Task abstraction

CS424: Visualization & Visual Analytics

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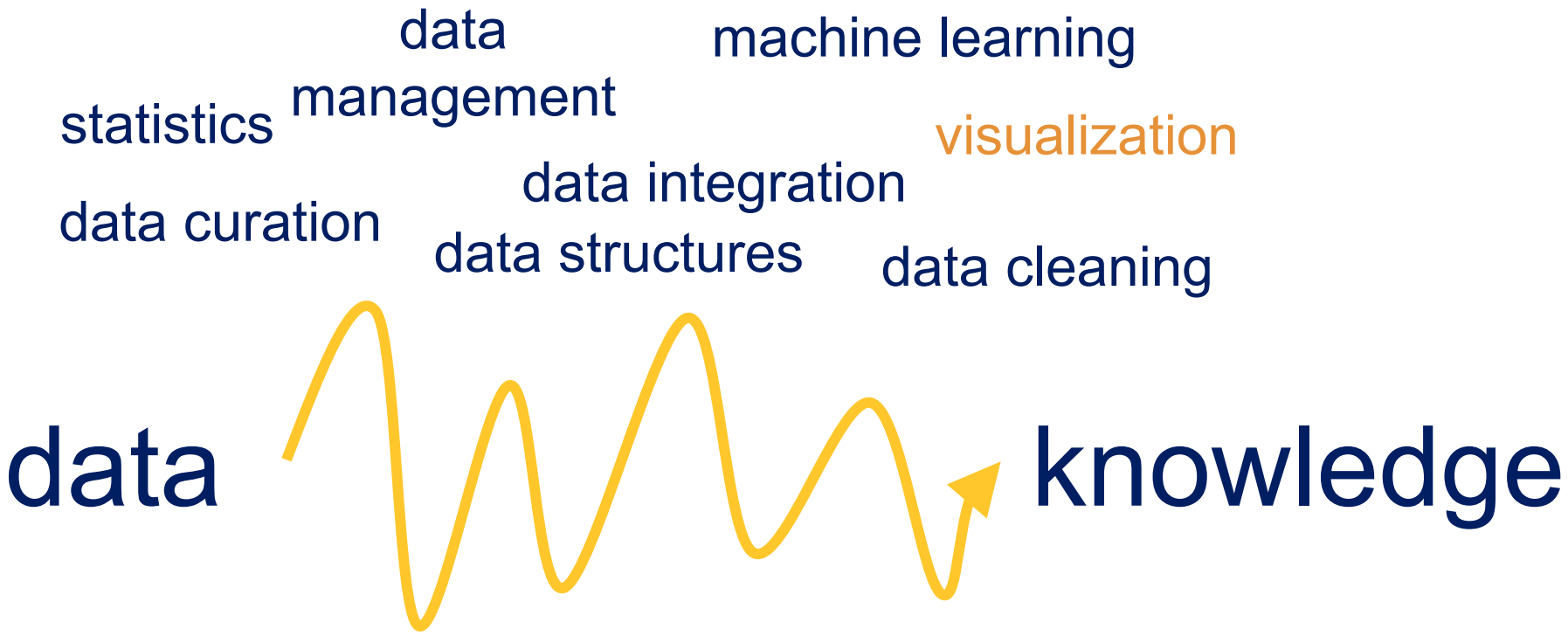
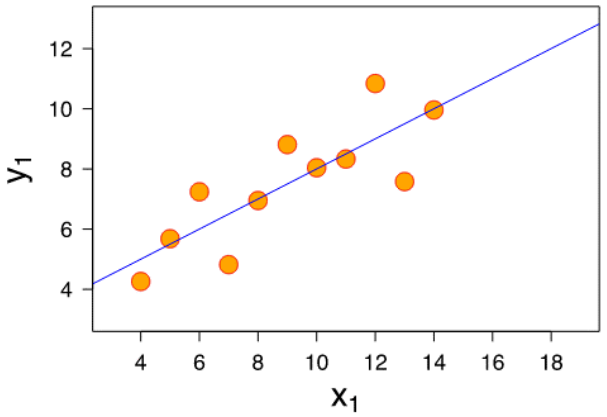
https://fmiranda.me

Data to knowledge

Data to knowledge



Data to knowledge



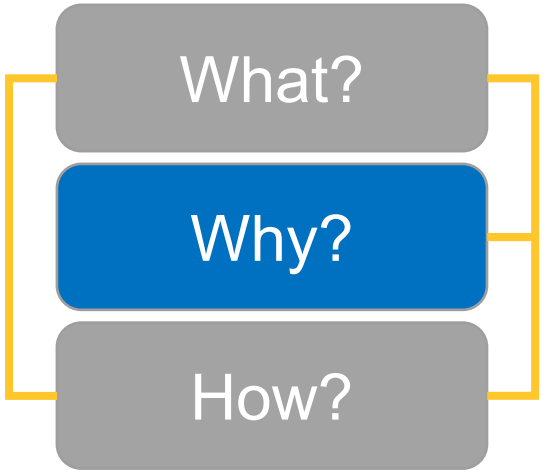
data

knowledge

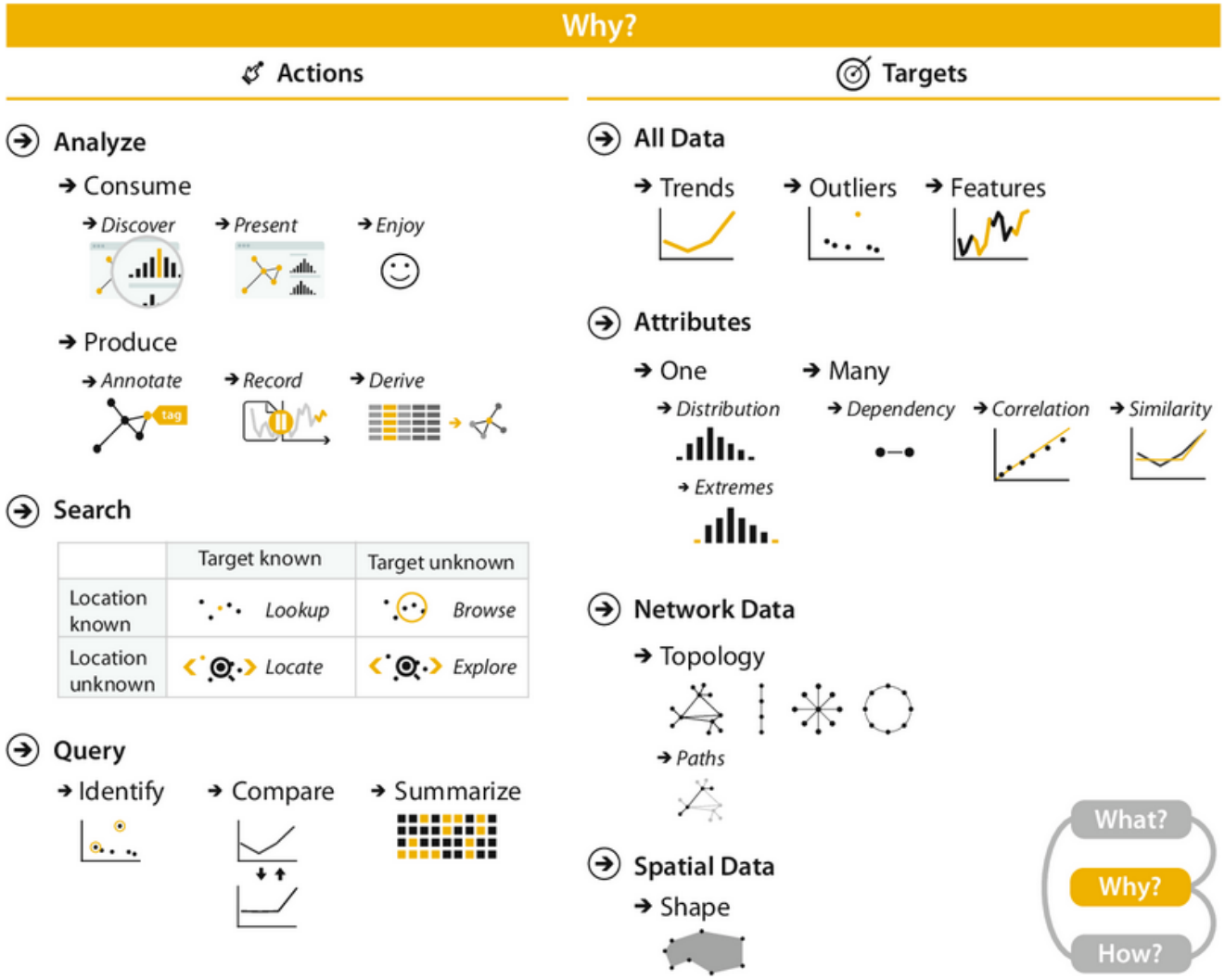
Transform data into visual marks

Task abstraction

- Analyzing tasks abstractly – rather than thinking of domain-specific tasks, think of abstract tasks.
- Domain-specific task: “contrast the prognosis of patients who were intubated in the ICU more than one month to patients hospitalized within the first week.”
- Abstract tasks: “compare values between two groups.”



Task abstraction



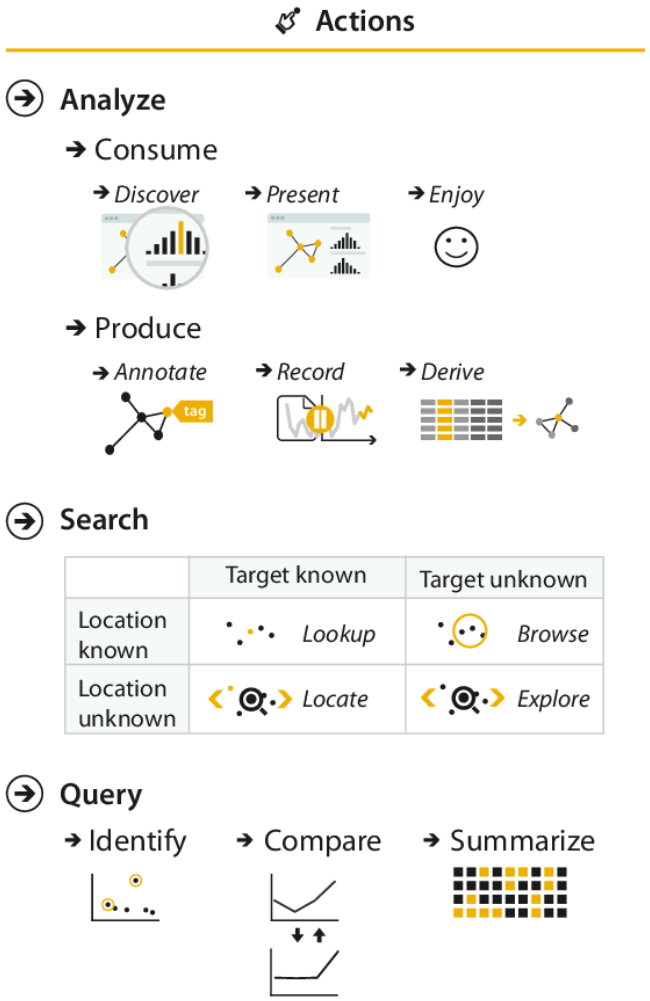
[Munzner, 2014]

Task = action + target

- Action verbs and target nouns
  - Action verbs:
    - Analyze
      - Consume
      - Produce
    - Search
      - Lookup, browse, locate, explore
    - Query
      - Identify, compare, summarize
  - Target nouns:
    - All data
      - Trends, outliers, features
    - Attributes
      - One
        - Distribution: extremes
      - Many
        - Dependency, correlation, similarity
    - Network data
    - Spatial data

Three levels of actions

- Analyze: high-level goals of the user
- Search: need to locate interesting items within the displayed data
- Query: different aspects of the extraction of information



Three levels of actions: Analyze

- Analyze: consume information already generated or produce new material for some purpose.
- Consume:
  - Discover: visualization to find new knowledge that was not previously known.
  - Present: help user communicate something known to someone.
  - Enjoy: casual interaction with a visualization.
- Produce:
  - Annotate: add graphical or textual annotations to pre-existing visualization.
  - Record: persist visualization elements.
  - Derive: produce new data elements based on existing data elements (i.e., transformation).

