

How do Users Interact with a Knowledge Graph?



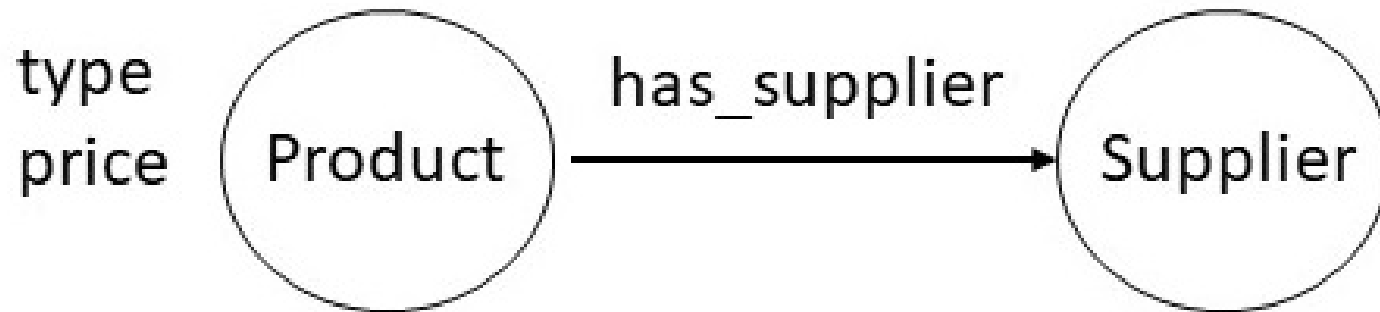
Outline

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

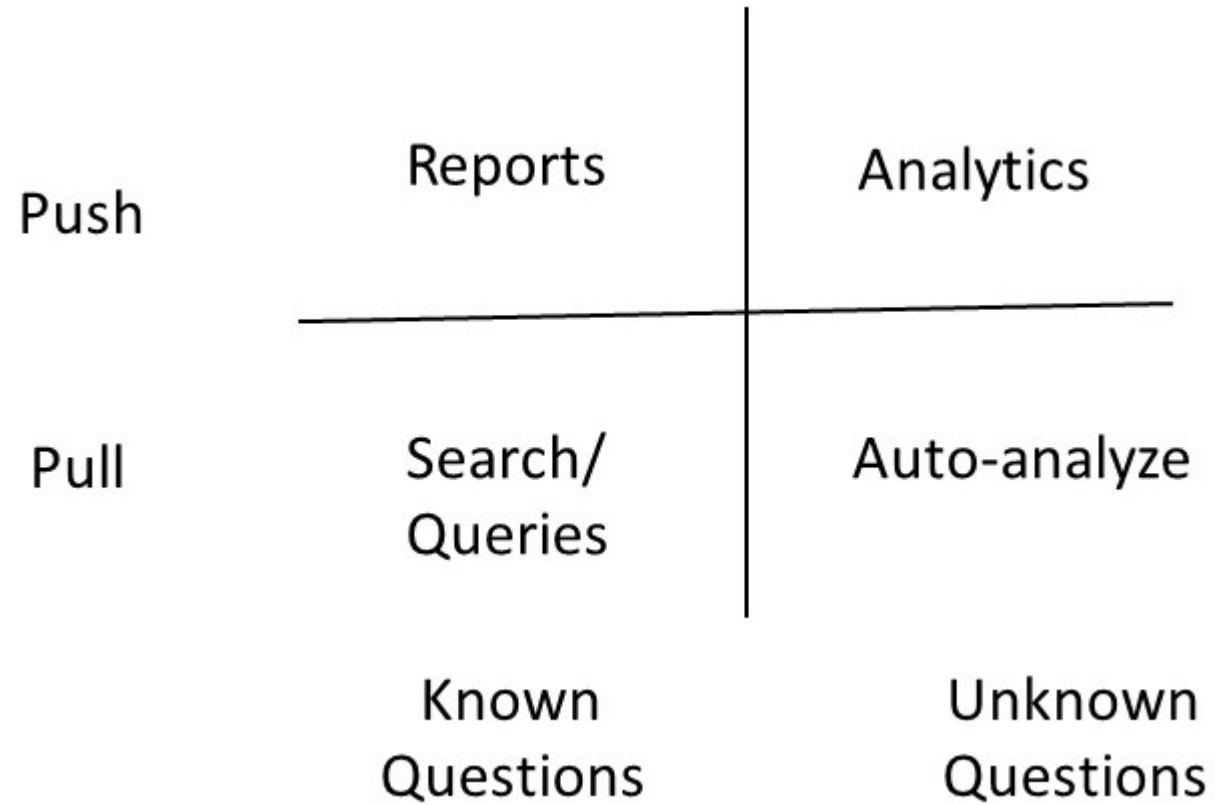


