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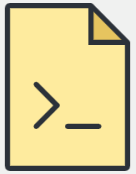

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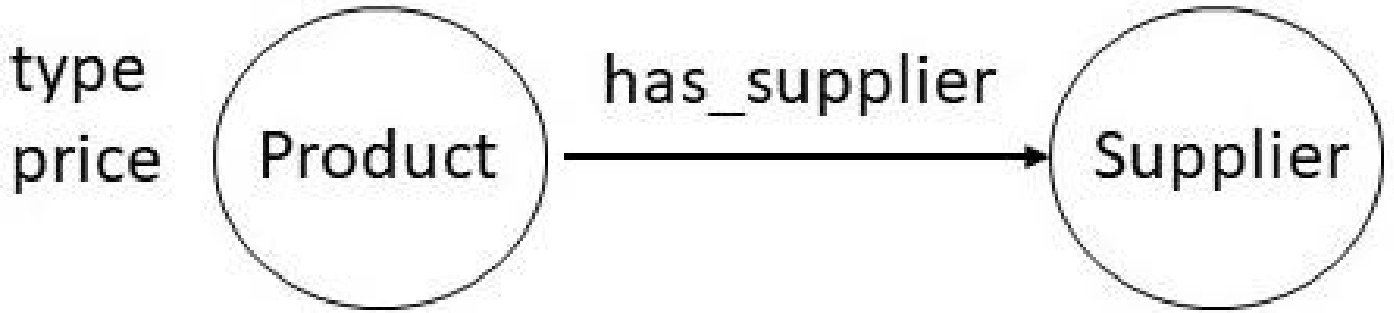
How do Users Interact with a Knowledge Graph?

Outline

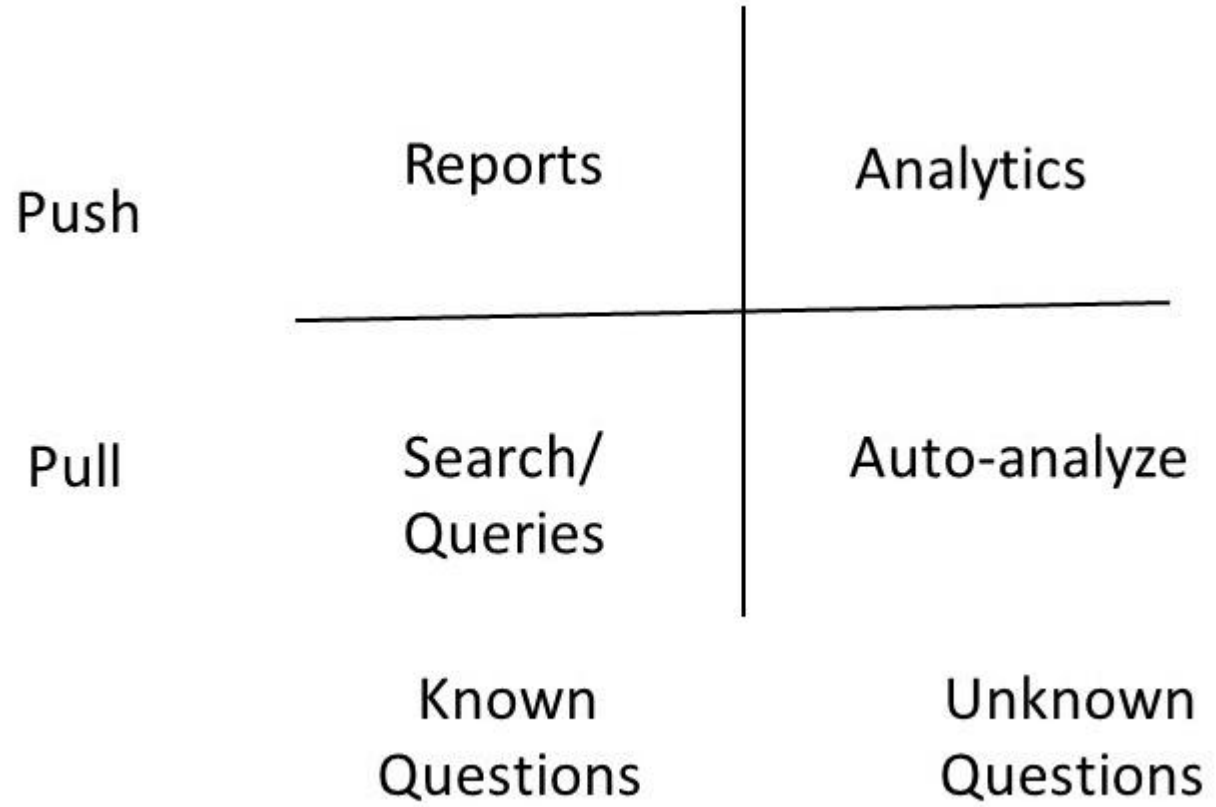
- Interaction Paradigms
- Visualization Techniques
- Structured Query Interfaces
- Natural Language Query Interfaces