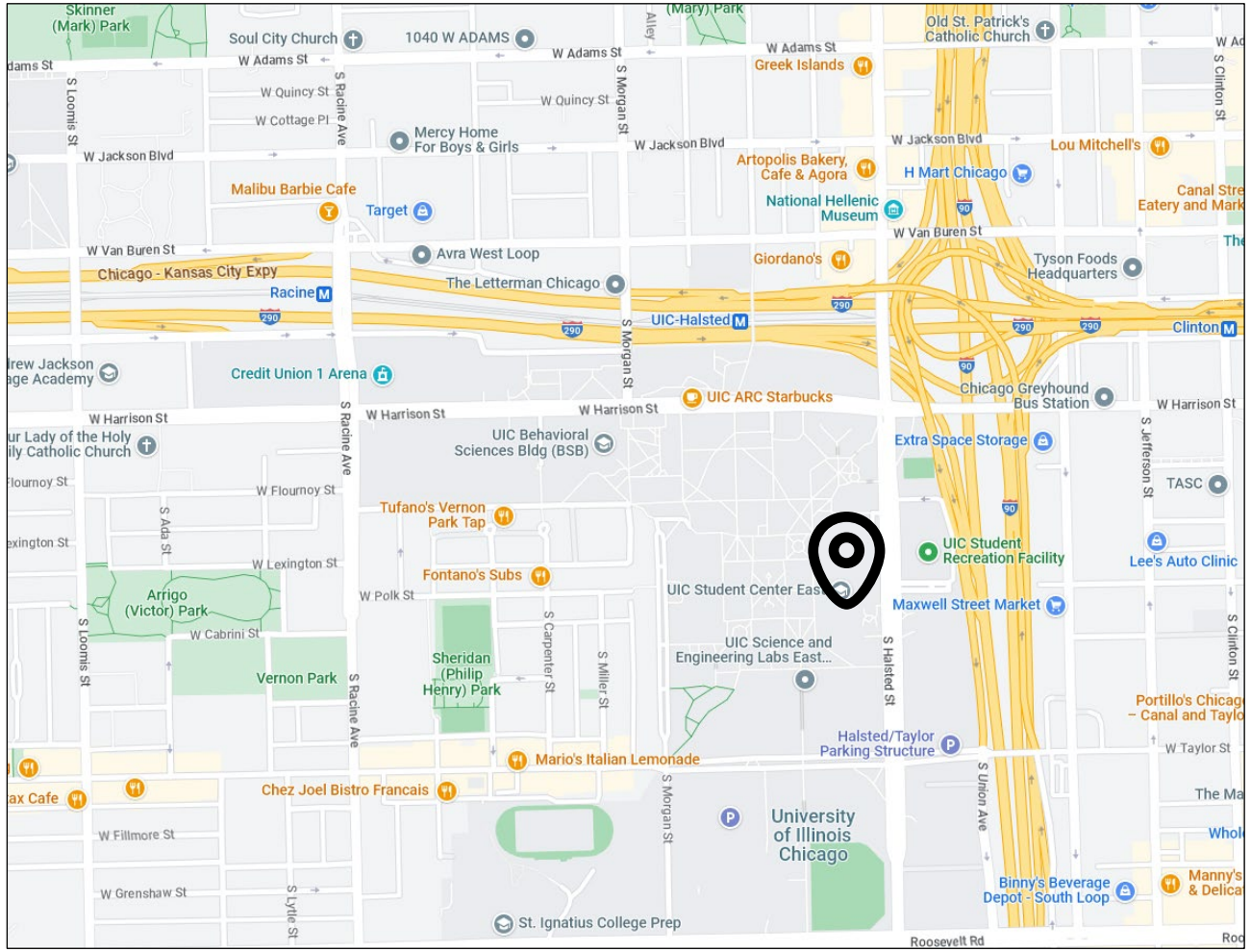
Three levels of actions: Search

- Each analyze goal requires the user to search for items of interest within the visualization.

	Location known	Location unknown
Target known	Lookup	Locate
Target unknown	Browse	Explore

Target: some aspect of the data that is of interest to the user.

Search example

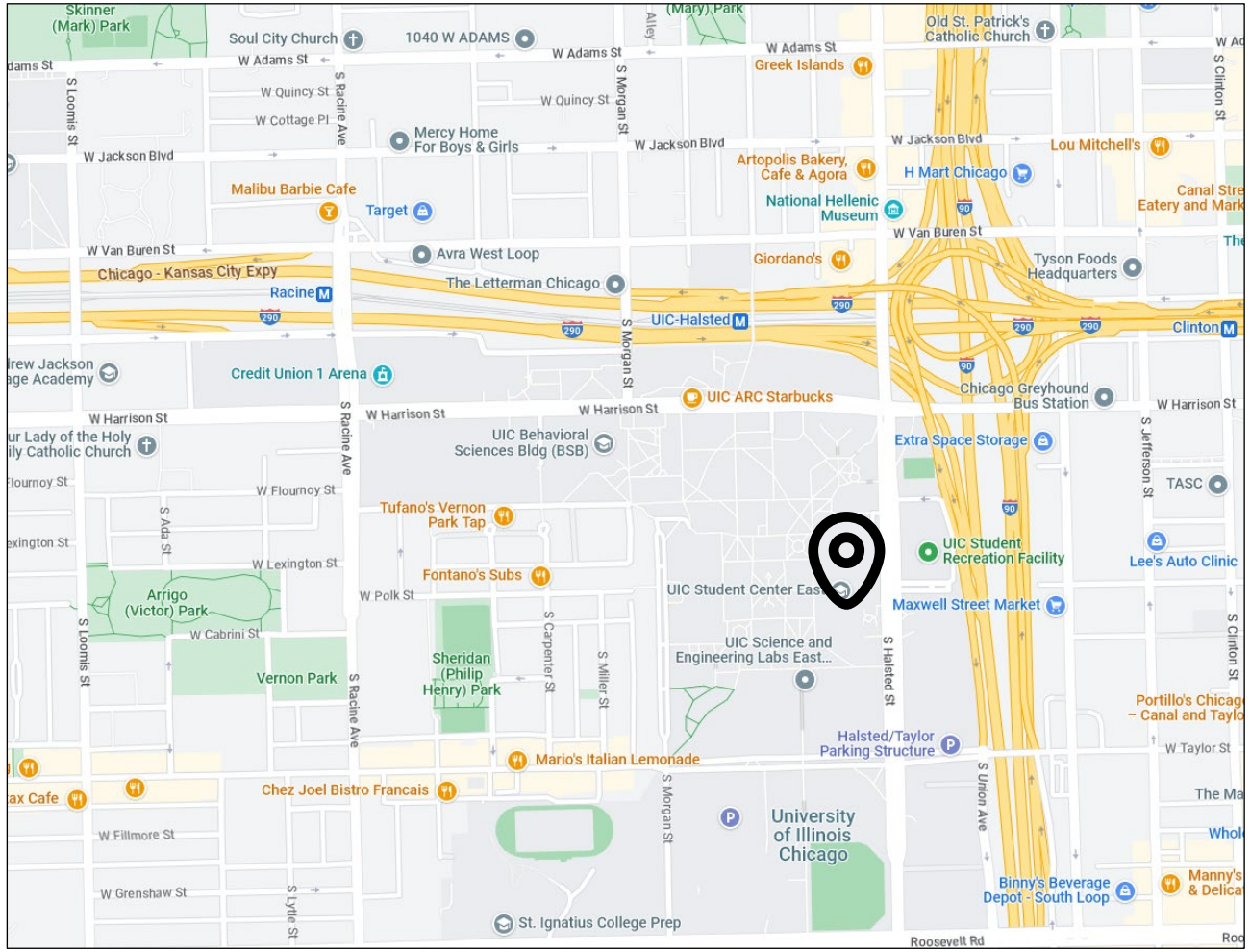


	Target known	Target unknown
Location known	Lookup	Browse
Location unknown	Locate	Explore

What is the address of ERF?