Interaction Paradigms

- 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

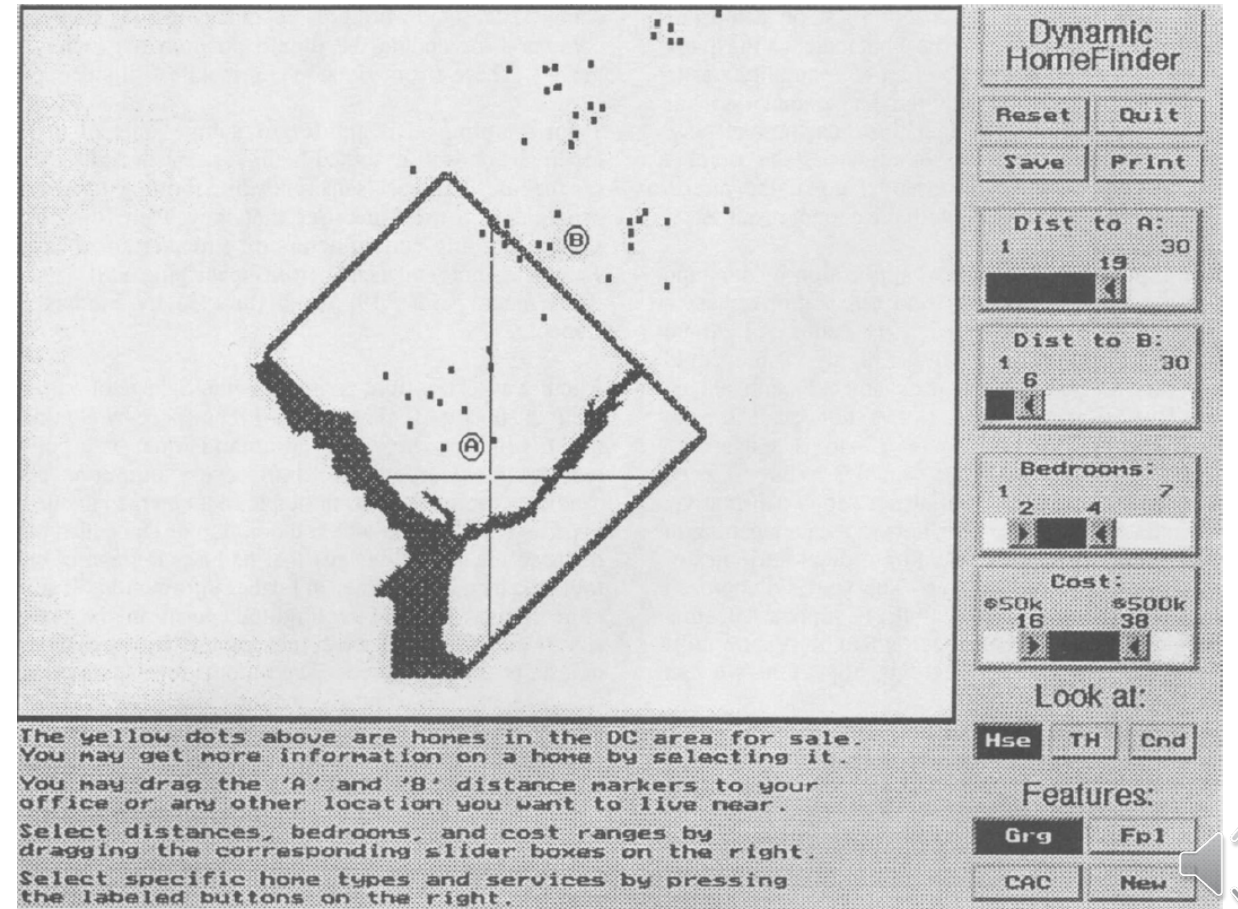
- Amplify the user understanding of data