Interaction Paradigms

- Schema provides an overview of the knowledge graph



Interaction Paradigms



Interaction Paradigm

- The interface to a knowledge graph is a combination of
  - Keyword search
  - Structured queries
  - Tabular presentation
  - Graph visualization

The user interface to a knowledge graph may not even expose the graph

Visualization Techniques

- General principles
- Best practices

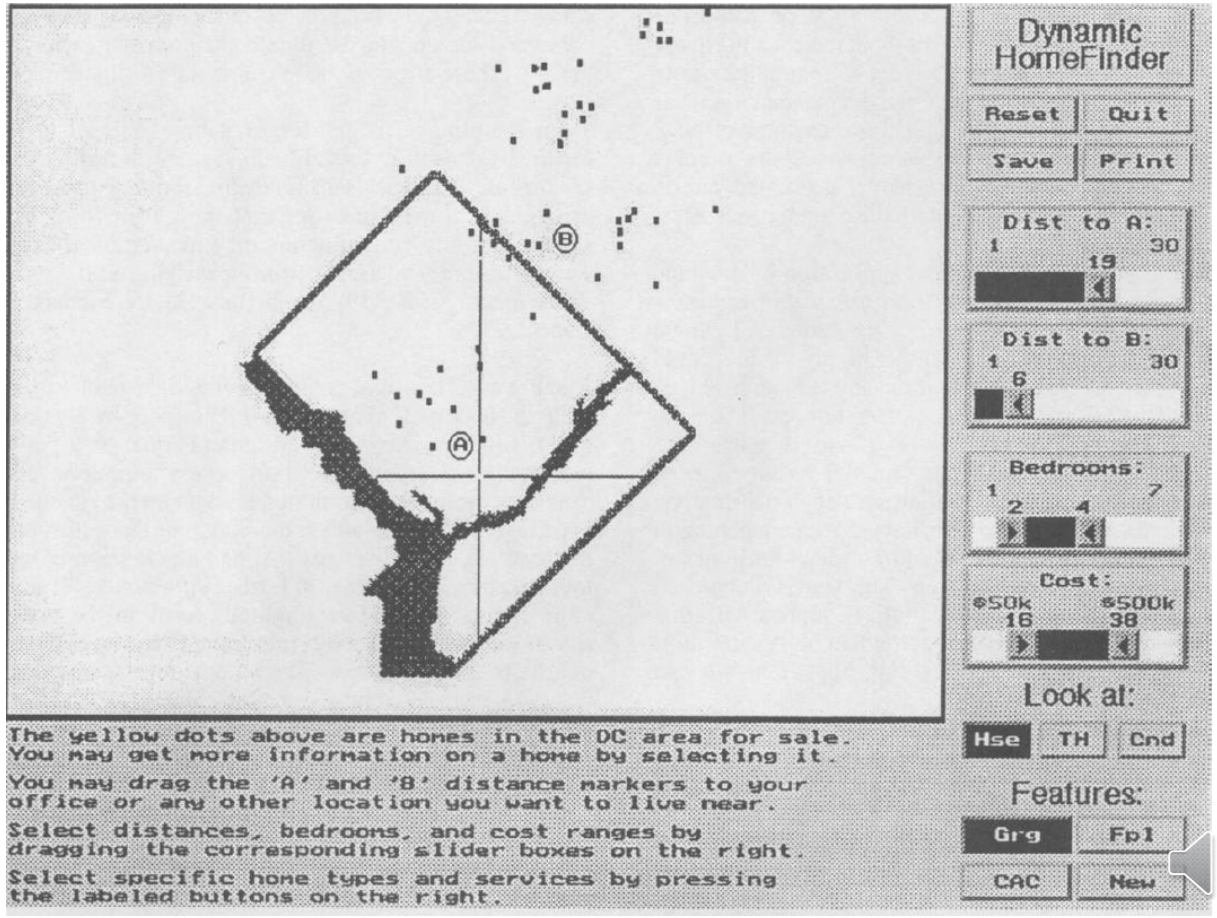
General Principles

- Amplify the user understanding of data

General Principles

- Amplify the user understanding of data

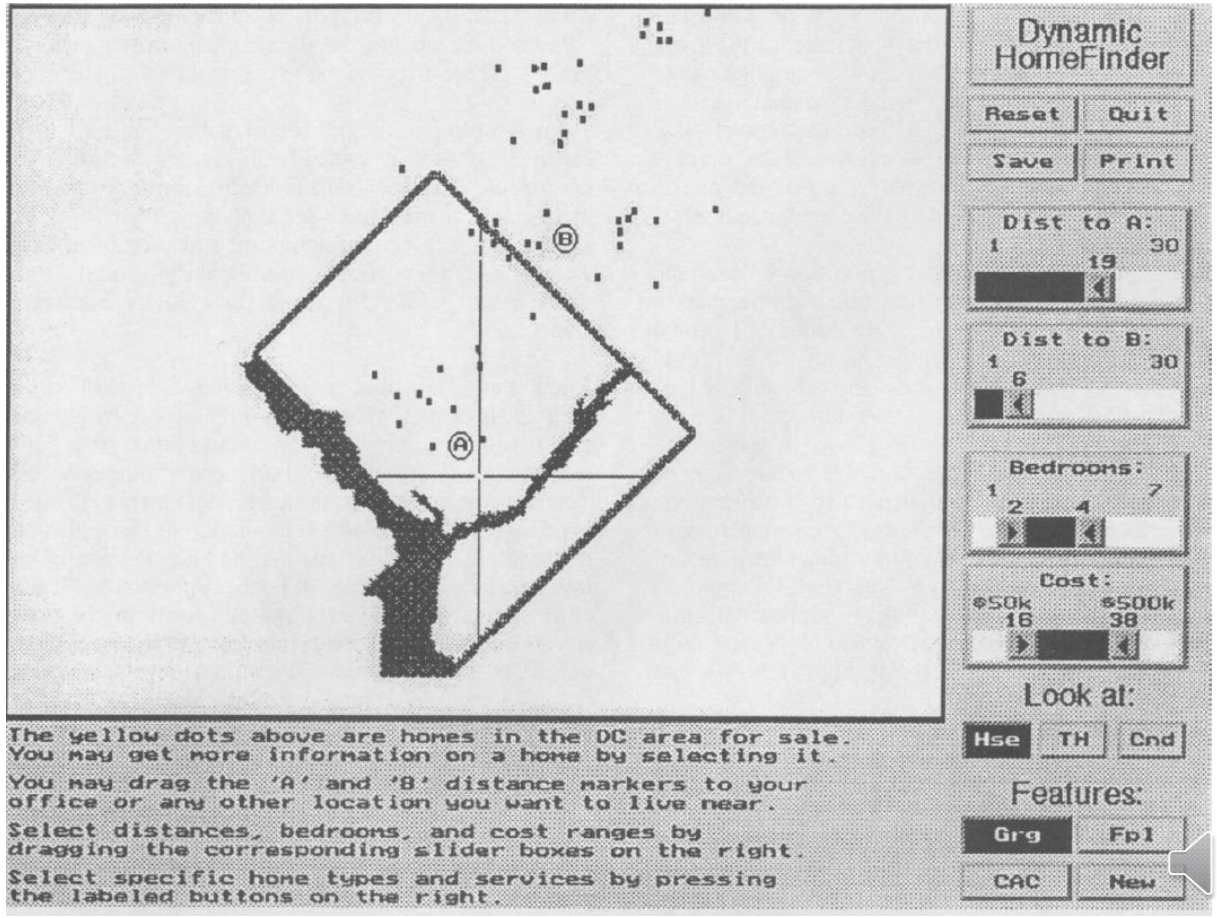
Present more information than a user might be able to remember at a time



