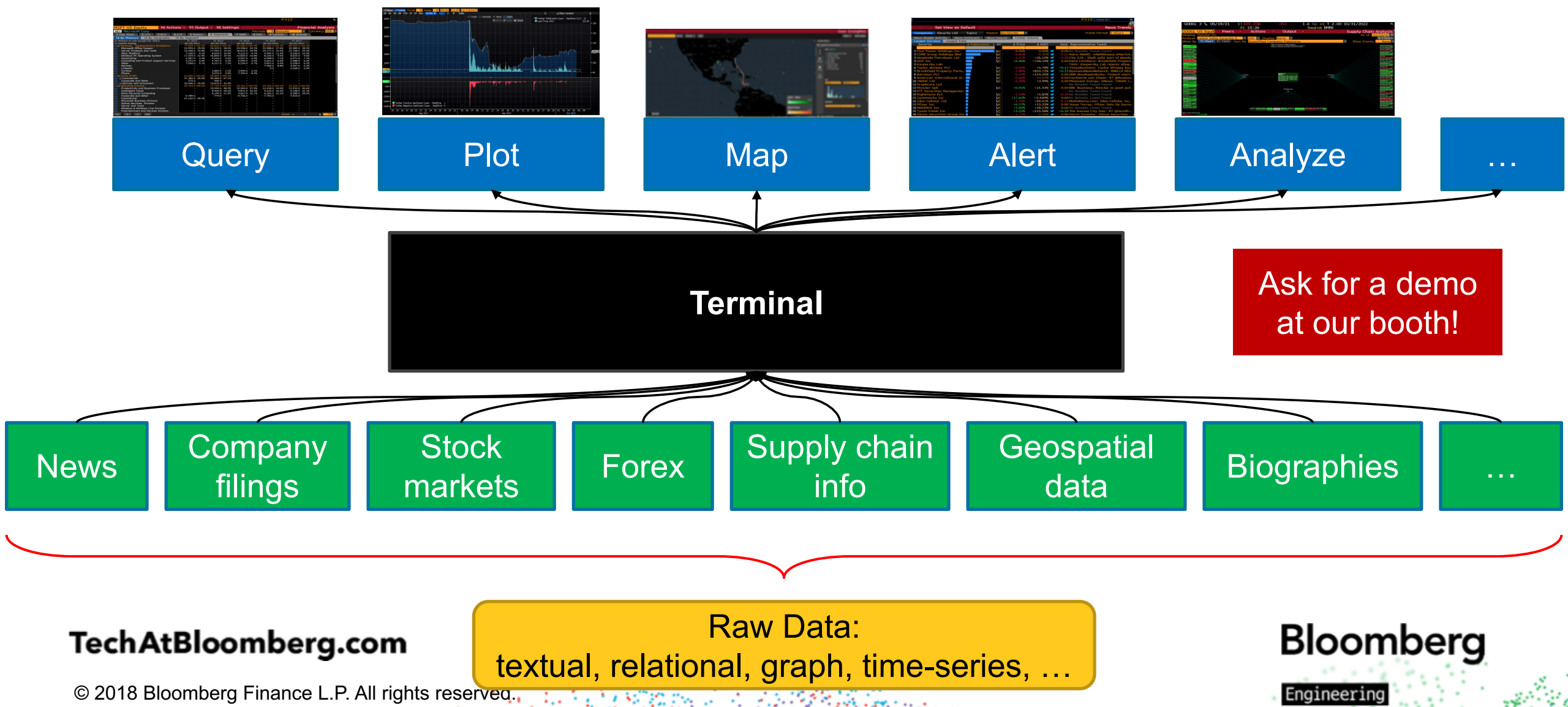 (325,000+ subscribers, 12,000+ functions)

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QA at Bloomberg

Query   Plot   Map   Alert   Analyze   …

Terminal

Ask for a demo at our booth!