General Principles

- Amplify the user understanding of data

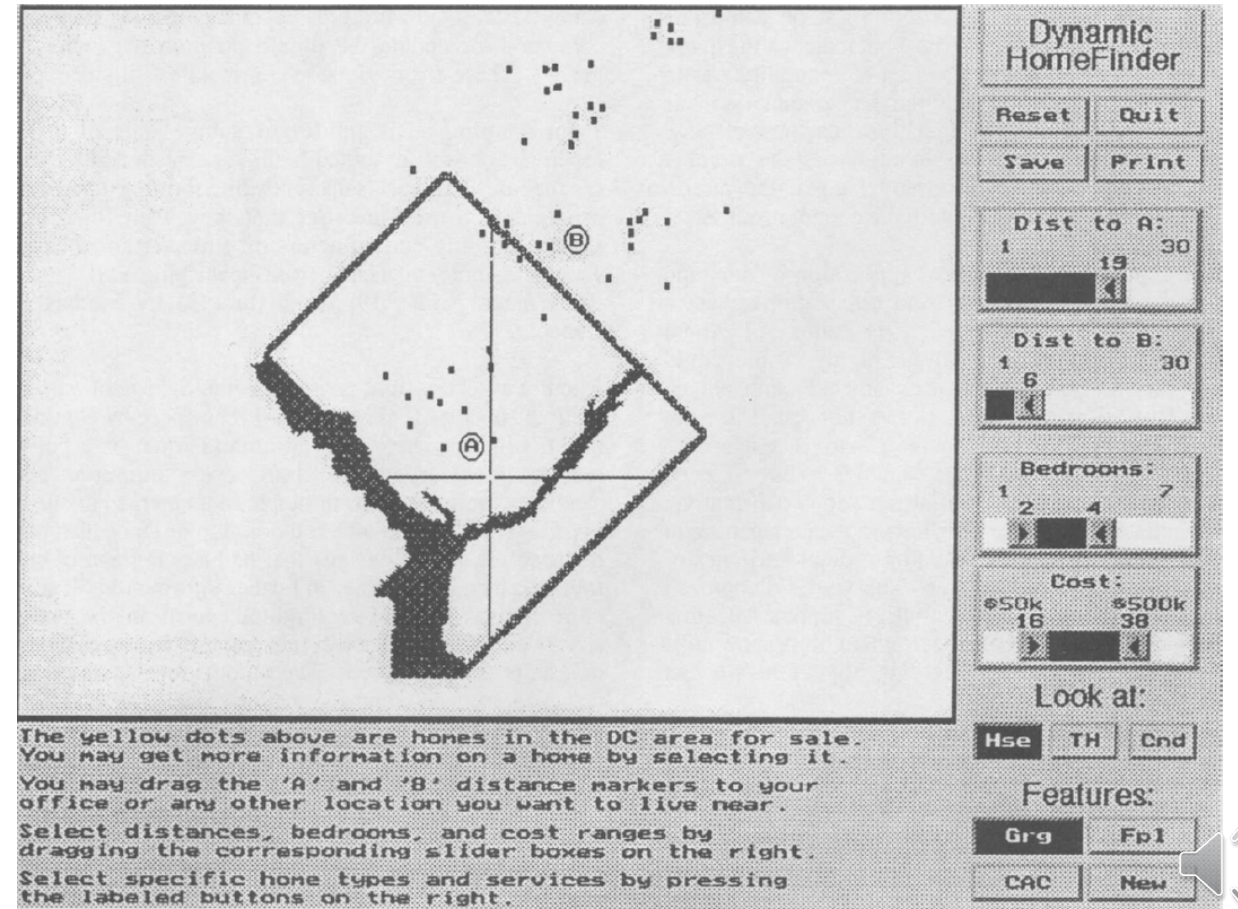
Present more information than a user might be able to remember at a time