General Principles

- Amplify the user understanding of data

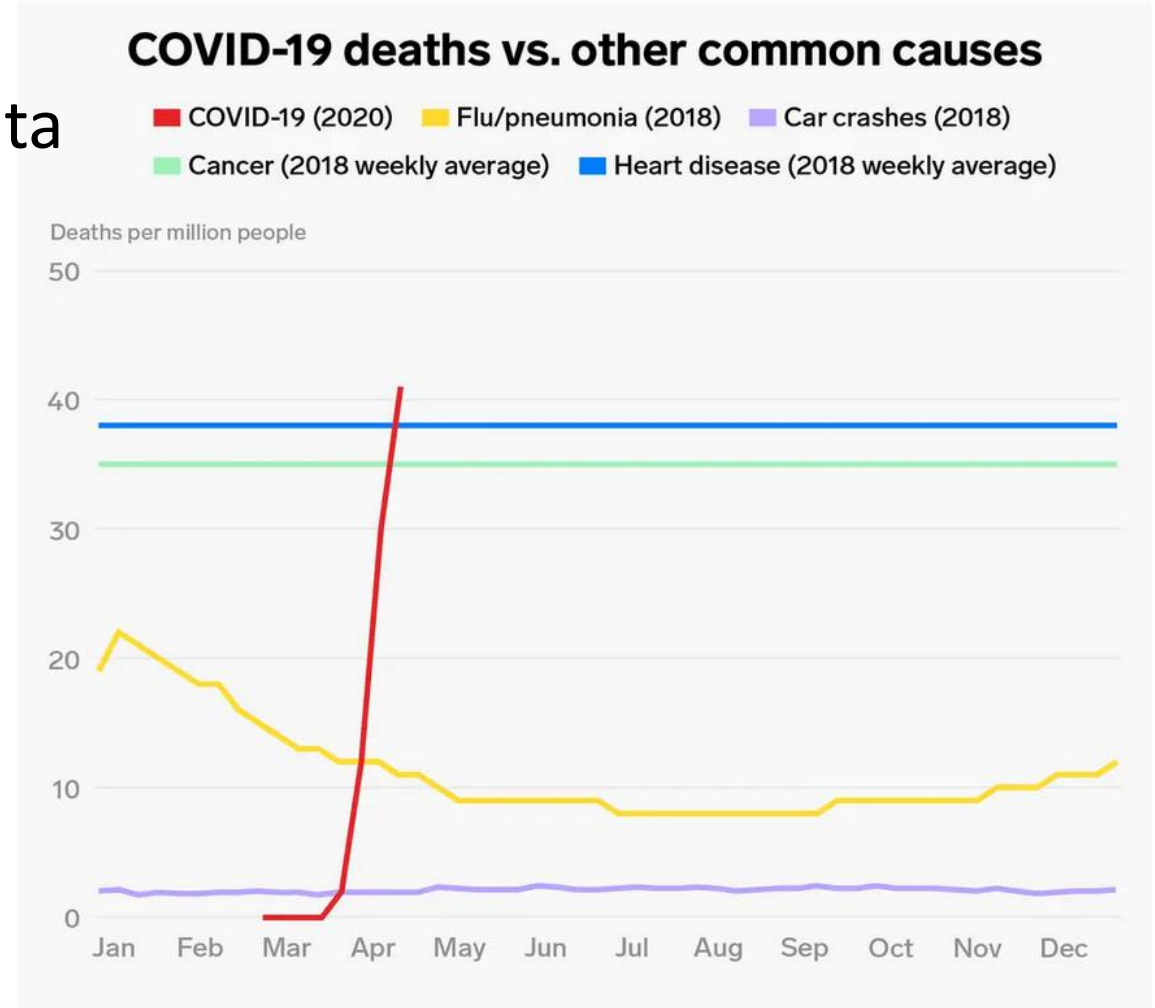
Take away the burden of having to look for information



General Principles

- Amplify the user understanding of data

Place relevant data next
to each other



General Principles

- Amplify the user understanding of data

