

Knowledge Graphs

Methodology, Tools and Selected Use Cases

Chapter3

2021.01.21

3.1 Introduction

- About **how Knowledge Graphs built** based on content, data, and service annotations can **improve search engine results and conversational systems**.
 - Introduce the merger of AI and Internet technology.
 - How to access Knowledge Graphs and optimize the interaction with them.
 - Introduce this architecture as a means for open dialog systems.

3.2 Merging Artificial Intelligence and the Internet

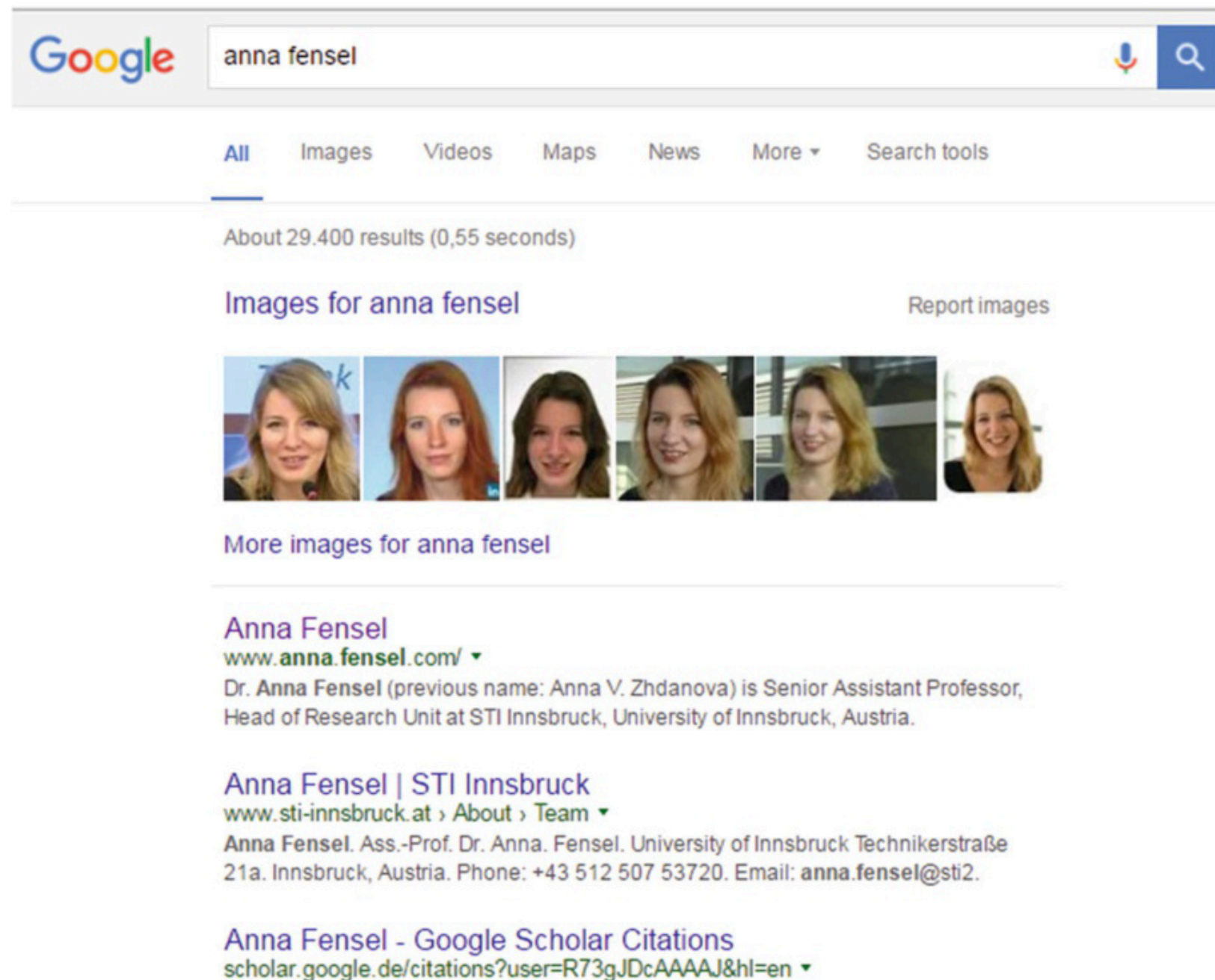
- 60 Years of AI in a Glimpse
 - Early on, the underlying assumptions were simple:
 - Logic expressions can define any problem (or solution)
 - A solution can be found by applying a formal reasoning engine
 - Logic reasoning is inherently complex
 - Without any grounding knowledge, any (of potential infinite) possible reasoning traces must be explored.
 - “Knowledge is power”
 - Researches providing means for presenting knowledge formally to make it machine-understandable were started.