General Principles

- Amplify the user understanding of data

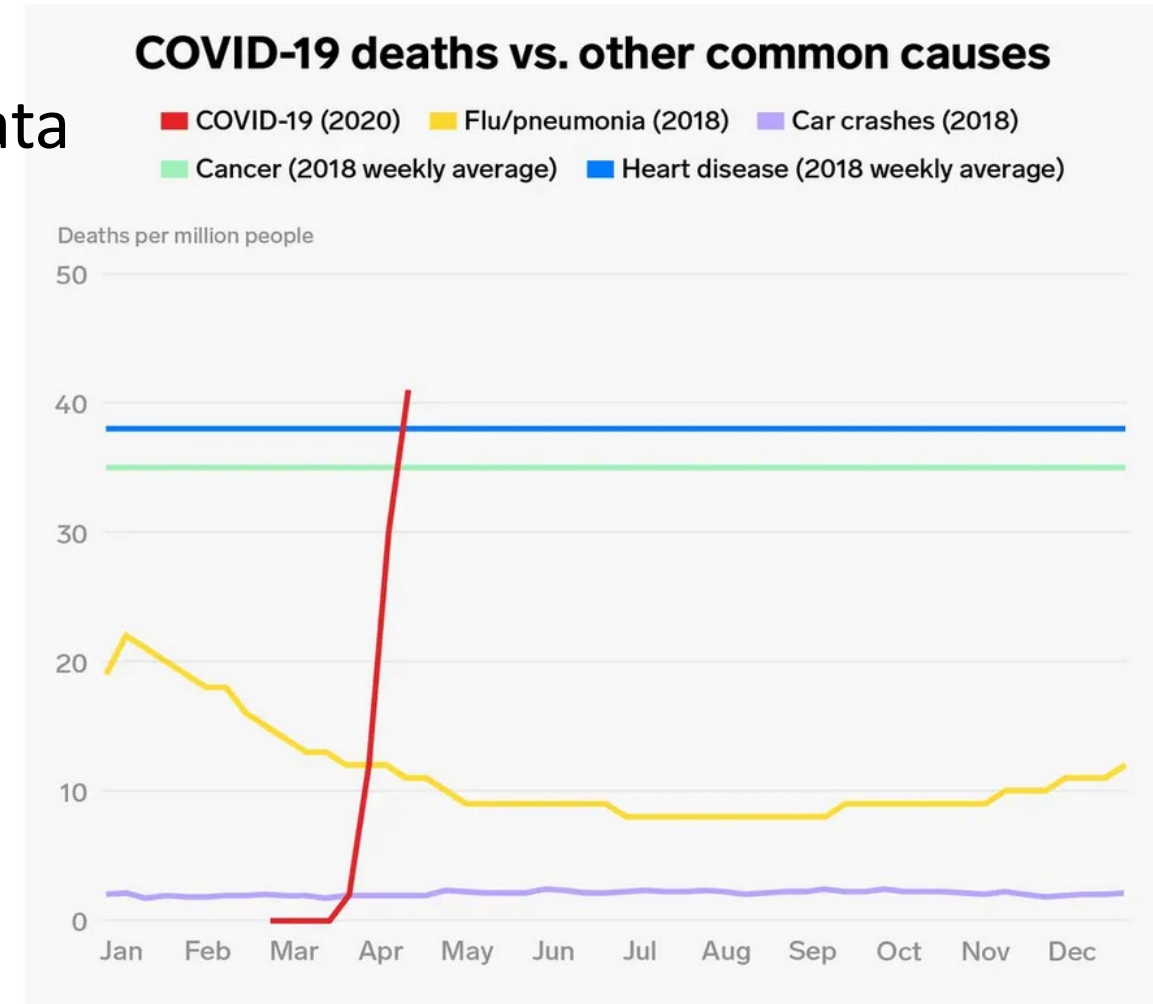
Take away the burden of having to look for information