Keep track of user's attention

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Acer Nitro 27" Class FHD IPS FreeSync Gaming Monitor

Item 1255477 | Model VG270

★★★★★ 4.6 (724)

Your Price $149.99

Shipping & Handling Included*

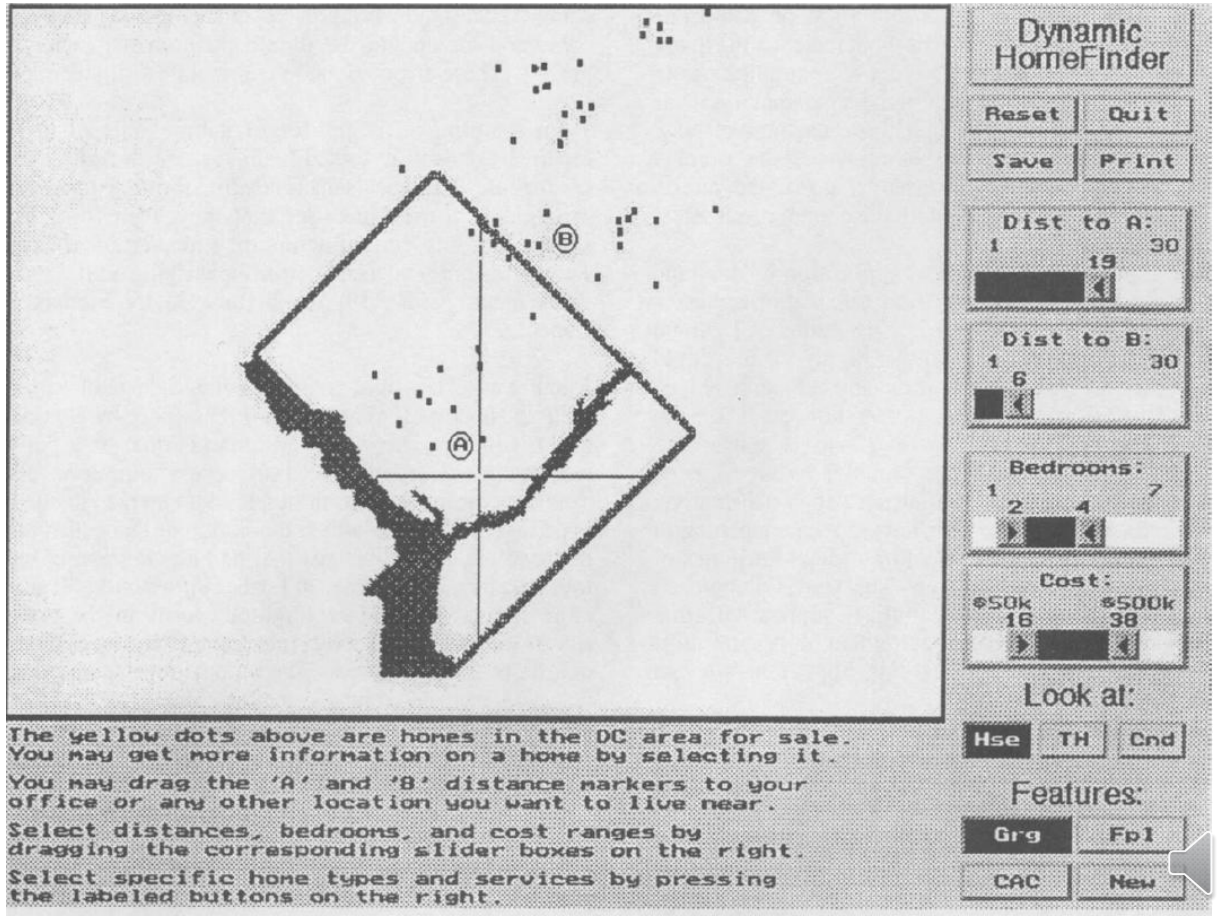
Features:

- 1920 x 1080 Resolution
- 75 Hz Refresh Rate
- 1ms Virtual Response Boost™
- AMD FreeSync
- VGA Cable Included

General Principles

- Amplify the user understanding of data

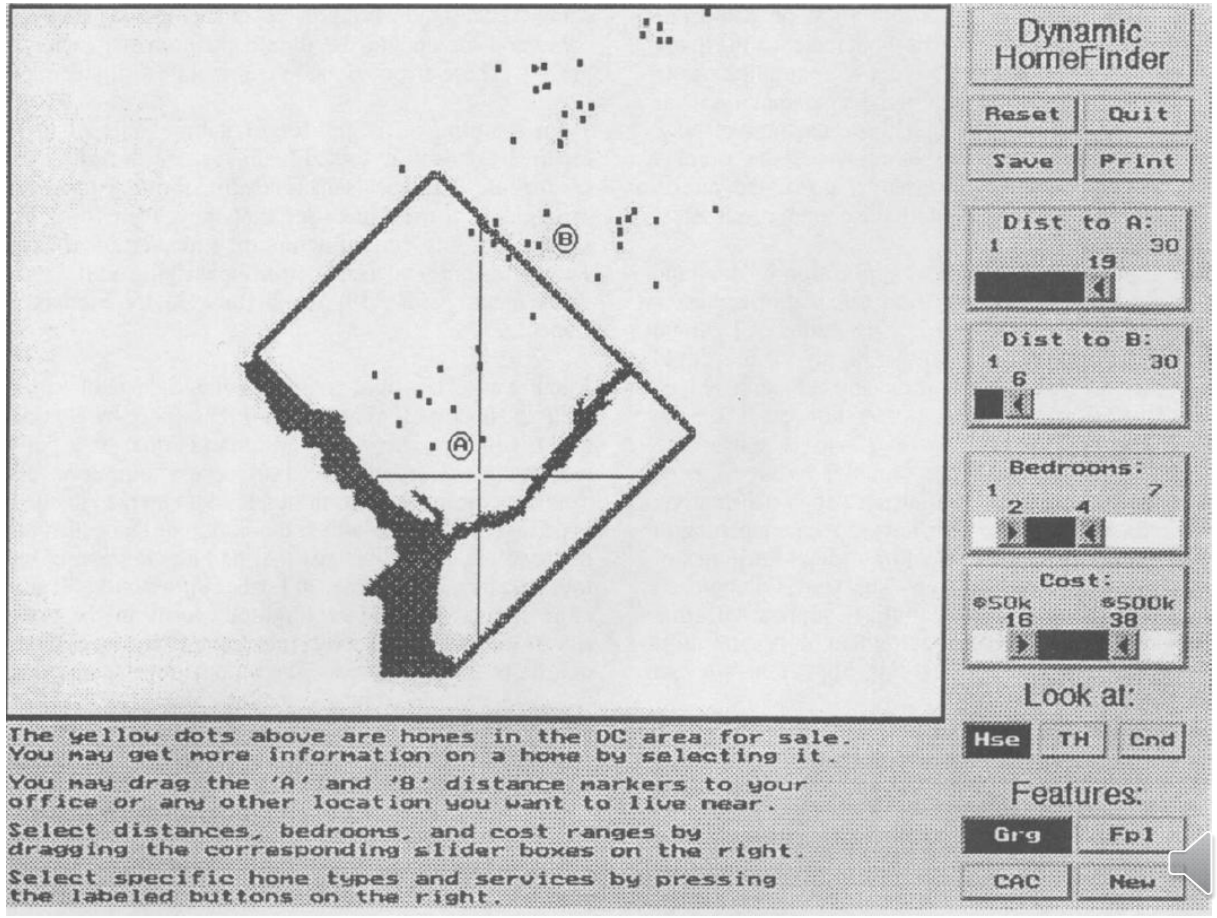
Provide more abstract view through omission and recoding of information