News | Company filings | Stock markets | Forex | Supply chain info | Geospatial data | Biographies | …

Raw Data:
textual, relational, graph, time-series, …

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QA at Bloomberg

- *What are the top 10 Asian tech **companies** with EPS of at least 4?*

- ***Who** are the UMich alumni with a net worth of more than $50M?*

- ***Plot** Apple's quarterly profits over the past four years against those of Samsung and Google.*

- *Find corporate **bonds** rated A or better and with coupon higher than 7%.*

- *Show me **news** about oil from the Financial Times over the last two months.*

Bloomberg has the data and Terminal functions to answer all of the above, but there are some **usability issues**…

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QA at Bloomberg

- **Functions**
  - 12,000+ functions, exposed mostly through form-filling interfaces
  - ***Function discovery***: Which function answers my information need?
  - ***Function usability***: What's the right input to the function?

- **Data**
  - Tons of semi-structured & structured data
  - Diversity everywhere: data models, back-ends, …
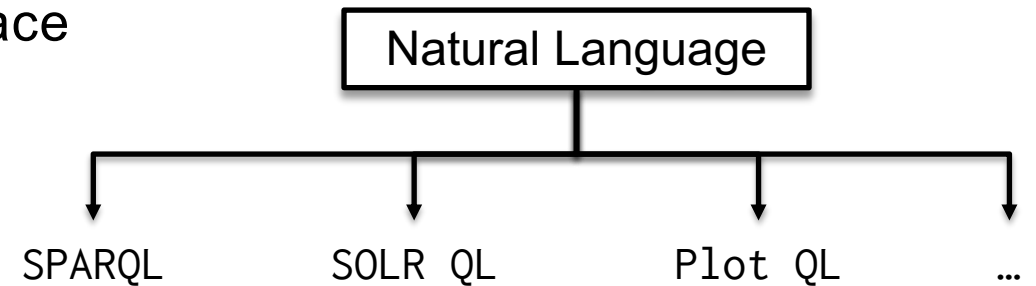 - Relations & joins very (very) important in this setting

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QA at Bloomberg

The vision: natural language is the ultimate declarative query language –
- Single entry point to the Terminal (and individual functions)
- Expressive questions

QA systems for several domains are already in place

Our flavor of QA relies on **Semantic Parsing**

```
                    ┌──────────────────┐
                    │ Natural Language │
                    └──────────────────┘
          ┌──────────────┬───────┴───────┬──────────────┐
          ↓              ↓               ↓              ↓
       SPARQL         SOLR QL         Plot QL           …
```

QA interfaces introduce their own set of usability issues;
We tackle these with **Question Auto-completion**…

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Why Auto-completion for QA?

- **Discovery**: AC as a vehicle to introduce users to QA capabilities

Prefix	Completion	Discovery
"Google sha"	"Google shares **plotted** against Apple shares"	Plotting!
"Chinese bonds m"	"Chinese bonds maturing **in the next 5 years**"	Temporal reasoning!
"Trum"	"Trump election **tweets** ordered by likes"	Tweet search!
"P"	"**Positive** news about Facebook"	News sentiment!

- **Expectation management**: All QA systems have limitations, expose them early on to avoid user frustration

> Where are my the keys of m…
>
> Sorry, no question suggestions!

- **Put users in the loop to help us help them**: Some inherent ambiguity can be resolved by guiding users to the appropriate formulation

> Assets of lloyd
>
> Assets of Lloyd Bank
> Assets of Lloyd's of London
> Assets of Lloyd Blankfein

- **Faster typing** ☺

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Desiderata

We want auto-completion systems that are:

- **Sound**
  Completions that we provide should be *understandable* & *answerable*

- **Complete**
  If a prefix can be extended to something we can understand & answer, then we should complete it

- **Diverse**
  Expose multiple capabilities of the underlying QA system

- **Propositional**
  Complete to next *full "subquestion"*

- **Predictive**
  High-ranked completion capture user's intended information need

- **Grammatical**
  Proper language (even if we can understand more "telegraphic" input)