60 Years of AI in a Glimpse

- Knowledge acquisition bottleneck:
 - Acquiring, modeling, and representing this knowledge was an extremely costly endeavor.
 - Most knowledge systems were small, shallow, not connected to overall processes in the enterprise, and not applicable to additional domains and tasks that steadily evolve.

The Web (for Bots)

- Google as a Search engine



The Web (for Bots)

- Google as a query-answering engine

The screenshot shows a Google search interface. The search bar contains the text "when was dieter fensel born". Below the search bar, there are tabs for "All", "Images", "News", "Shopping", "Videos", "More", and "Search tools". The "All" tab is selected. Below the tabs, it says "About 11.100 results (0,82 seconds)".

The main result is a knowledge panel for Dieter Fensel. It includes a photo of Dieter Fensel and the text "Dieter Fensel / Date of birth" and "October 10, 1960 (age 55 years)". Below the photo is a "Feedback" link. To the right of the photo is a section titled "Dieter Fensel" with a share icon. It contains a brief biography: "Dieter Fensel is a German researcher in the field of formal languages and the semantic web. He is University Professor at the University of Innsbruck, where he directs the Semantic Technologies Institute ...". Below this is a link to "Wikipedia". It also lists "Born: October 10, 1960 (age 55), Nuremberg" and "Education: Free University of Berlin". Below that is a section "People also search for: Rudi Studer, Frank van Harmelen, G. Antoniou".

Below the knowledge panel, there are two search results. The first is "Dieter Fensel - Wikipedia, the free encyclopedia" with the URL "https://en.wikipedia.org/wiki/Dieter_Fensel". It includes a "Jump to Biography" link and a brief description: "Dieter Fensel (born 10 October 1960, in Nuremberg) is a German researcher in the field of formal languages and the semantic web." The second result is "when was dieter fensel born - Evi" with the URL "https://www.evi.com/q/when_was_dieter_fensel_born". It includes a brief description: "when was dieter fensel born. Dieter Fensel was born on Monday October 10th 1960." and a footer: "wikipedia - About - Careers - Mobile. © 2016 Evi Technologies Ltd. The Evi ...".

At the bottom right, there is a section titled "Books" with four book covers: "Ontologies: A Silver Bullet for..." (2001), "The knowledge acquisitio..." (1995), "Semantic Web Services" (2011), and "Spinning the Semantic..." (2003).

The Web (for Bots)

- Search for “Hotel Innsbruck” with Google

The image shows a Google search for "hotel innsbruck". The search bar at the top contains the text "hotel innsbruck" and a magnifying glass icon. Below the search bar, there are tabs for "All", "Maps", "Images", "Shopping", "News", "More +", and "Search tools". The search results are displayed in a grid format. On the left side, there are three search results from booking.com, hotelscan.com, and HRS, each with a red box around it and a red number "1" next to it. On the right side, there is a detailed listing for "Hotel Innsbruck" with a green box around it and a green number "2" next to it. At the bottom, there are more search results from TripAdvisor, trivago, and Booking.com, each with a blue box around it and a blue number "3" next to it.