General Principles

- Amplify the user understanding of data

Allow a user to interact with and manipulate the visualization



General Principles

- Amplify user understanding of data
  - Present more information than a user might be able to remember at a time
  - Take away the burden of having to look for information
  - Place relevant data next to each other
  - Keep track of user’s attention
  - Provide more abstract view through omission and recoding of information
  - Allow a user to interact with and manipulate the visualization

General Principles

- Amplify the user understanding of data
- Design Choices
  - Spatial substrate
  - Marks
  - Connections and enclosures
  - Retinal properties
  - Temporal encoding

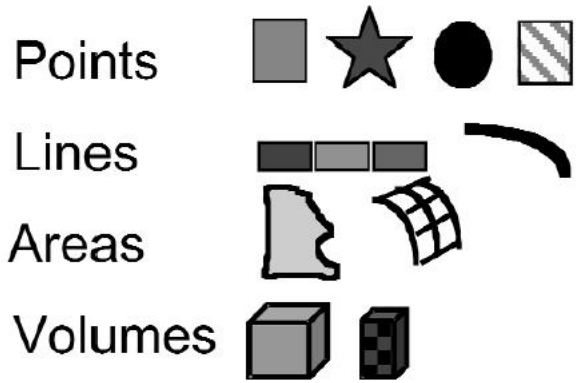
General Principles

- Amplify the user understanding of data
- Design Choices
  - Spatial substrate → Geographical data naturally shown on a map
  - Marks
  - Connections and enclosures
  - Retinal properties
  - Temporal encoding

For non-geographic data choose suitable axes and coordinates

General Principles

- Amplify the user understanding of data
- Design Choices
  - Spatial substrate
  - Marks → Visible things that happen in space that help a user in distinguishing between data items
  - Connections and enclosures
  - Retinal properties
  - Temporal encoding



General Principles

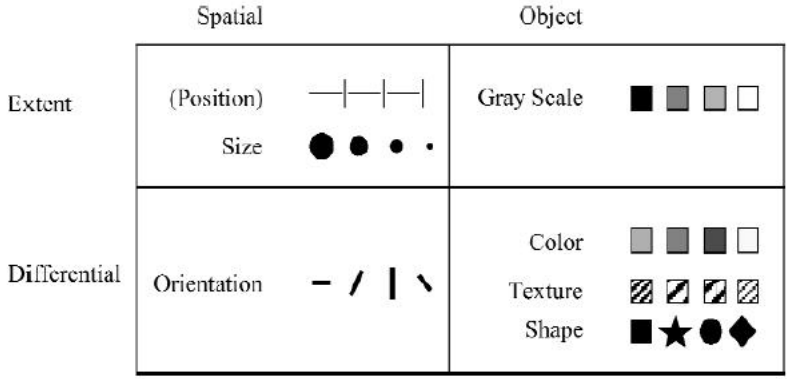
- Amplify the user understanding of data
- Design steps
  - Spatial substrate
  - Marks
  - Connections and enclosures → Connections include graphs, trees, and other hierarchical organization

    We can draw enclosures around certain nodes
  - Retinal properties
  - Temporal encoding

General Principles

- Amplify the user understanding of data
- Design Choices
  - Spatial substrate
  - Marks
  - Connections and enclosures
  - Retinal properties
  - Temporal encoding

Color, crispness, hue, transparency can be used to make a point



General Principles

- Amplify the user understanding of data
- Design Choices
  - Spatial substrate
  - Marks
  - Connections and enclosures
  - Retinal properties
  - Temporal encoding → Animation of data as it changes over time can help understand its evolution over a period of time