Example by Prof. Cody Dunne

Search example



	Target known	Target unknown
Location known	Lookup	Browse
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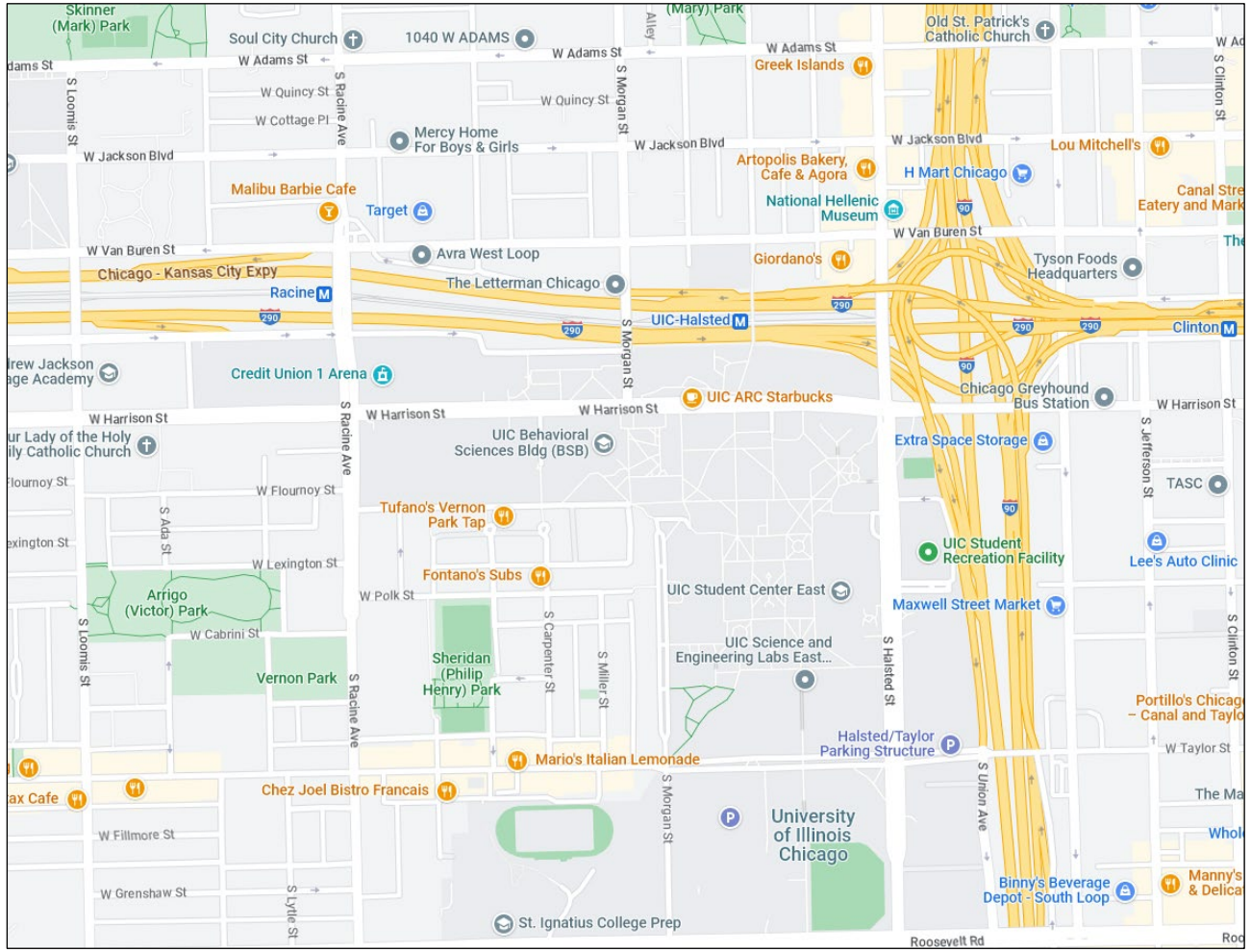
What is the address of ERF?

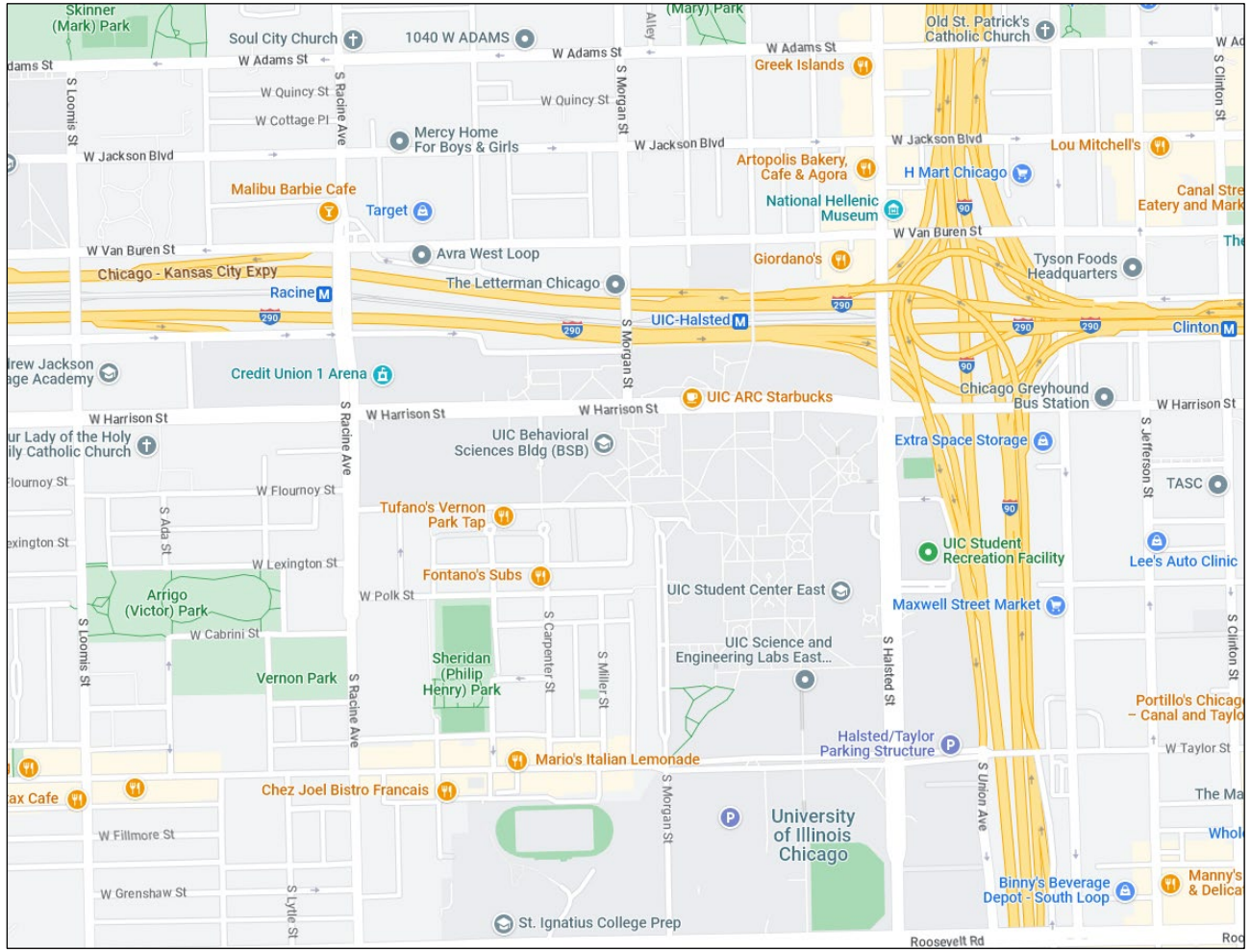
Search example



	Target known	Target unknown
Location known	Lookup	Browse
Location unknown	Locate	Explore

Where is ERF?

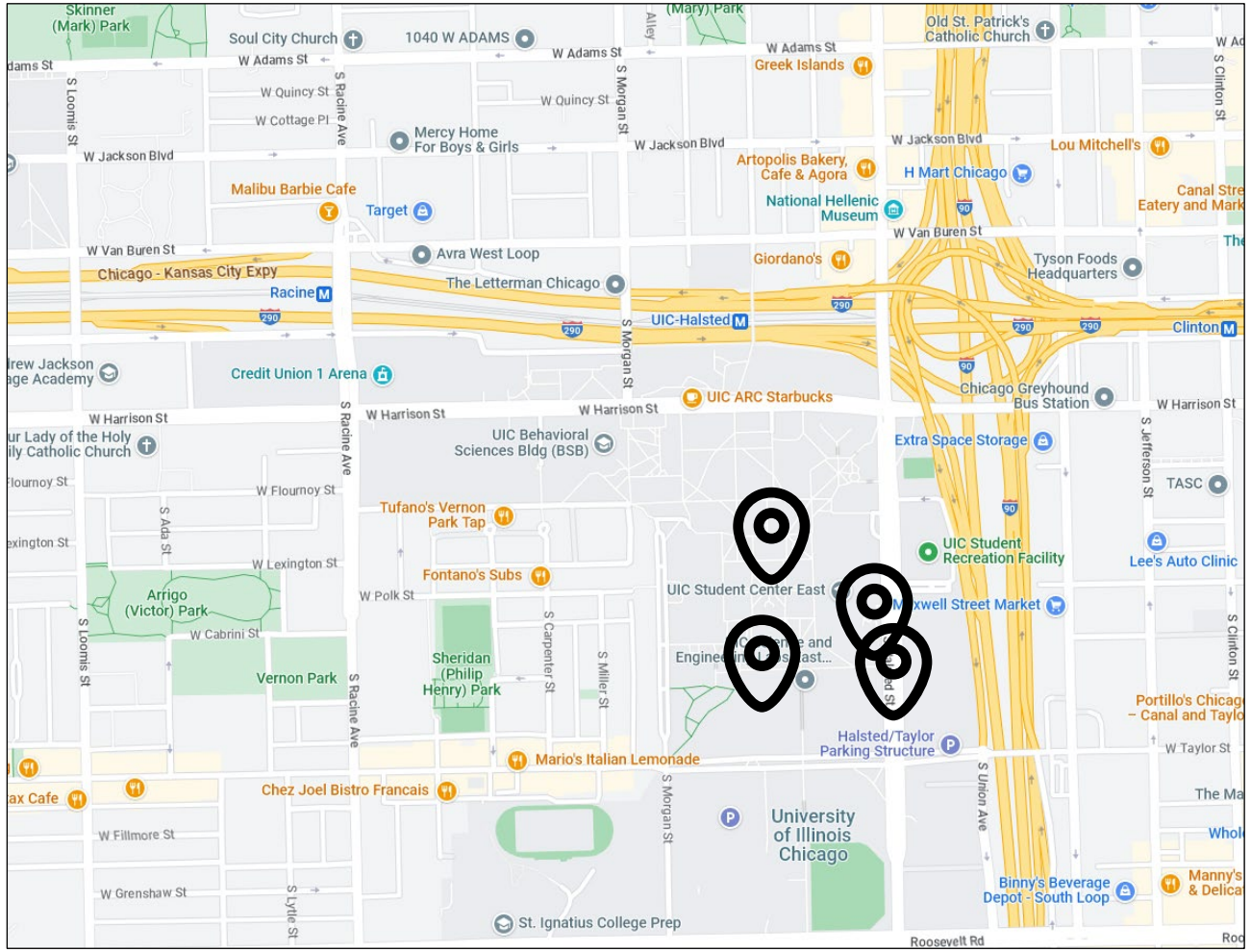
Search example



	Target known	Target unknown
Location known	Lookup	Browse
Location unknown	Locate	Explore

Where is ERF?