News QA

Show m	
Show me news about Mexican elections	TOPIC
Show me news from yesterday	TIME
Show me news by the NYT	WIRE
Show me news about Angela Merkel	PERSON
Show me news about Facebook	COMPANY

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Challenges

Our setting is very different than that of AC for more traditional keyword-based search

- AC solves major usability issues for QA →
  Simultaneous deployment of QA and corresponding AC system

- **Cold-start problem**: No, or very meager, query logs to make use of

- In a semantic setting like ours, especially in the financial sector, **infinite sets (e.g., numbers, dates, …)** are fundamental, but a major challenge for completeness

- **Grammaticality**: We must complete and produce potentially complex, multi-clause natural language utterances that have to sound, well, **natural**

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But, it's not all bad

Semantics allows us to do some things much better:

"*German non-tech bonds maturing in the next 5 years*"

```
(CNTRY_OF_RISK = GERMANY) AND
(NOT (INDUSTRY_SECTOR = SECTOR_TECHNOLOGY)) AND
(MATURITY_DATE = Interval(Relative_Time_Reference(1,year,now) through
                          Relative_Time_Reference(5,year,now)))
```

But, it's not all bad

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                         Relative_Time_Reference(5,year,now)))
```

- **Diversity & Deduping**
  Completions can be binned into different classes based on "categories" determined by underlying semantics (which we know)

  semantics("Alphabet") = semantics("GOOGL")

- **Metadata**
  Utilize whatever metadata other teams collect to inform AC (e.g., entity popularity, better lexicons, …)

Show m	
Show me news about Mexican elections	TOPIC
Show me news from yesterday	TIME
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Approaches – Query Logs

- Where query logs exist, this is a good approach

- But, the **world changes**

  o AC has to keep up

  o Access to semantics very helpful in **log-normalization**

- **Compositionality** is a major issue!!

Last month
Trump's supreme cou
Trump's supreme court travel ban ruling

This month
Trump's supreme cou
Trump's supreme court nomination news