General Principles

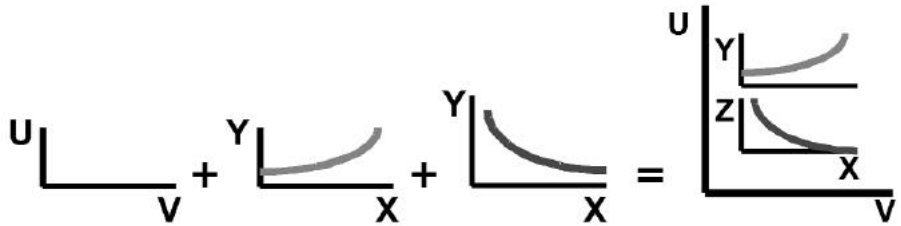
- Amplify the user understanding of data
- Design Choices
- Visualization type
  - Simple
  - Composed
  - Interactive
  - Attentive-Reactive

General Principles

- Amplify the user understanding of data
- Design Choices
- Visualization type
  - Simple → Static mapping of data into up to three dimensions
  - Composed
  - Interactive
  - Attentive-Reactive

General Principles

- Amplify the user understanding of data
- Design Choices
- Visualization type
  - Simple
  - Composed → Combined visualization
  - Interactive
  - Attentive-Reactive



General Principles

- Amplify the user understanding of data
- Design Choices
- Visualization type
  - Simple
  - Composed
  - Interactive → User selectively controls, expands, and navigates
  - Attentive-Reactive

Movable filters
Dynamic queries
Overview + Detail

General Principles

- Amplify the user understanding of data
- Design Choices
- Visualization type
  - Simple
  - Composed
  - Interactive
  - Attentive-Reactive → The system anticipates what is most useful thing to display next

Calculate degree of interest

Visualization Techniques

- General principles
- Best practices

Visualization Techniques

- Best Practices
  - Five step design process
    - Identify variables that could be mapped to spatial positions
    - Combine mappings to increase dimensionality
    - Use retinal properties to add more dimensions
    - Add controls for user interaction
    - Consider attentive reactive capabilities

Visualization Techniques

- Best Practices
  - Five step design process
  - Design template
    - Overview
    - Dynamic queries
    - Zooming in
    - Details on demand
    - Retrieval by example

Outline

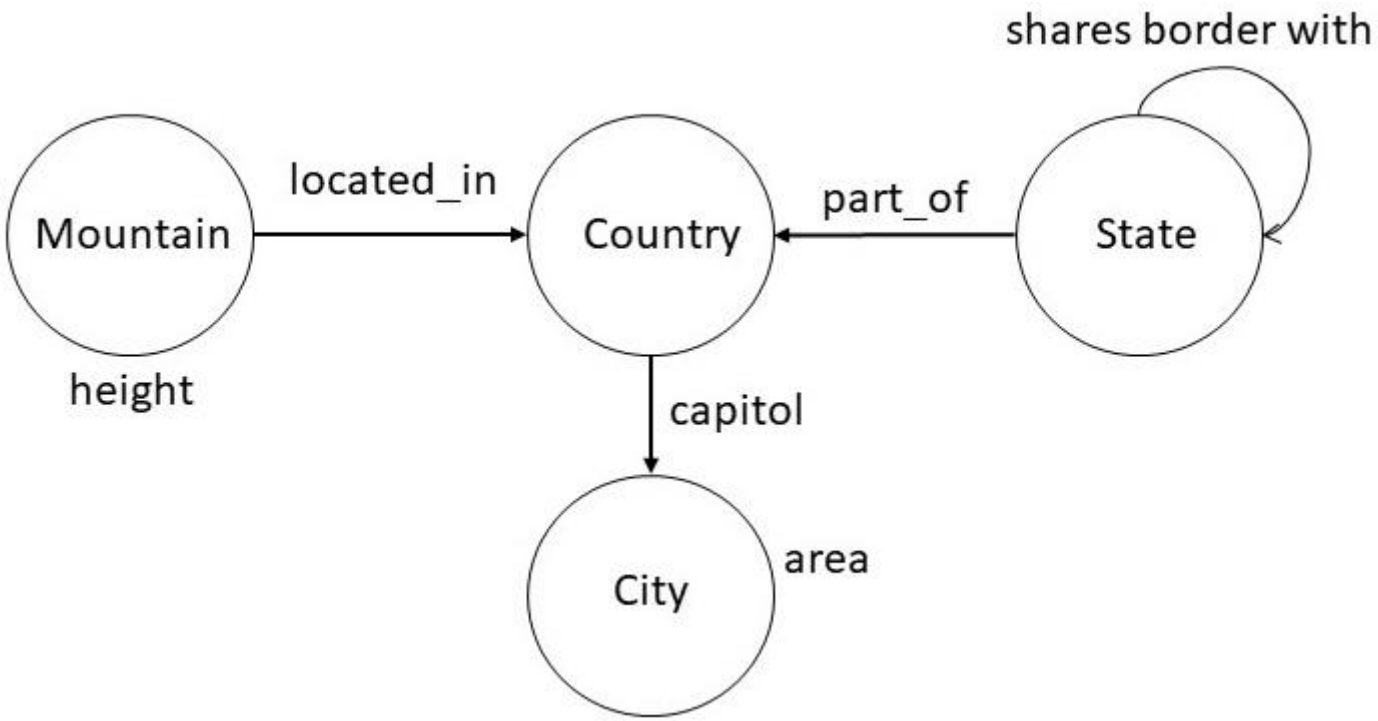
- Interaction Paradigms
- Visualization Techniques
- Structured Query Interfaces
- Natural Language Query Interfaces

Structured Queries

- The queries conform to a pre-defined grammar
- System uses auto-completion in response to user’s input

Structured Queries

- Example



city with largest area

top five cities by area

countries whose capitals have area at least 500 squared kilometers

states bordering Oregon and Washington

second tallest mountain in France

Structured Queries

- Can be specified using a BNF Grammar

<np> ::= <noun> "and" <noun>

<np> ::= <geographical-region> |

<geographical-region> <spatial-relation> <geographical-region>

<geographical-region> ::= "capital of country" | "city" | "country" |

"mountain" | "river" | "state"

<property> ::= "area" | "height"

<aggregate-relator> ::= "with the most number of" | "with the largest" |"with"

<aggregate-modifier> ::= "top" <number> | "second tallest"

<spatial-relation> ::= "bordering" | "inside"

<number-constaint> ::= "atleast" <quantity>

<quantity> ::= <number> <unit>

<unit> ::= "Square Kilometer"

<ranking> ::= "by"

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city with the largest area

<geographical-region> <aggregate-relator> <property>

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top five cities by area

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<number-constaint> ::= "atleast" <quantity>

<quantity> ::= <number> <unit>

<unit> ::= "Square Kilometer"

<ranking> ::= "by"

countries whose capitals have area at least 500 squared kilometers

<geographical-region> <aggregate-relator> <geographical-region>

<aggregate-relator> <property> <number-constraint> <quantity>

Structured Queries

- Grammar allows us
  - To check for legal queries
  - To auto-complete queries
  - To suggest completions of partial queries

Structured Queries

- Improving the range of queries requires
  - Expanding the grammar
- Well-suited only for limited domains
  - Not designed to handle numerous variations in English language

Outline

- Interaction Paradigms
- Visualization Techniques
- Structured Query Interfaces
- Natural Language Query Interfaces

Natural Language Query Interface

- Semantic Parsing Technology
  - Begin with a minimal grammar
  - Train the semantic parser to choose most likely interpretation

Natural Language Query Interface

- Semantic Parsing System
  - Executor
  - Grammar
  - Parser
  - Model
  - Learner

Natural Language Query Interface

- Semantic Parsing System
  - Executor → Produces a SPARQL or Cypher query that could be executed by the query engine
  - Grammar
  - Model
  - Parser
  - Learner

Natural Language Query Interface

- Semantic Parsing System
  - Executor
  - Grammar
  - Model
  - Parser
  - Learner

a grammar is set of rules of the form $\alpha \Rightarrow \beta$

Maps input sentence to logical forms

NP(x) with the largest RelNP(r) ⇒ argmax(1,1,x,r)

top NP(n) NP(X) by the RelNP(r) ⇒ argmax(1,n,x,r)

NP(x) has RelNP(r) at least NP(n) ⇒ (< arg(x,r) n)

Natural Language Query Interface

- Semantic Parsing System
  - Executor
  - Grammar
  - Model
  - Parser
  - Learner

Grammar produces multiple interpretations

A model defines a probability distribution over those interpretations

Natural Language Query Interface

- Semantic Parsing System
  - Executor
  - Grammar
  - Model
  - Parser → Parser maintains a certain number of interpretations at each step

    Computes the most likely interpretation
  - Learner

Natural Language Query Interface

- Semantic Parsing System
  - Executor
  - Grammar
  - Model
  - Parser
  - Learner → Computes the parameters of the model and in some cases additions to the grammar

Natural Language Query Interface

- Extremely difficult problem
- Requires amassing a large amount of training data
- Most systems report accuracy in the range of 50-60%

Summary

- Users want to consume a knowledge graph in different modes
  - Pull vs push and interactive vs batch
- We must not assume that a graphical visualization is the best display
  - Graphs are usually effective for schema but not always for instances
- Ideal interfaces will use a combination of method
  - Leverage visualization design principles

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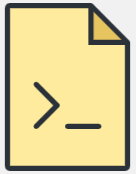

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