Google hotel innsbruck

All Maps Images Shopping News More + Search tools

About 76,600,000 results (0.45 seconds)

85 Hotels in Innsbruck - Best Price Guarantee - booking.com
www.booking.com/innsbruck-hotels
Book your Hotel in Innsbruck online
Types: Hotels, Apartments, Villas, Hostels, Resorts, B&Bs
World's Leading Online Travel Agency Website - World Travel Awards
Book for Tomorrow Book for Tonight Secure Booking Book Now

Hotels Innsbruck ab 23€ - hotelscan.com
www.hotelscan.com/Hotels_Innsbruck
Angebote Hotels in Innsbruck. Jetzt Vergleichen, Buchen & Sparen!
Keine zusätzlichen Kosten - +700.000 Hotels - Bis zu 50% sparen
Ziele: Berlin, London, Paris, Rom, Wien, Madrid, Barcelona, Prag, Graz, Innsbruck
Hotels in Amras - Hotels in Nordkette - 4-Sterne Hotels Innsbruck - Hotels am Igls

Günstiges Hotel Innsbruck - Hotels zu Tiefstpreisen bei HRS
www.hrs.de/Hotel_Innsbruck
Online buchen & im Hotel bezahlen!

Hotels Innsbruck ab 28€ - Hotelreservierung.at
www.hotelreservierung.at/innsbruck-Nr.1
Hotel Innsbruck - 4-Sterne Hotel in Innsbruck, Tirol, Österreich

Hotel Innsbruck - Tyrolean hospitality with 4-star comforts i...
www.hotelinnsbruck.com/en/

Our hotel, the Hotel Innsbruck, is based at the heart of the Tyrolean state capital and is one of the most historic hotels in the city as well as the hotel with the most ...

Das 4 Sterne Hotel Innsbruck im Zentrum der Tiroler ...
www.hotelinnsbruck.com/ Translate this page
Das 4 Sterne Hotel Innsbruck im Zentrum der Tiroler Landeshauptstadt Innsbruck.
✓ größtes Hotel/Wellnessangebot in Innsbruck - Jetzt 3% Direktbucherabbatt ...

The 10 Best Innsbruck Hotels - TripAdvisor
www.tripadvisor.com/ ... Austria > Austrian Alps > Tirol > Innsbruck
Book the Best Innsbruck Hotels on TripAdvisor: Find 15590 traveler reviews, 6494 candid photos, and prices for 81 hotels in Innsbruck, Austria.

Hotel Innsbruck (Austria) - Hotel Reviews - TripAdvisor
www.tripadvisor.com/ ... Tirol > Innsbruck > Innsbruck Hotels
★★★★★ Rating: 4.5 - 910 reviews - Price range: \$111 - \$238 (Based on Average Rates for a Standard Room)
Book Hotel Innsbruck, Innsbruck on TripAdvisor: See 448 traveler reviews, 373 candid photos, and great deals for Hotel Innsbruck, ranked #7 of 81 hotels in ...

Hotels Innsbruck bis zu 77% günstiger | trivago®
www.trivago.de / Österreich > Tirol
174 Hotels in Innsbruck und Preise aus 200 Webseiten verglichen. Bis zu 77% sparen. Günstige Hotels Innsbruck? - trivago!

Hotel Innsbruck, Austria - Booking.com
www.booking.com/hotel-at/hotelinnsbruck.html
★★★★★ Rating: 8.9/10 - 1,971 reviews

Hotel Innsbruck
4.4 ★★★★★
4-star hotel

Dating from 1870, this historic hotel with a colorful facade is a 2-minute walk from the Museum Goldenes Dachl, 2 km from Alpenzoo Innsbruck, and 19 km from the Patscherkofel mountain/ski ... More
Address: Innrain 3, 6020 Innsbruck, Austria
Phone: +43 512 596680
Suggest an edit

Book a room

Check in Sun, 1 May Check out Mon, 2 May

Booking.com Read Real Guest Reviews - Get Instant Confirmation €129 >
HotelTravel.com €108 >
View more rates

Amenities

Free WiFi Free breakfast Restaurant Gym

Review summary

Rooms - 3.3 ★★★★★
Guests liked the large, clean rooms, though some commented maintenance could be improved - Rooms had views - Some guests mentioned bathroom cleanliness could be improved

Location - 4.6 ★★★★★
Near the city center, shopping, sightseeing, restaurants & bars nearby - Near public transit - Easily accessible by car

Service & facilities - 4.2 ★★★★★
Guests appreciated the friendly, professional staff - Guests enjoyed the sauna - Guests spoke highly of the reception staff

The Web (for Bots)

- Successful access to new conversation-based information.
 - Need to understand user requests precisely.
 - Need to have access to vast sources of smart content, data, and services.
 - Need to proper match-making of intents identified by NLP with semantically annotated resource.
 - Steady improvement and adaptation of achieved solutions through semiautomatic and fully automatic techniques.