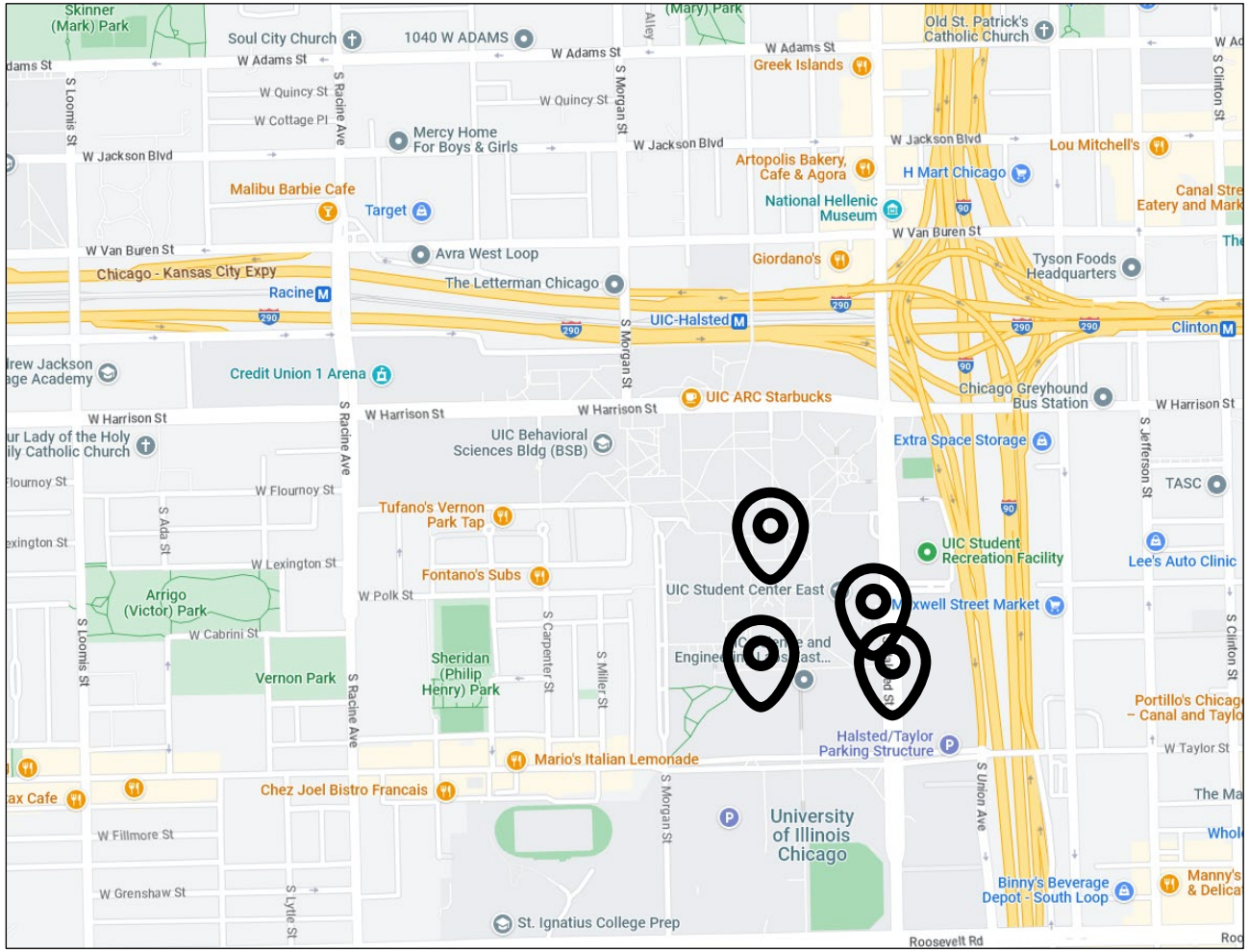
Search example



	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

What buildings are near ERF?

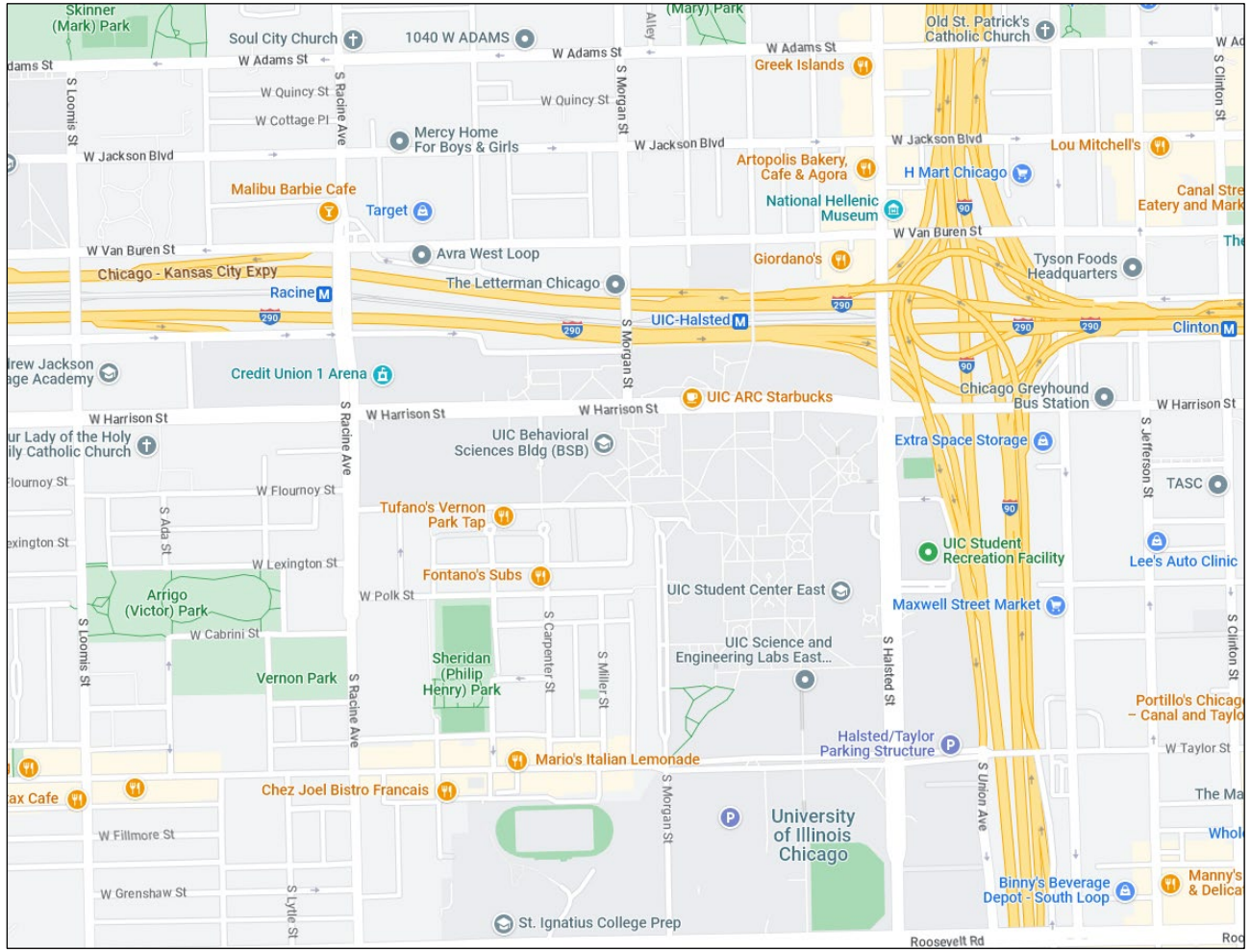
Search example



	Target known	Target unknown
Location known	Lookup	Browse
Location unknown	Locate	Explore

What buildings are near ERF?

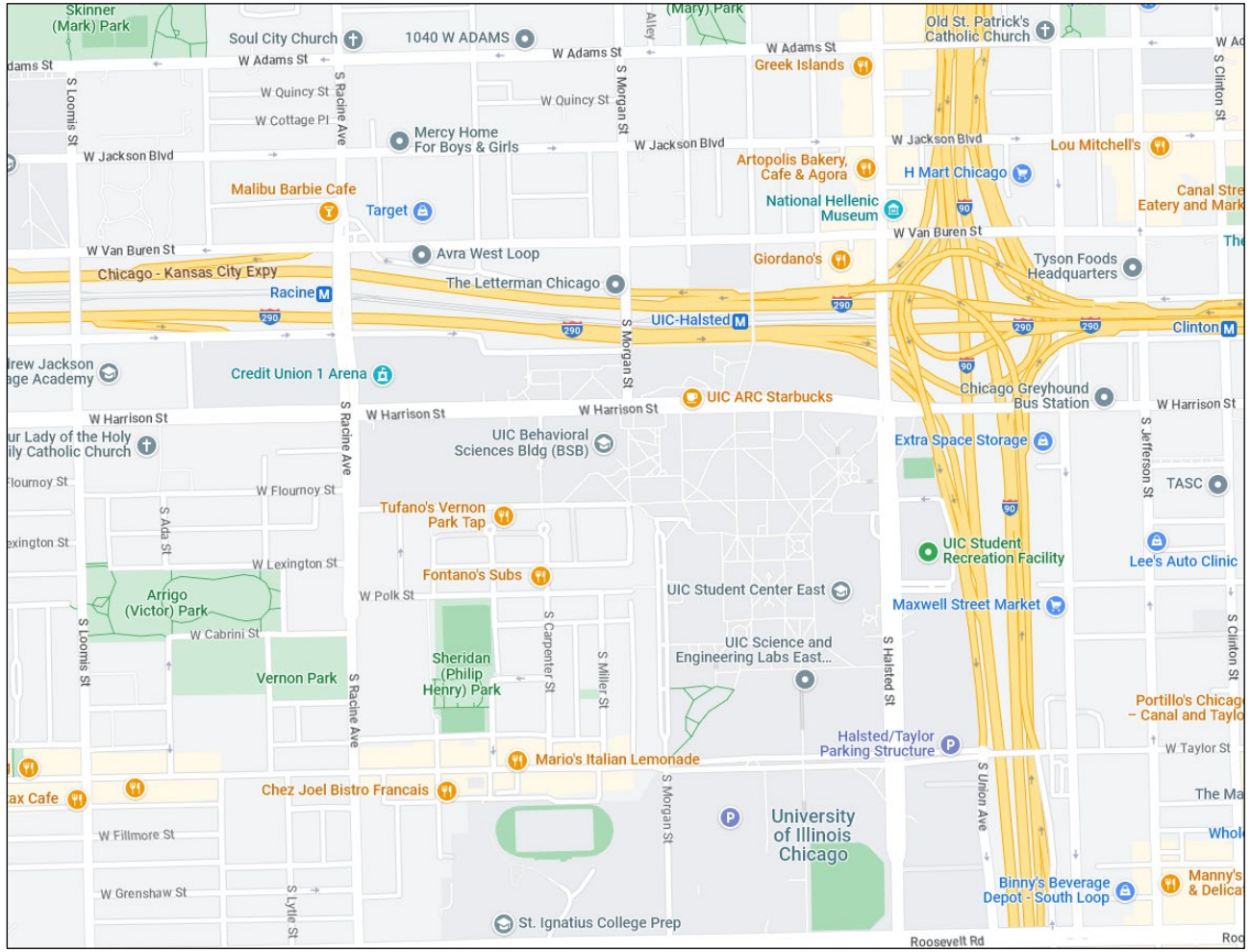
Search example



	Target known	Target unknown
Location known	Lookup	Browse
Location unknown	Locate	Explore

What is north of ERF?