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

Home / Computers / Monitors & Computer Screens



Acer Nitro 27" Class FHD IPS FreeSync Gaming Monitor

Item 1255477 | Model VG270

★★★★★ 4.6 (724)

Your Price **\$149.99**

Shipping & Handling Included*

Features:

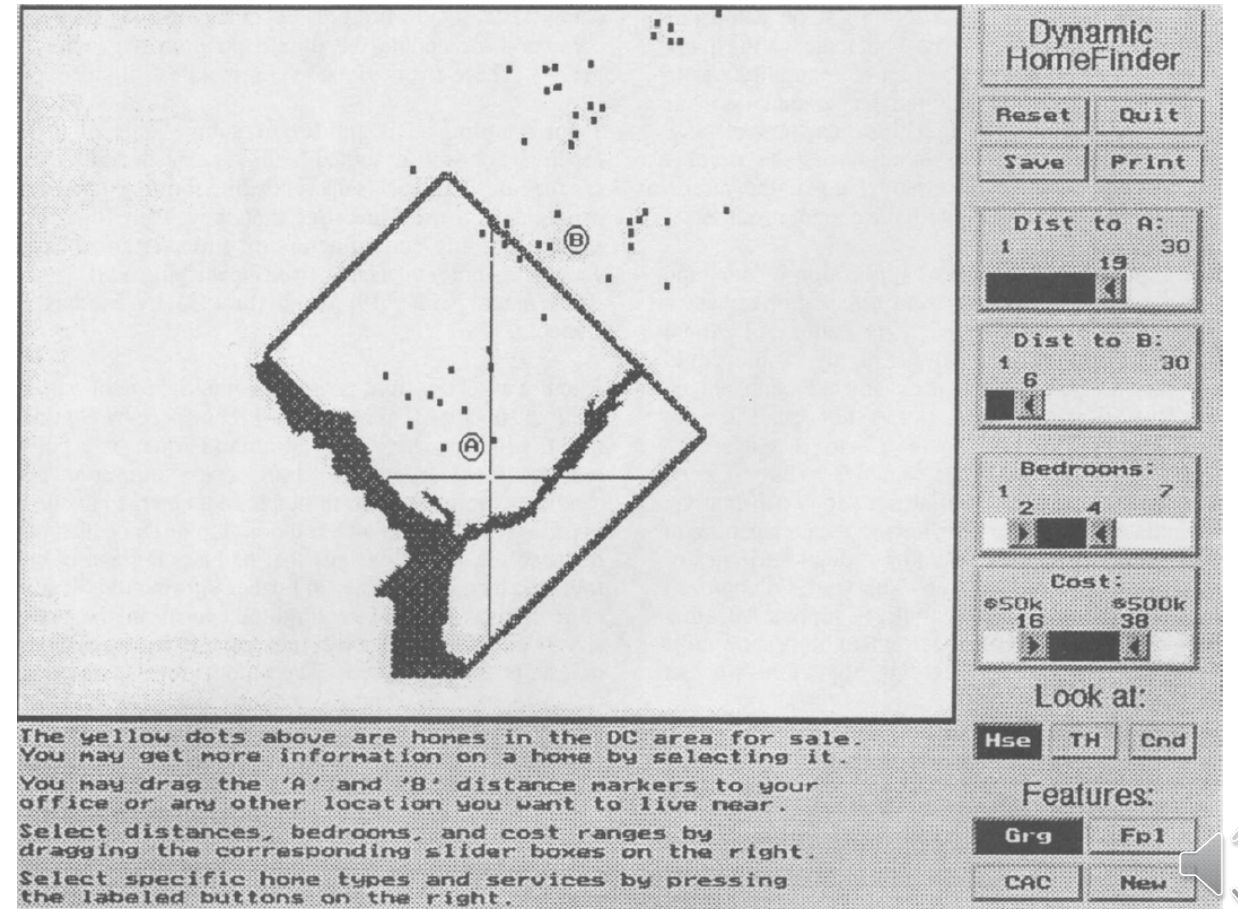
- 1920 x 1080 Resolution
- 75 Hz Refresh Rate
- 1ms Virtual Response Boost™
- AMD FreeSync
- VGA Cable Included