In 2015: "bonds maturing in 2016" ✔
In 2018: "bonds maturing in 2016" ✗

Query log
German bonds maturing in 2023
Siemens bonds denominated in Euros
Danish Krone bonds

German bonds d
Sorry, no question suggestions!

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Approaches – Query Log Atoms

Let's switch to log **atoms, utilizing semantics**
"***German bonds* *maturing in 2023***"
($CNTRY\_OF\_RISK = GERMANY$) AND
($MATURITY\_DATE = Year(2023)$)

- Great mileage, but requires tackling **coherence** and **well-formedness** issues when **stitching** atoms together. We tackle this as a **ranking problem** using **statistical techniques**

- Fixes the fat head that appears in logs, but there is a **long tail** that rarely appears in the logs …

Query log
German bonds maturing in 2023
Siemens bonds denominated in Euros
Danish Krone bonds

German bonds d

Sorry, no question suggestions!

Query log atoms
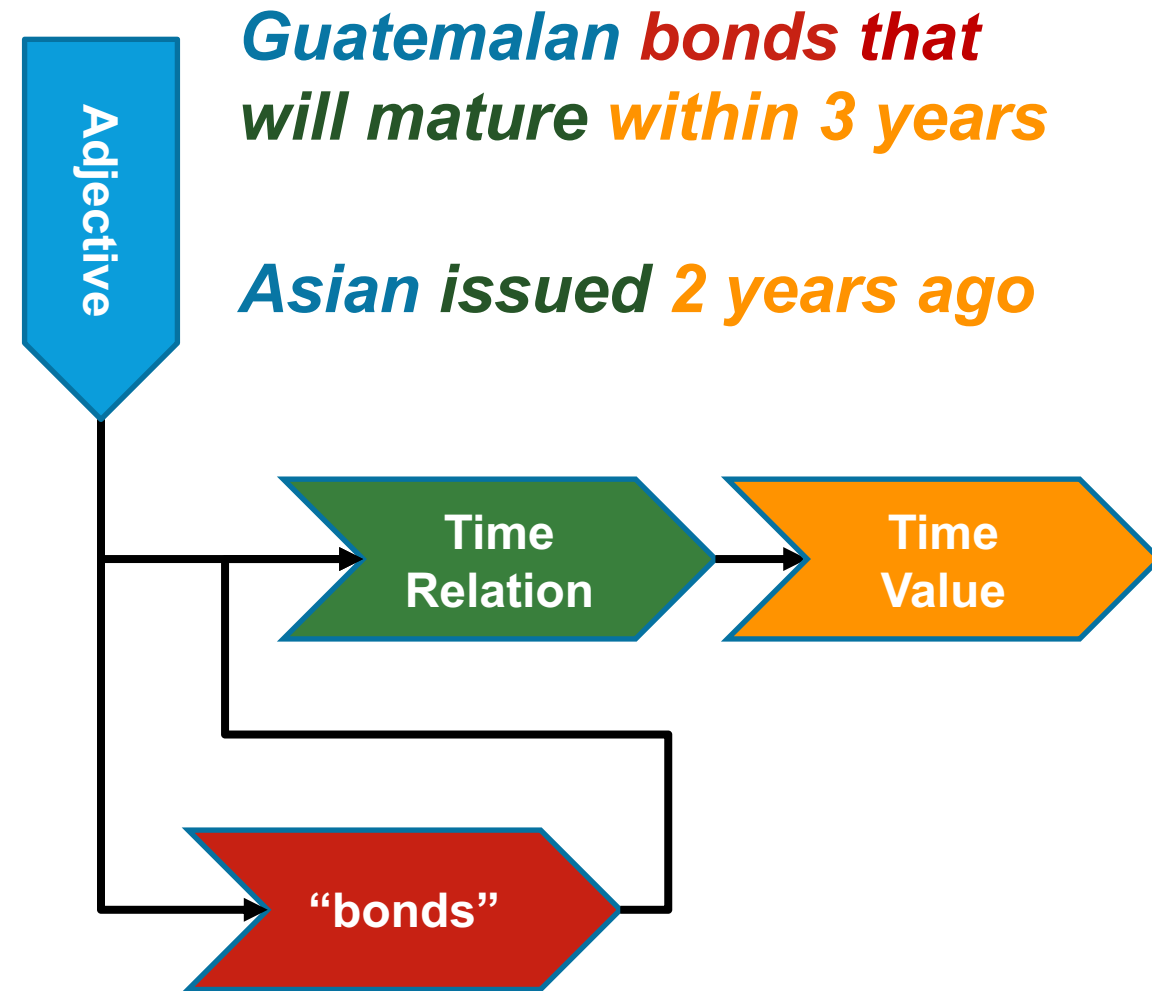| German bonds | denominated in Euros |
| maturing in 2023 | Danish Krone bonds |
| Siemens bonds | |

German bonds d

German bonds denominated in Euros ✔

German bonds Danish Krone bonds ✗

Approaches – Templates

- **Grammars** are used for semantic parsing (question understanding). Why not use them for **generation** as well?

- Based on **recursive**, **reusable components**

- This way we achieve **completeness**

- Again, **coherence** & **well-formedness** are major issues here

- AC has to happen, end-to-end in **<50ms**

Guatemalan bonds that will mature within 3 years

Asian issued 2 years ago

Adjective

Time Relation

Time Value

"bonds"

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Conclusion

- **QA** is an important step in enhancing **usability & discovery** of information systems
  AC is an important step in enhancing **usability & discovery** of QA systems!

- AC for QA facilitates **discovery**, **expectation management**, and **ambiguity resolution**

- Simultaneous deployment of QA & AC → **cold-start problem**

- We've shown some of our **complementary approaches** to AC, with **semantics** playing a crucial role!

- Still, much more left to do: **We're hiring**!
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