Search example



	Target known	Target unknown
Location known	Lookup	Browse
Location unknown	Locate	Explore

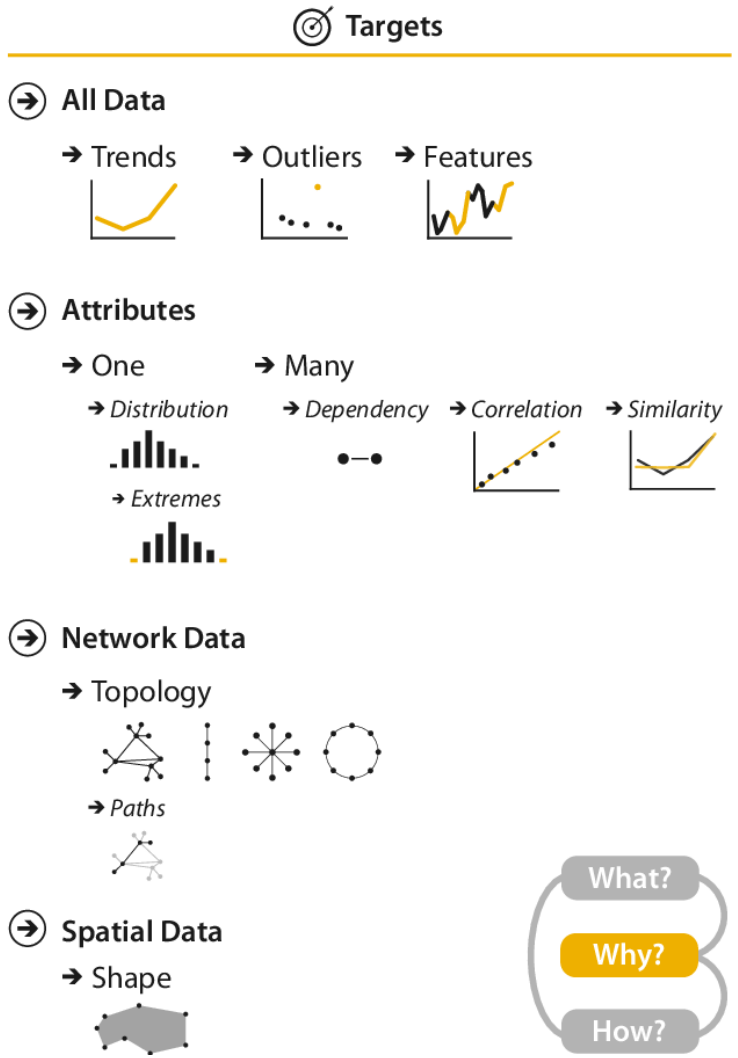
What is north of ERF?

Three levels of actions: Query

- Once items of interest have been found, user likely wants to extract some information from the visualization.
- Identify: extract characteristics or references from a single target.
- Compare: compare multiple targets to each other.
- Summarize: provide a comprehensive view of all the data (i.e., overview).

Targets

- Targets are the aspects of the data of interest to the user.
- Targets that apply to all data:
  - Trends (or patterns)
  - Outliers
  - Features
- If data carries attributes:
  - Single attribute (e.g., distribution, extremes)
  - Many (dependencies, correlation, similarity)



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  - Trends (or patterns)
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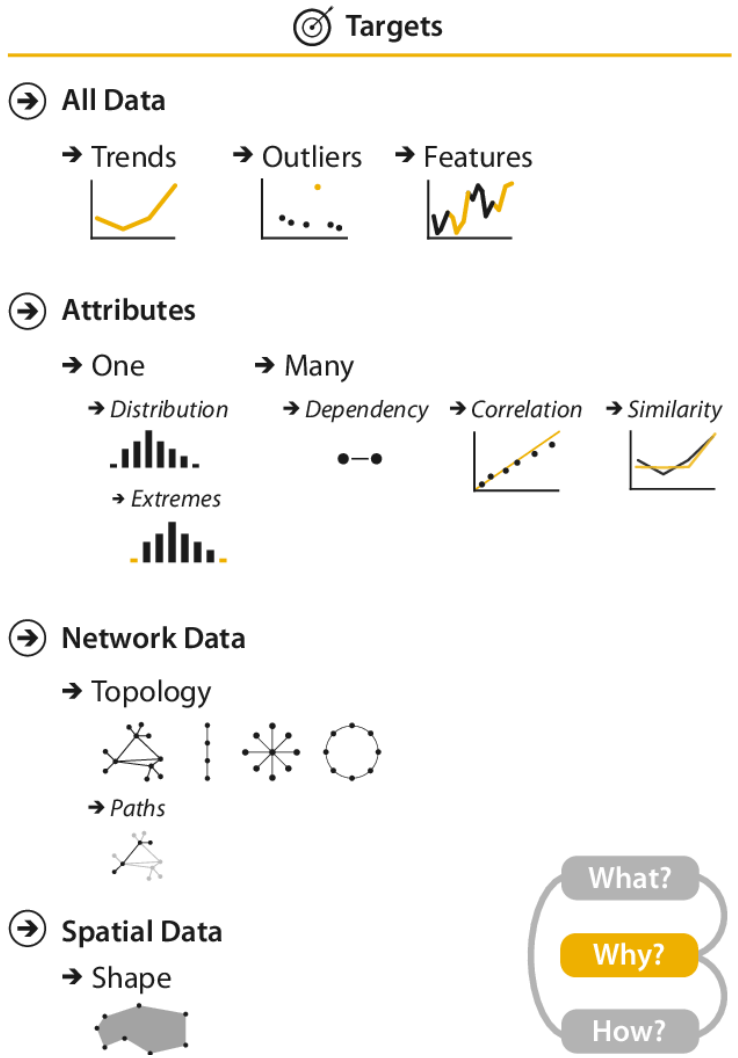
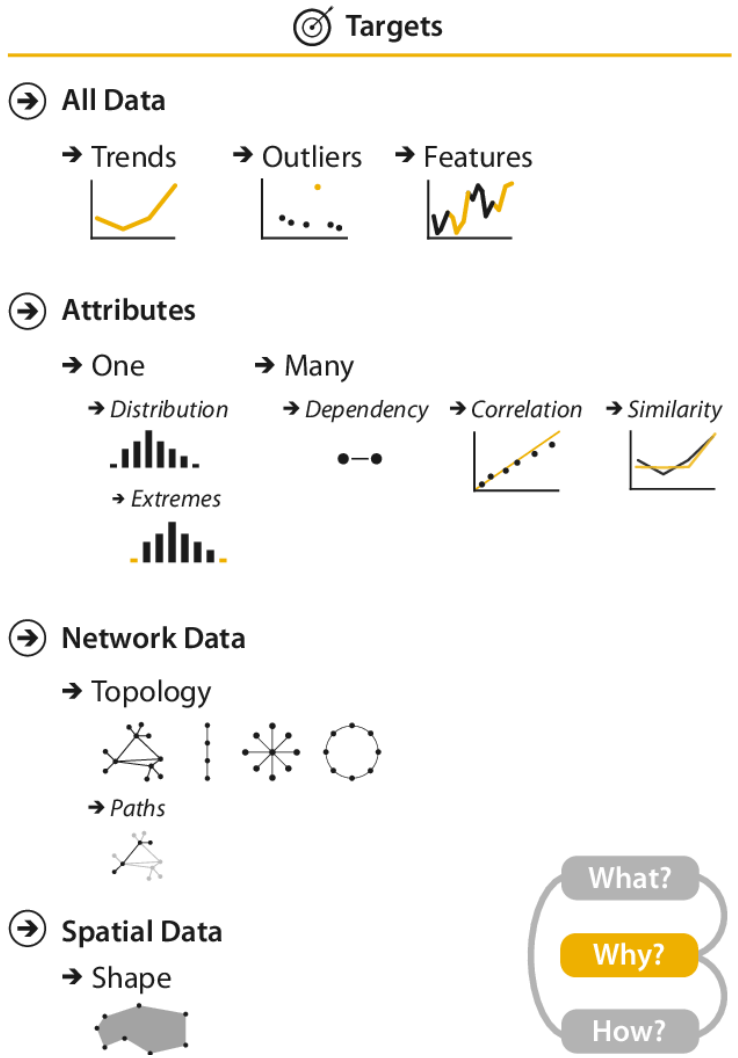
  - Single attribute (e.g., distribution, extremes)
  - Many (dependencies, correlation, similarity)



Targets (cont.)

- Domain target types:
- Network data: user may be interested in studying aspects of the topology (connection patterns) or analyzing paths through the topology.
- Spatial data: user interaction with spatial data may be interesting in studying shapes.



Task abstraction exercise

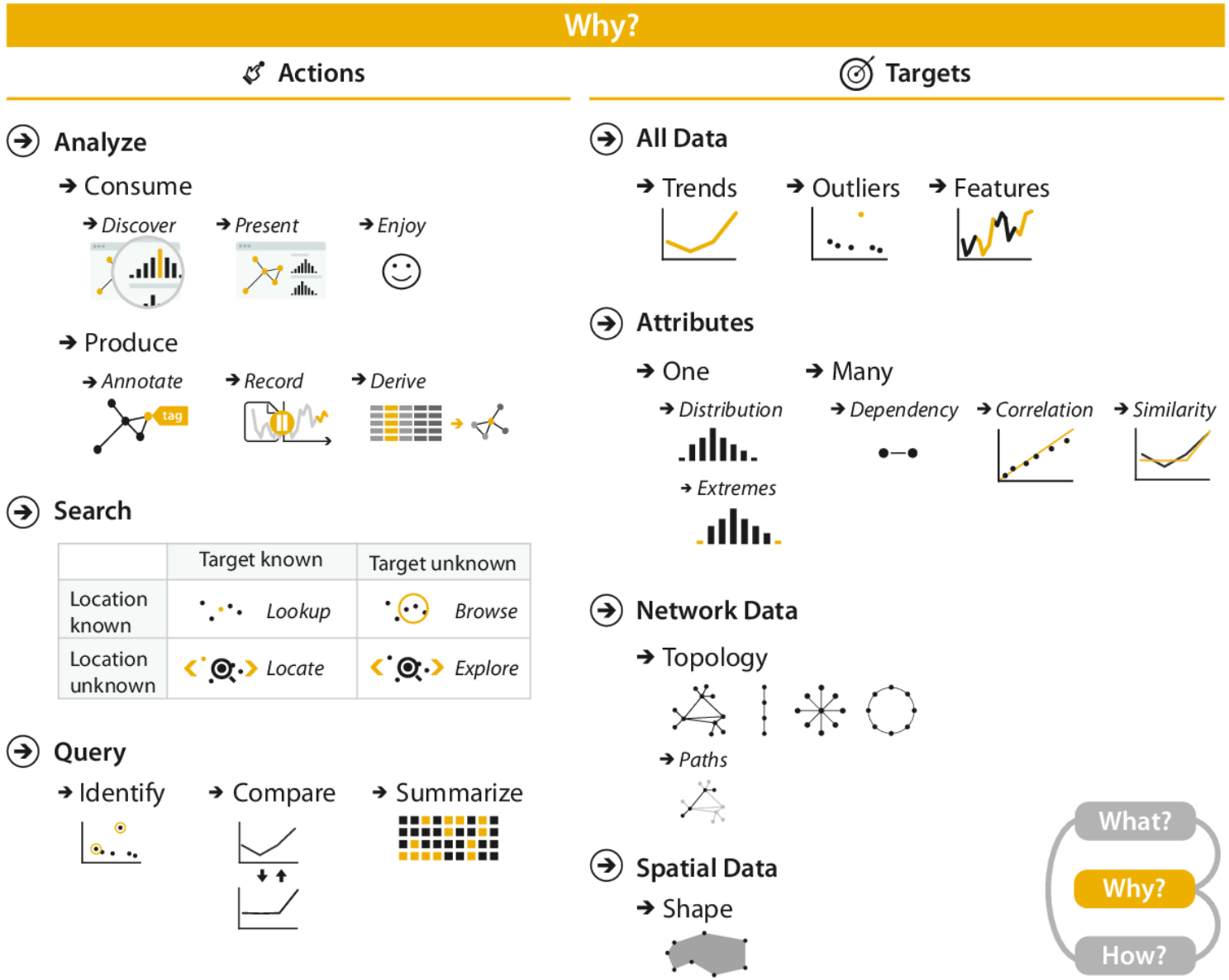
Visualization:

https://new.mta.info/document/59281

- Discuss 4 tasks that the map helps a user perform.
- Task: action + target

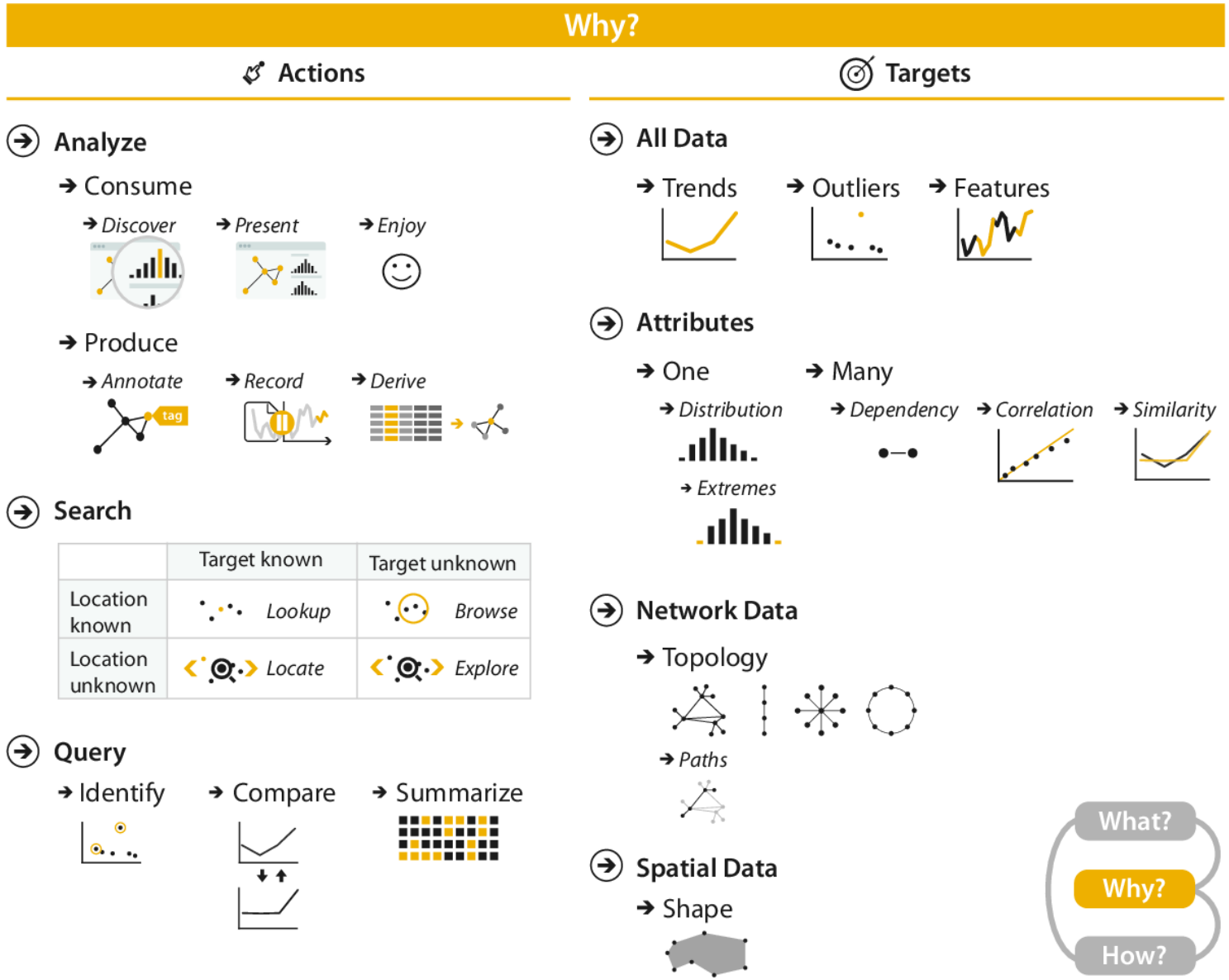
Task abstraction exercise

- *"Figuring out how to get from A to B"*
- *"Explaining to someone how to get from A to B"*
- *"Finding the nearest station"*

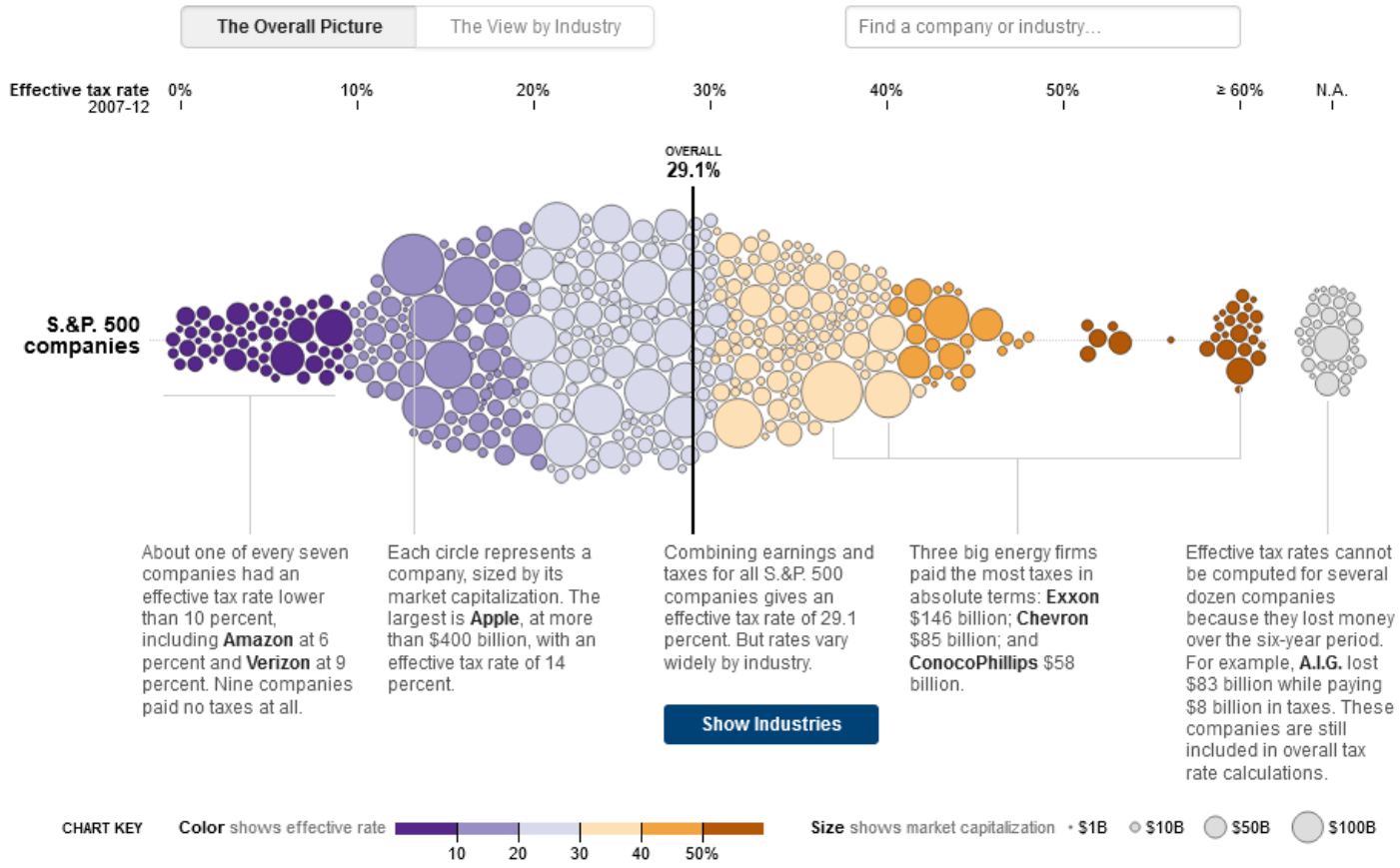


Task abstraction exercise

- *"Figuring out how to get from A to B"*
  - Action: Discover, locate path, identify
  - Target: Path (network data)
- *"Explaining to someone how to get from A to B"*
  - Action: Present
  - Target: Path (network data)
- *"Finding the nearest station"*
  - Action: Locate (target known, location unknown)
  - Target: Single attribute

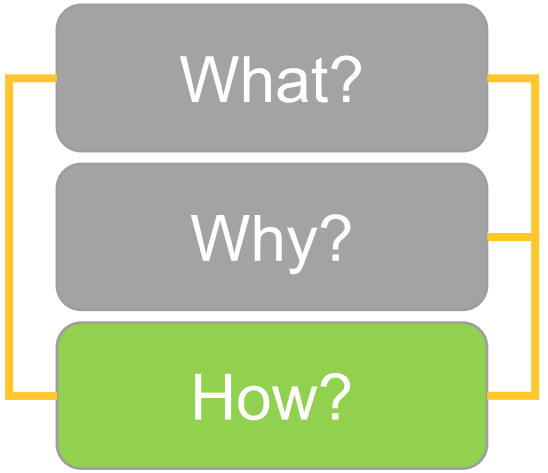


Task abstraction exercise



How to design vis idioms

- How a vis idiom can be constructed out of a set of design choices?
  - Encode
  - Manipulate: change, select, navigate
  - Facet: coordinate multiple views
  - Reduce: filter, aggregate



Big data example

Distribution of NYC Taxi Pickups and Dropoffs in Midtown Manhattan

Big data example

VendorID	tpep_pickup_datetime	tpep_dropoff_datetime	passenger_count	trip_distance	RatecodeID	store_and_f	PULocationID	DOLocationID	payment_	fare_amo	extra	mta_tax	tip_amou	tolls_amo	improvem	total_amount
1	1/1/2018 0:21	1/1/2018 0:24	1	0.5	1	N	41	24	2	4.5	0.5	0.5	0	0	0.3	5.8
1	1/1/2018 0:44	1/1/2018 1:03	1	2.7	1	N	239	140	2	14	0.5	0.5	0	0	0.3	15.3
1	1/1/2018 0:08	1/1/2018 0:14	2	0.8	1	N	262	141	1	6	0.5	0.5	1	0	0.3	8.3
1	1/1/2018 0:20	1/1/2018 0:52	1	10.2	1	N	140	257	2	33.5	0.5	0.5	0	0	0.3	34.8
1	1/1/2018 0:09	1/1/2018 0:27	2	2.5	1	N	246	239	1	12.5	0.5	0.5	2.75	0	0.3	16.55
1	1/1/2018 0:29	1/1/2018 0:32	3	0.5	1	N	143	143	2	4.5	0.5	0.5	0	0	0.3	5.8
1	1/1/2018 0:38	1/1/2018 0:48	2	1.7	1	N	50	239	1	9	0.5	0.5	2.05	0	0.3	12.35
1	1/1/2018 0:49	1/1/2018 0:51	1	0.7	1	N	239	238	1	4	0.5	0.5	1	0	0.3	6.3
1	1/1/2018 0:56	1/1/2018 1:01	1	1	1	N	238	24	1	5.5	0.5	0.5	1.7	0	0.3	8.5
1	1/1/2018 0:17	1/1/2018 0:22	1	0.7	1	N	170	170	2	5.5	0.5	0.5	0	0	0.3	6.8
1	1/1/2018 0:41	1/1/2018 0:46	1	0.6	1	N	162	229	1	5.5	0.5	0.5	1.35	0	0.3	8.15

Data transformation

- Filter the data:
  - Only rows within Manhattan.
  - Only rows inside certain blocks of Manhattan.
- Merge data with other data:
  - Traffic accidents within 100 meters and 1 hour of pickup and dropoff.
- Aggregate the data:
  - Number of pickups in each hour.
  - Number of pickups in each day of the week..

Data transformation

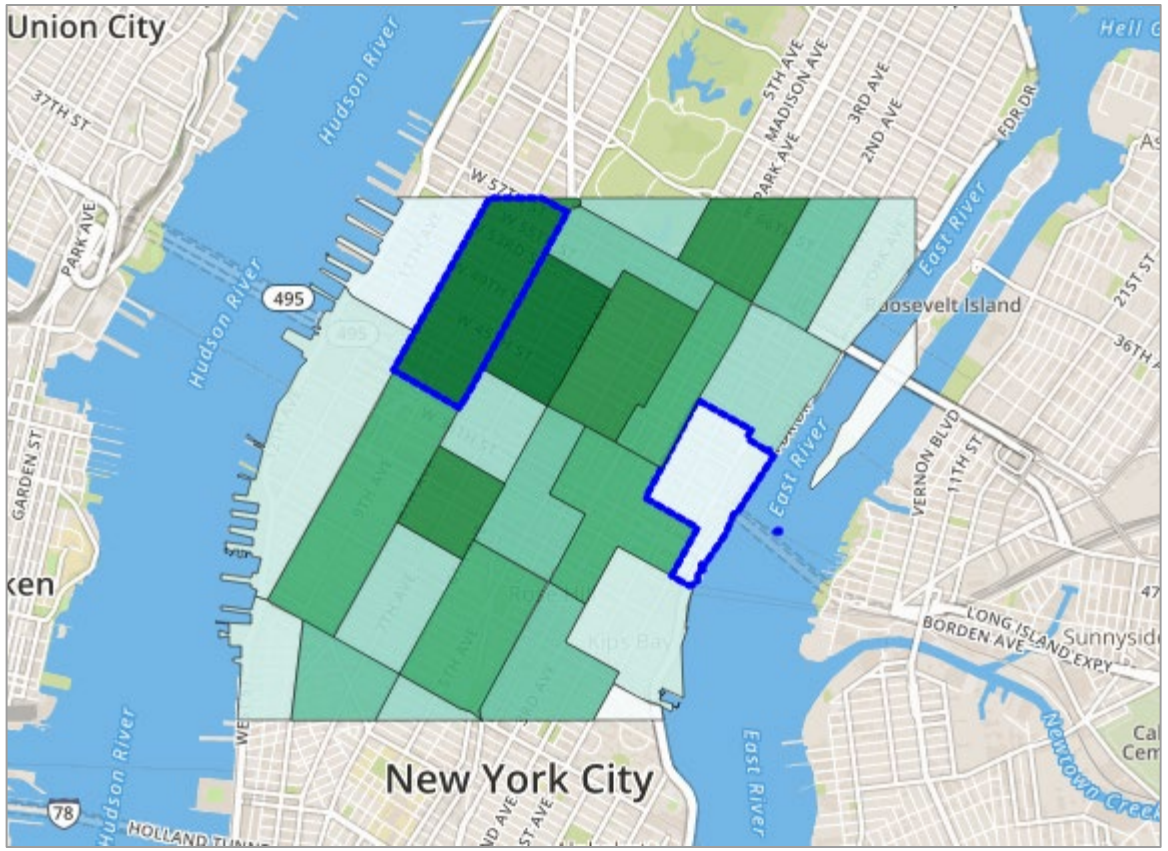
VendorID	tpep_pickup_datetime	tpep_dropoff_datetime	passenger_count	trip_distance	RatecodeID	store_and_f	PULocationID	DOLocationI	payment_	fare_amo	extra	mta_tax	tip_amou	tolls_amo	improven	total_amount
1	1/1/2018 0:21	1/1/2018 0:24	1	0.5	1	N	41	24	2	4.5	0.5	0.5	0	0	0.3	5.8
1	1/1/2018 0:44	1/1/2018 1:03	1	2.7	1	N	239	140	2	14	0.5	0.5	0	0	0.3	15.3
1	1/1/2018 0:08	1/1/2018 0:14	2	0.8	1	N	262	141	1	6	0.5	0.5	1	0	0.3	8.3
1	1/1/2018 0:20	1/1/2018 0:52	1	10.2	1	N	140	257	2	33.5	0.5	0.5	0	0	0.3	34.8
1	1/1/2018 0:09	1/1/2018 0:27	2	2.5	1	N	246	239	1	12.5	0.5	0.5	2.75	0	0.3	16.55
1	1/1/2018 0:29	1/1/2018 0:32	3	0.5	1	N	143	143	2	4.5	0.5	0.5	0	0	0.3	5.8
1	1/1/2018 0:38	1/1/2018 0:48	2	1.7	1	N	50	239	1	9	0.5	0.5	2.05	0	0.3	12.35
1	1/1/2018 0:49	1/1/2018 0:51	1	0.7	1	N	239	238	1	4	0.5	0.5	1	0	0.3	6.3
1	1/1/2018 0:56	1/1/2018 1:01	1	1	1	N	238	24	1	5.5	0.5	0.5	1.7	0	0.3	8.5
1	1/1/2018 0:17	1/1/2018 0:22	1	0.7	1	N	170	170	2	5.5	0.5	0.5	0	0	0.3	6.8
1	1/1/2018 0:41	1/1/2018 0:46	1	0.6	1	N	162	229	1	5.5	0.5	0.5	1.35	0	0.3	8.15
1	1/1/2018 0:52	1/1/2018 1:17	1	3.5	1	N	141	113	2	16.5	0.5	0.5	0	0	0.3	17.8
2	1/1/2018 0:17	1/1/2018 0:22	1	1.04	1	N	137	224	2	5.5	0.5	0.5	0	0	0.3	6.8
2	1/1/2018 0:24	1/1/2018 0:34	1	1.22	1	N	224	79	2	7.5	0.5	0.5	0	0	0.3	8.8
2	1/1/2018 0:37	1/1/2018 0:53	1	1.92	1	N	234	100	2	10	0.5	0.5	0	0	0.3	11.3
1	1/1/2018 0:35	1/1/2018 0:52	1	5.7	1	N	13	189	1	19	0.5	0.5	4.05	0	0.3	24.35
2	1/1/2018 0:30	1/1/2018 1:13	1	3.74	1	N	48	236	1	25.5	0.5	0.5	6.7	0	0.3	33.5
1	1/1/2018 0:21	1/1/2018 0:25	2	0.6	1	N	163	162	1	4.5	0.5	0.5	1.7	0	0.3	7.5
1	1/1/2018 0:31	1/1/2018 1:07	1	10.9	1	N	229	61	2	35	0.5	0.5	0	0	0.3	36.3
2	1/1/2018 0:15	1/1/2018 0:21	5	1.22	1	N	236	75	2	6	0.5	0.5	0	0	0.3	7.3
2	1/1/2018 0:25	1/1/2018 0:45	5	3.13	1	N	263	143	2	13	0.5	0.5	0	0	0.3	14.3
2	1/1/2018 0:51	1/1/2018 1:04	5	2.22	1	N	239	24	2	9.5	0.5	0.5	0	0	0.3	10.8
2	1/1/2018 0:09	1/1/2018 0:30	1	2.93	1	N	90	233	1	14.5	0.5	0.5	2	0	0.3	17.8
2	1/1/2018 0:32	1/1/2018 0:58	1	3.52	1	N	233	125	2	18	0.5	0.5	0	0	0.3	19.3
1	1/1/2018 0:41	1/1/2018 0:54	4	3	1	N	161	146	1	12	0.5	0.5	2.65	0	0.3	15.95
2	1/1/2018 0:17	1/1/2018 0:21	5	0.25	1	N	234	234	2	4.5	0.5	0.5	0	0	0.3	5.8
2	1/1/2018 0:24	1/1/2018 0:46	5	3.31	1	N	234	143	1	16	0.5	0.5	3.46	0	0.3	20.76
2	1/1/2018 0:48	1/1/2018 0:51	5	0.57	1	N	142	239	1	4	0.5	0.5	1.06	0	0.3	6.36
1	1/1/2018 0:24	1/1/2018 0:31	2	0.7	1	N	170	162	2	6	0.5	0.5	0	0	0.3	7.3
1	1/1/2018 0:36	1/1/2018 0:43	1	1.8	1	N	233	263	2	7.5	0.5	0.5	0	0	0.3	8.8
1	1/1/2018 0:49	1/1/2018 0:57	2	1.2	1	N	236	237	2	7.5	0.5	0.5	0	0	0.3	8.8
1	1/1/2018 0:13	1/1/2018 0:23	1	2.7	1	N	142	166	1	10.5	0.5	0.5	2.35	0	0.3	14.15
1	1/1/2018 0:33	1/1/2018 1:18	2	4.3	1	N	238	249	2	27.5	0.5	0.5	0	0	0.3	28.8
2	1/1/2018 0:15	1/1/2018 0:22	1	0.89	1	N	151	238	2	5.5	0.5	0.5	0	0	0.3	6.8
2	1/1/2018 0:25	1/1/2018 0:29	1	0.49	1	N	238	238	1	4.5	0.5	0.5	1.45	0	0.3	7.25
2	1/1/2018 0:32	1/1/2018 0:36	2	0.8	1	N	238	151	1	5	0.5	0.5	1.26	0	0.3	7.56
2	1/1/2018 0:45	1/1/2018 0:58	1	2.09	1	N	238	143	1	11	0.5	0.5	2.46	0	0.3	14.76
2	1/1/2018 0:31	1/1/2018 0:45	1	2.32	1	N	186	231	1	11	0.5	0.5	3.08	0	0.3	15.38
2	1/1/2018 0:47	1/1/2018 1:26	1	9.49	1	N	231	116	1	35	0.5	0.5	9.08	0	0.3	45.38
1	1/1/2018 0:21	1/1/2018 0:28	2	2.5	1	N	141	145	1	9.5	0.5	0.5	2.7	0	0.3	13.5
1	1/1/2018 0:32	1/1/2018 0:47	1	4.6	1	N	145	263	1	15.5	0.5	0.5	4.2	0	0.3	21
1	1/1/2018 0:54	1/1/2018 1:03	1	3	1	N	141	146	2	10.5	0.5	0.5	0	0	0.3	11.8
1	1/1/2018 0:23	1/1/2018 0:52	1	7.3	1	N	90	82	1	26.5	0.5	0.5	1	5.76	0.3	34.56
1	1/1/2018 0:04	1/1/2018 0:15	1	1.3	1	N	144	234	1	9	0.5	0.5	2.05	0	0.3	12.35
1	1/1/2018 0:17	1/1/2018 0:41	1	0.8	1	N	234	164	2	14.5	0.5	0.5	0	0	0.3	15.8
1	1/1/2018 0:42	1/1/2018 0:44	1	0.1	1	N	164	164	2	3	0.5	0.5	0	0	0.3	4.3
1	1/1/2018 0:48	1/1/2018 0:55	2	0.2	1	N	164	164	1	6	0.5	0.5	1.45	0	0.3	8.75