3.3 Knowledge Access Layer

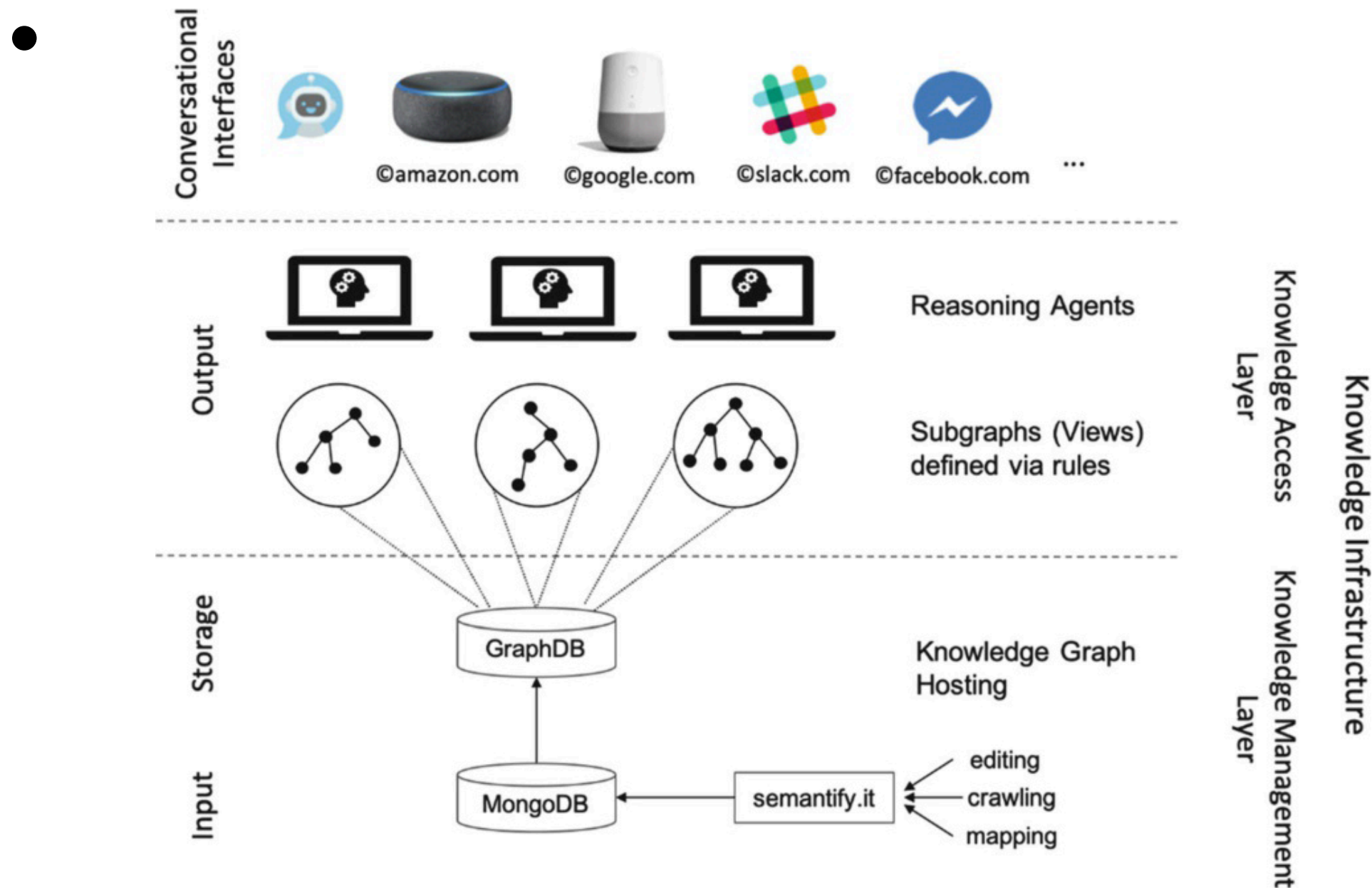
- The inference engines access this information to obtain data
 - for their reasoning that provides input to the dialog engine interacting with the human user.
 - Handling of dynamic and active data.