General Principles

- Amplify the user understanding of data

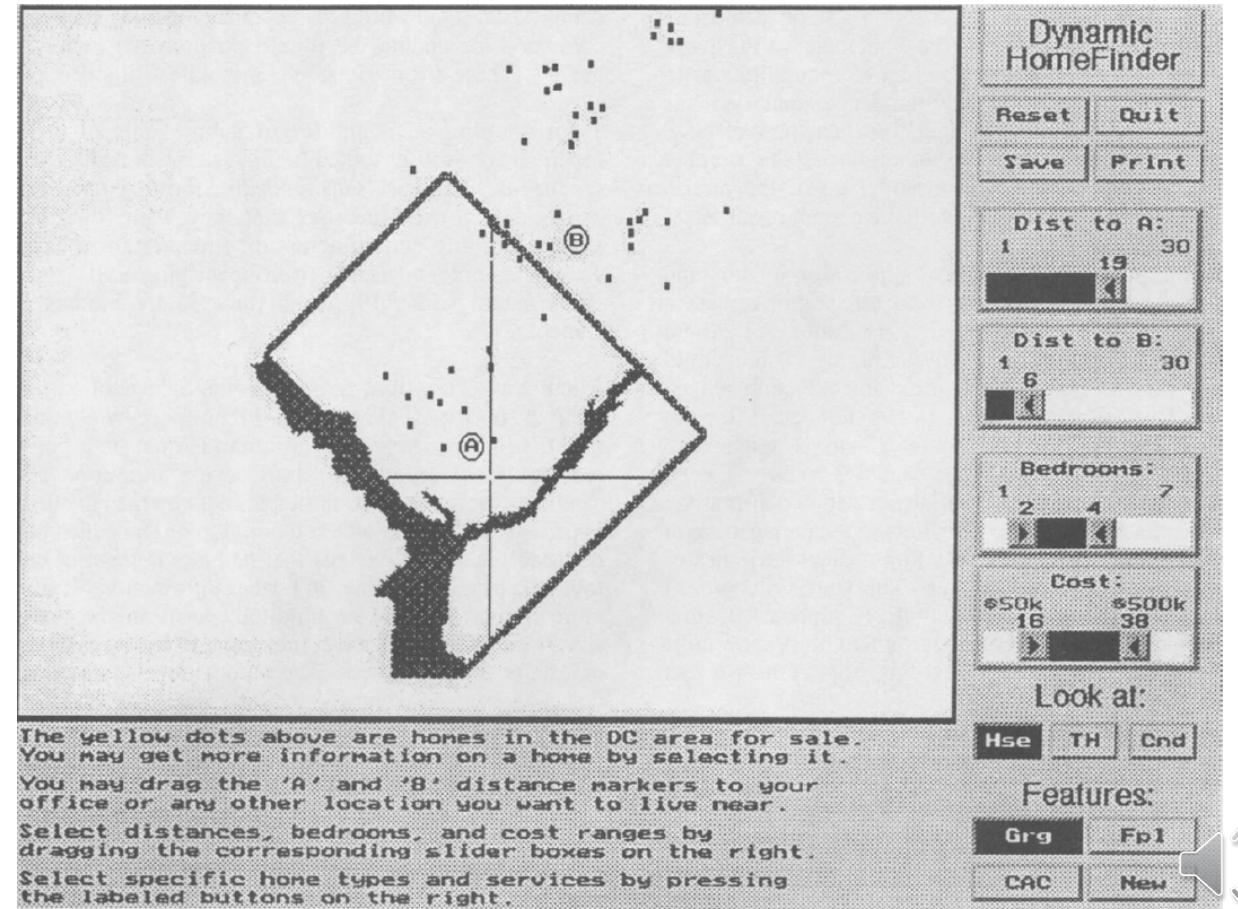
Provide more abstract view through omission and recoding of information



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

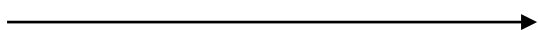
- Amplify the user understanding of data
- Design Choices
 - Spatial substrate
 - Marks
 - Connections and enclosures
 - Retinal properties
 - Temporal encoding



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

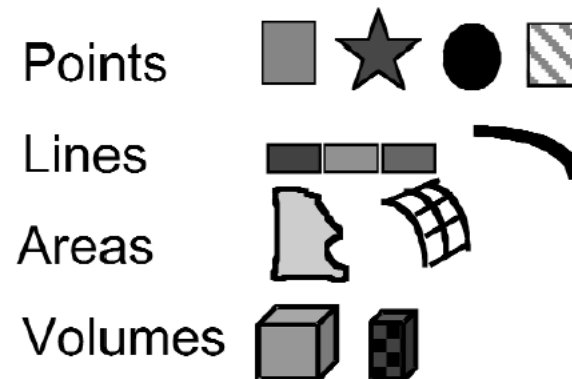
- Marks

- Connections and enclosures

- Retinal properties

- Temporal encoding

Visible things that happen in space that help a user in distinguishing between data items



General Principles






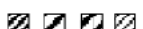

- Amplify the user understanding of data
 - Design steps
 - Spatial substrate
 - Marks
 - Connections and enclosures → Connections include graphs, trees, and other hierarchical organization
 - Retinal properties
 - Temporal encoding
- We can draw enclosures around certain nodes



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

	Spatial	Object
Extent	(Position) 	Gray Scale 
	Size 	
Differential	Orientation 	Color 
		Texture 
		Shape 

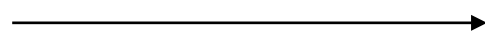


General Principles

- 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



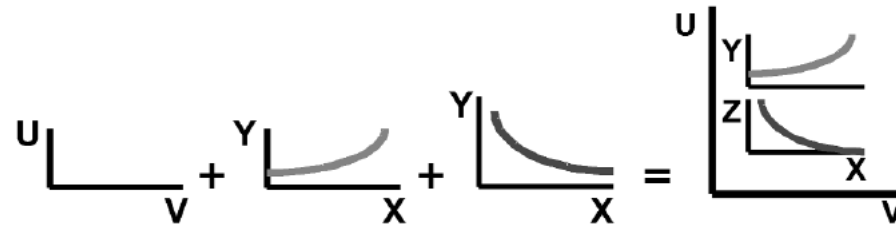
General Principles

- 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 \longrightarrow 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



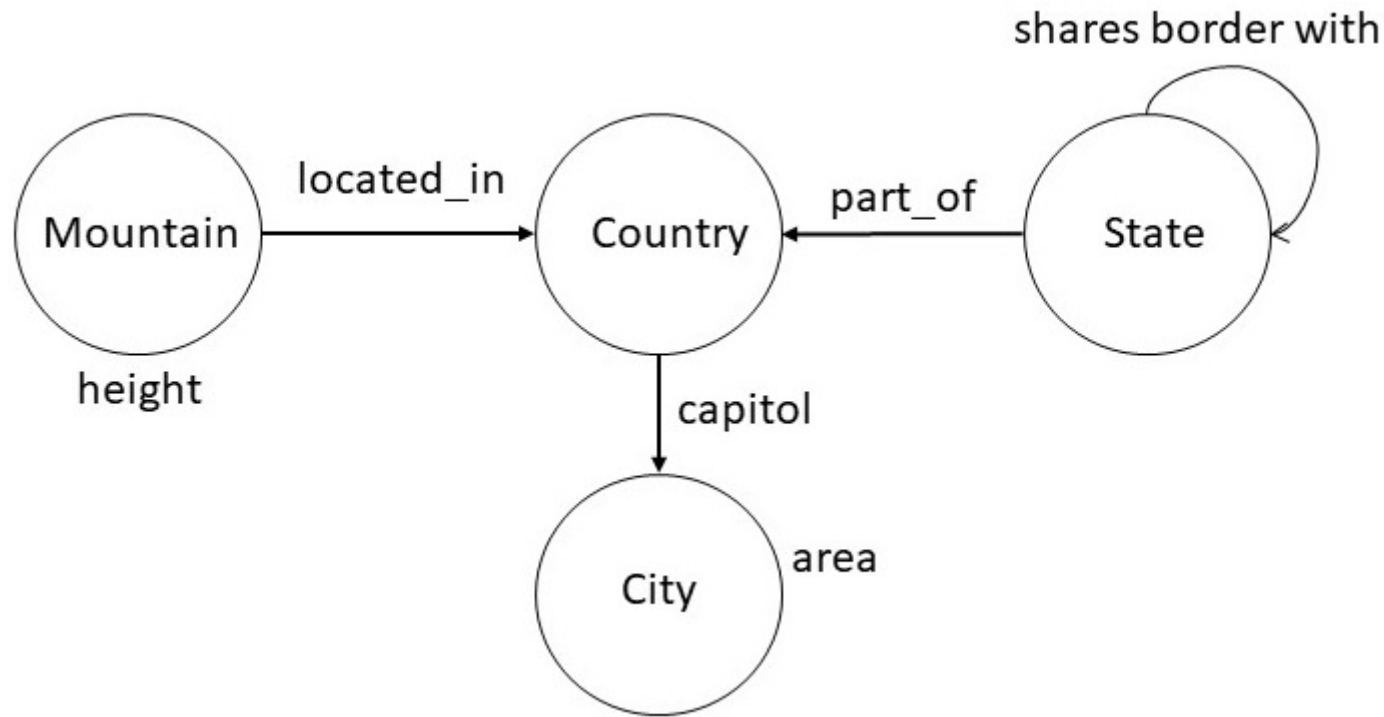
Structured Queries

- 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-constant> ::= "atleast" <quantity>

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

<unit> ::= "Square Kilometer"

<ranking> ::= "by"



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-constant> ::= "atleast" <quantity>

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

<unit> ::= "Square Kilometer"

<ranking> ::= "by"

city with the largest area

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



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-constant> ::= "atleast" <quantity>

top five cities by area

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

<unit> ::= "Square Kilometer"

<ranking> ::= "by"

<aggregate-modifier> <geographical-region> <ranking> <property>



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-constant> ::= "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-constant> <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 \longrightarrow a grammar is set of rules of the form $\alpha \Rightarrow \beta$

- Model

- Parser

- Learner

Maps input sentence to logical forms

$NP(x)$ with the largest $RelNP(r) \Rightarrow \operatorname{argmax}(1,1,x,r)$

top $NP(n)$ $NP(X)$ by the $RelNP(r) \Rightarrow \operatorname{argmax}(1,n,x,r)$

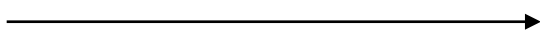
$NP(x)$ has $RelNP(r)$ at least $NP(n) \Rightarrow (< \operatorname{arg}(x,r) n)$



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
- Learner

→ Parser maintains a certain number of interpretations at each step


Computes the most likely interpretation



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