Data transformation

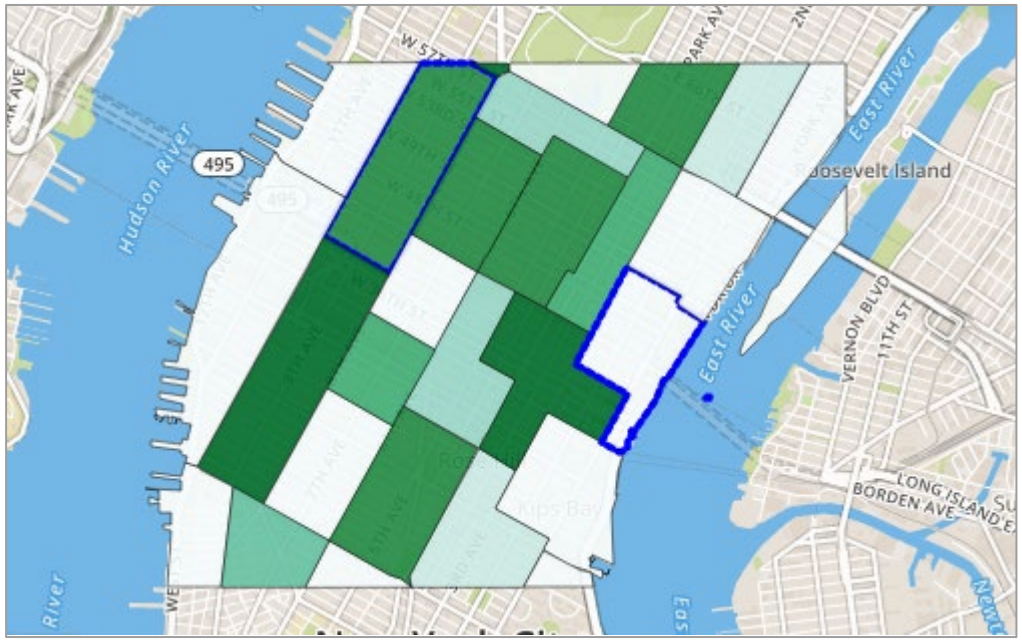
VendorID	tpep_pickup_datetime	tpep_dropoff_datetime	passenger_count	trip_distance	RatecodeID	store_and_f	PULocationID	DOLocationID	payment_	fare_amo	extra	mta_tax	tip_amou	tolls_amo	improvem	total_amount	Area
1	1/1/2018 0:21	1/1/2018 0:24	1	0.5	1	N	41	24	2	4.5	0.5	0.5	0	0	0.3	5.8	Midtown
1	1/1/2018 0:44	1/1/2018 1:03	1	2.7	1	N	239	140	2	14	0.5	0.5	0	0	0.3	15.3	Chelsea
1	1/1/2018 0:08	1/1/2018 0:14	2	0.8	1	N	262	141	1	6	0.5	0.5	1	0	0.3	8.3	Downtown
1	1/1/2018 0:20	1/1/2018 0:52	1	10.2	1	N	140	257	2	33.5	0.5	0.5	0	0	0.3	34.8	Downtown
1	1/1/2018 0:09	1/1/2018 0:27	2	2.5	1	N	246	239	1	12.5	0.5	0.5	2.75	0	0.3	16.55	Downtown
1	1/1/2018 0:29	1/1/2018 0:32	3	0.5	1	N	143	143	2	4.5	0.5	0.5	0	0	0.3	5.8	Midtown
1	1/1/2018 0:38	1/1/2018 0:48	2	1.7	1	N	50	239	1	9	0.5	0.5	2.05	0	0.3	12.35	Downtown
1	1/1/2018 0:49	1/1/2018 0:51	1	0.7	1	N	239	238	1	4	0.5	0.5	1	0	0.3	6.3	Downtown
1	1/1/2018 0:56	1/1/2018 1:01	1	1	1	N	238	24	1	5.5	0.5	0.5	1.7	0	0.3	8.5	Downtown
1	1/1/2018 0:17	1/1/2018 0:22	1	0.7	1	N	170	170	2	5.5	0.5	0.5	0	0	0.3	6.8	Downtown
1	1/1/2018 0:41	1/1/2018 0:46	1	0.6	1	N	162	229	1	5.5	0.5	0.5	1.35	0	0.3	8.15	Midtown
1	1/1/2018 0:52	1/1/2018 1:17	1	3.5	1	N	141	113	2	16.5	0.5	0.5	0	0	0.3	17.8	Downtown
2	1/1/2018 0:17	1/1/2018 0:22	1	1.04	1	N	137	224	2	5.5	0.5	0.5	0	0	0.3	6.8	Downtown
2	1/1/2018 0:24	1/1/2018 0:34	1	1.22	1	N	224	79	2	7.5	0.5	0.5	0	0	0.3	8.8	Downtown
2	1/1/2018 0:37	1/1/2018 0:53	1	1.92	1	N	234	100	2	10	0.5	0.5	0	0	0.3	11.3	Downtown
1	1/1/2018 0:35	1/1/2018 0:52	1	5.7	1	N	13	189	1	19	0.5	0.5	4.05	0	0.3	24.35	Downtown
2	1/1/2018 0:30	1/1/2018 1:13	1	3.74	1	N	48	236	1	25.5	0.5	0.5	6.7	0	0.3	33.5	Downtown
1	1/1/2018 0:21	1/1/2018 0:25	2	0.6	1	N	163	162	1	4.5	0.5	0.5	1.7	0	0.3	7.5	Midtown
1	1/1/2018 0:31	1/1/2018 1:07	1	10.9	1	N	229	61	2	35	0.5	0.5	0	0	0.3	36.3	Midtown
2	1/1/2018 0:15	1/1/2018 0:21	5	1.22	1	N	236	75	2	6	0.5	0.5	0	0	0.3	7.3	Midtown
2	1/1/2018 0:25	1/1/2018 0:45	5	3.13	1	N	263	143	2	13	0.5	0.5	0	0	0.3	14.3	Midtown
2	1/1/2018 0:51	1/1/2018 1:04	5	2.22	1	N	239	24	2	9.5	0.5	0.5	0	0	0.3	10.8	Midtown
2	1/1/2018 0:09	1/1/2018 0:30	1	2.93	1	N	90	233	1	14.5	0.5	0.5	2	0	0.3	17.8	Midtown
2	1/1/2018 0:32	1/1/2018 0:58	1	3.52	1	N	233	125	2	18	0.5	0.5	0	0	0.3	19.3	Midtown

Visual mapping

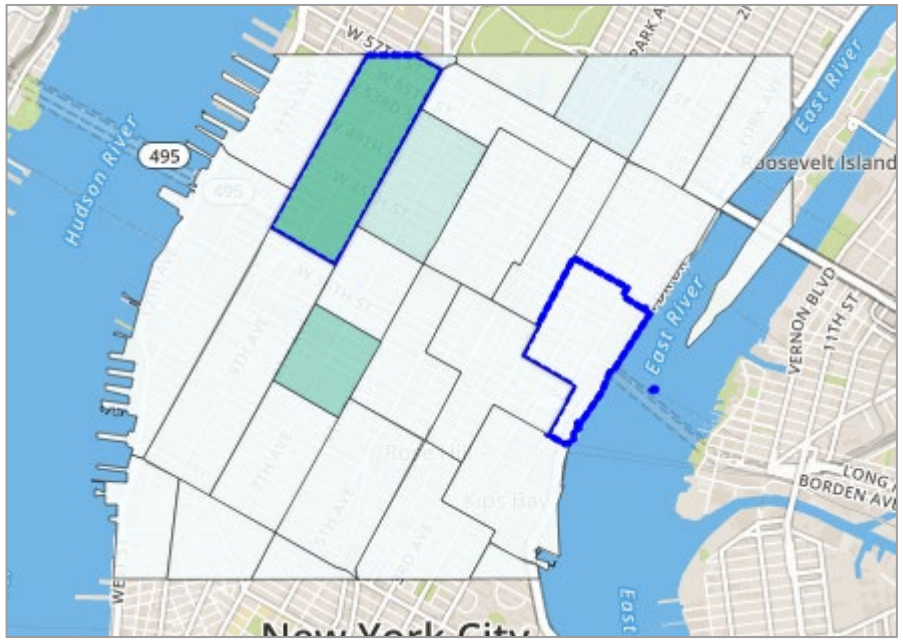
Quantitative data
Mark: polygon areas
Channel: color



Visual interaction



12pm– 2pm pickups



6am pickups