Loosely Connected Boxes Defining Logic-Based Views on Knowledge Graphs

- Reasoning is about discovering new knowledge from existing one.
 - It starts with one or more general premises and links them to reach specific conclusions.
 - It operates on logical propositions that may be either true or false.
 - Identification and reclassification of misclassified knowledge are also needed, as well as the incorporation of probabilities into reasoning to deal with uncertainty.

Loosely Connected Boxes Defining Logic-Based Views on Knowledge Graphs

- Reasoning can be used to find errors, correct errors, and enrich the knowledge in a Knowledge Graph.



Dynamic and Active Data: Semantic Web Services

- 3 different types of data:
 - Static data are data that do not likely change frequently.
 - Dynamic data change with a high frequency, for instance, age, weather forecast, traffic information, or share prices.
 - Active data, which changing the state of an external resource.

Dynamic and Active Data: Semantic Web Services

- Overview of the Semantic Web services technology that enables semantic description of web services allowing them to integrate dynamic and active data.
 - Heavyweight approaches, targeting mainly SOAP web services.
 - IRS-II, OWL-S, MEATEOR-s, ...
 - Lightweight approaches that enable semantic descriptions of RESTful web services.
 - WSMO-Lite, RESTDesc, ...

3.4 Open and Service-Oriented Dialog Systems

- As intelligent dialog systems,
 - The general case of Knowledge Graph-supported dialog systems.
 - The role of semantic description of services for building dialog-based systems.

Open Dialog Systems

- From the dialog strategy perspective, dialog systems can be classified into three categories:
 - System initiative systems where only the system guides the dialog.
 - User initiative where only the user asks the questions.
 - Mixed initiative where both parties can guide the dialog.
- Question-Answering System (QAS)
 - Running typical NLP tasks for syntactic analysis of the question.
 - Entity mapping and disambiguation over the Knowledge Graph.
 - Query construction (e.g., SPARQL), query execution, and answer provision.

Open Dialog Systems

- Applying such a pipeline bares certain challenges at each step.
 - Lexical Gap
 - The situation where the vocabulary used in the question does not directly match the vocabulary used in the labels of the resources in a Knowledge Graph.
 - Ambiguity
 - The notion of the same phrase having different meanings.
 - Multilingualism
 - The notion of being able to handle questions and answers in multiple languages.
 - Complex questions and queries
 - Complex questions may require queries with a more sophisticated structure (e.g., subqueries, union patterns, aggregation).

Open Dialog Systems

- How Knowledge Graphs can be used to improve dialog systems, Chatbots and Intelligent Personal Assistants.
 - To power the language understanding part of the dialog system
 - Use the Knowledge Graphs to provide training data for the NLU service.
 - To react on the conversations and provide additional interactions
 - React to the conversations and provide additional interactions, information, and recommendations to the user.

Service-Guided Dialogs

- For goal-oriented dialog systems that aim beyond simple question answering,
 - Guide users to elicit all the necessary information that is needed to achieve their goal.

User:	I want a hotel room in Seefeld from 12.09.2019 to 14.09.2019
Bot:	How many guests?
User:	2
Bot:	Ok I have found following hotel rooms: 1. Double room, shower or bathtub, WC offered by Alpenpark resort for 200 EUR per night. 2. Double room, shower or bath, toilet offered by central Seefeld for 119 EUR per night. You can purchase an offer.
User:	Ok I want number 2.
...	...
Bot:	Done. Here is the reservation: