Adaptive Routing

Generating route instructions with varying levels of detail

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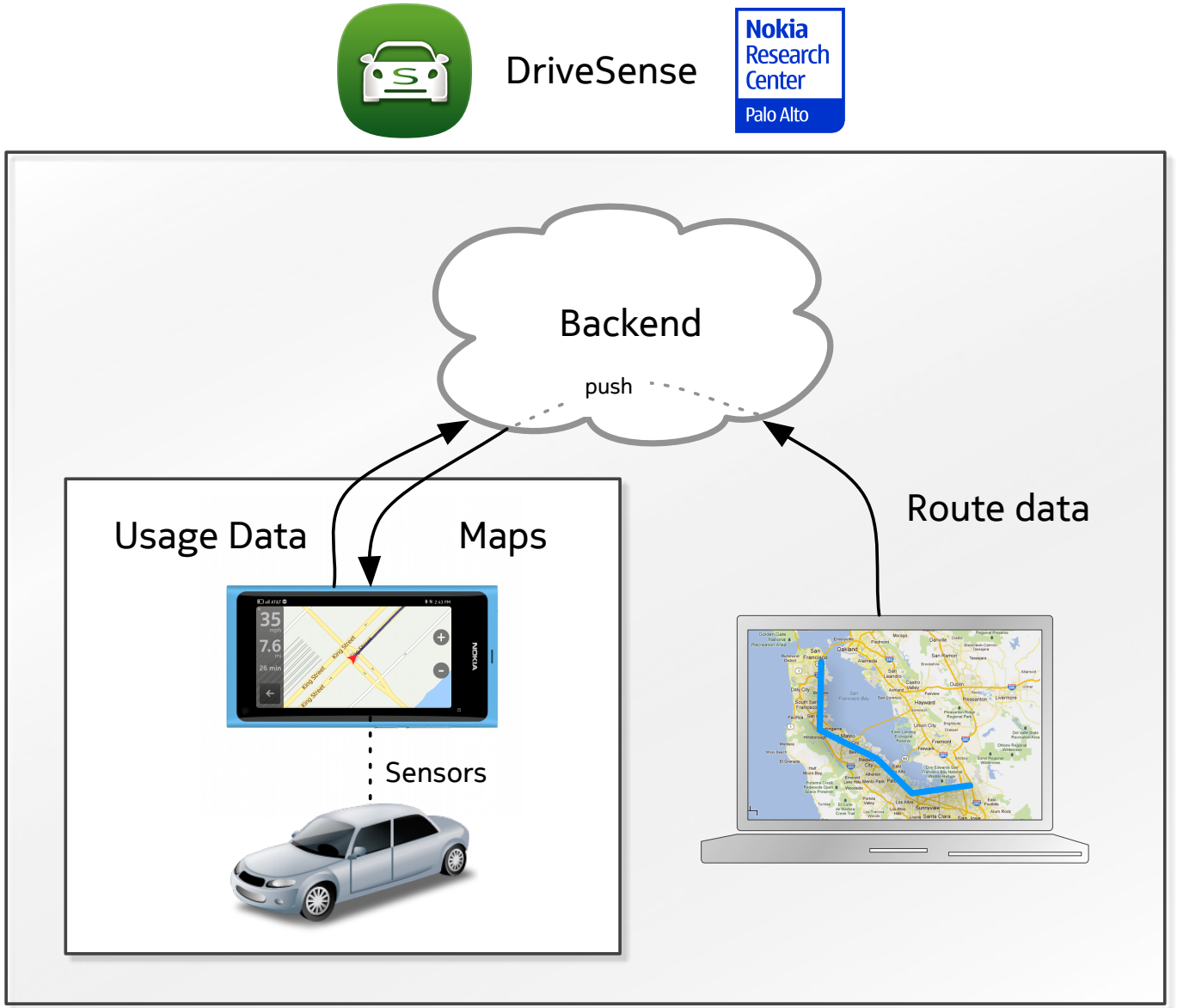
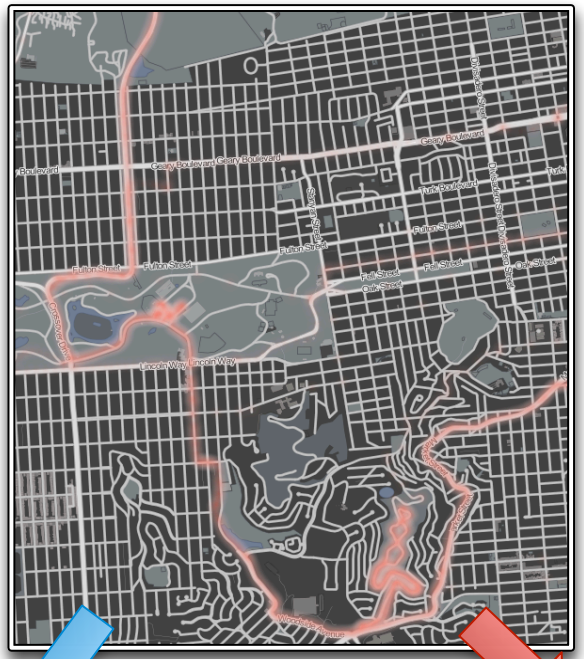
DriveSense - System Overview

System components and Implementation

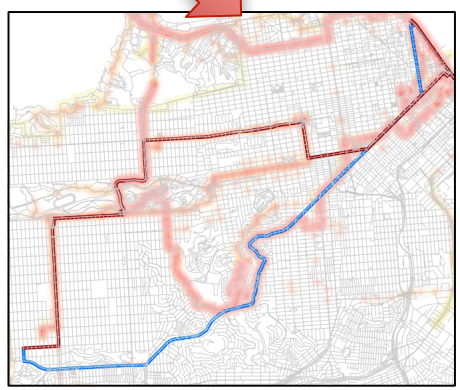


DriveSense Ideas

Sensor Data: GPS / OBD2

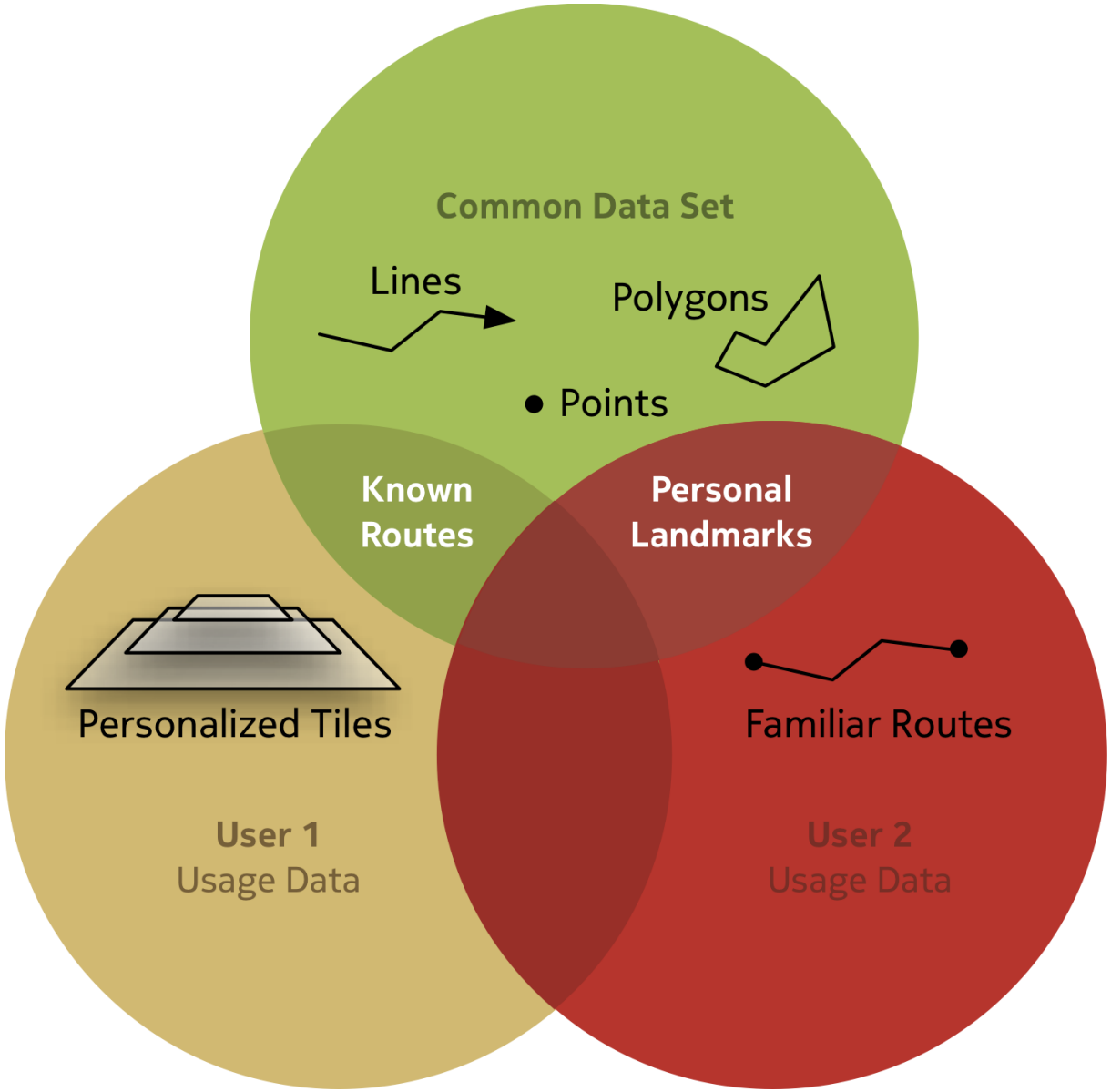


Context-sensitive Route Maps

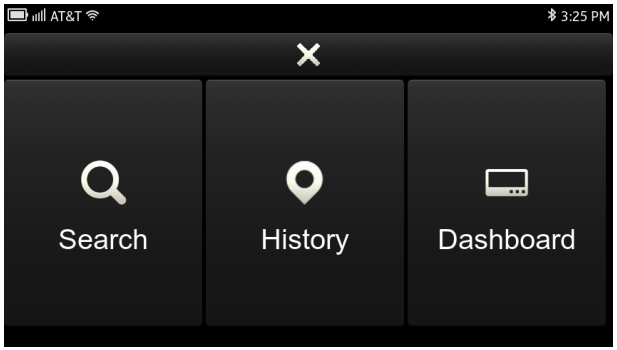


Routing based on Familairty

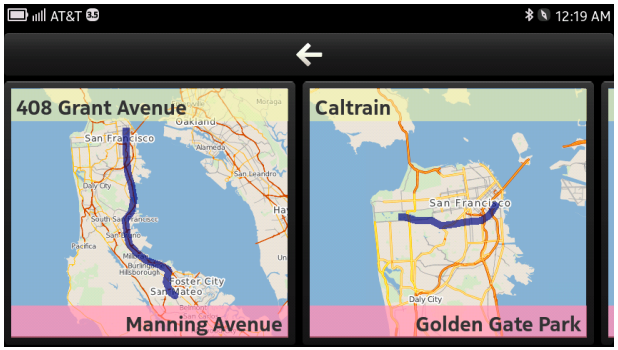
Database DriveSense



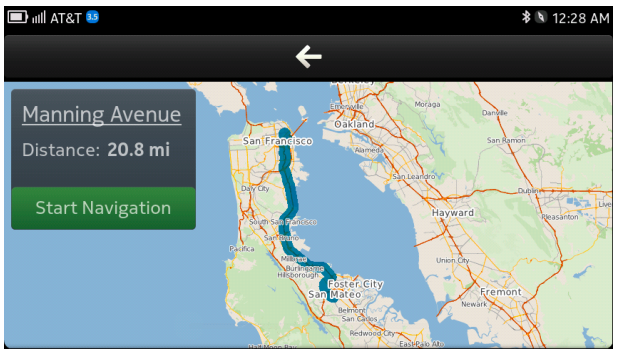
DriveSense Mobile Application



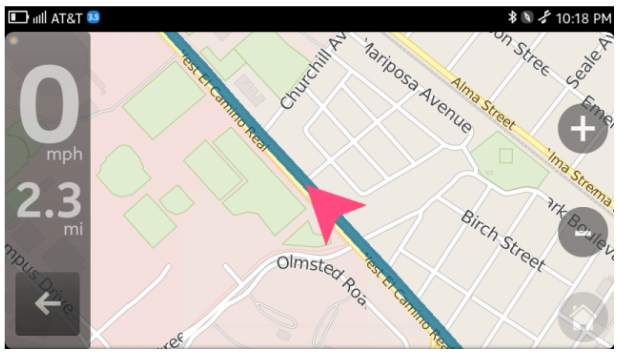
(a) Home Screen



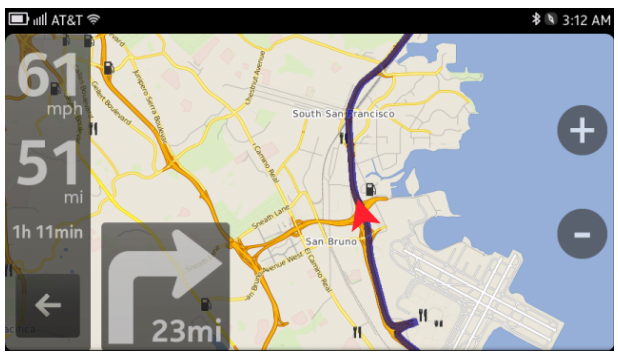
(b) Map Snippets



(c) Route Overview



(d) Navigation View



(e) Inset Arrow for Showing Next Step

Outline

Outline

Wise Guys

The most profound technologies are those that disappear.
Mark Weiser *[8]*

Attention is the limiting factor in our world and it could - most likely - replace our currency. [1]
Georg Franck *[4]*

[1] analogous translation

Nobody is interested in stuff like that!

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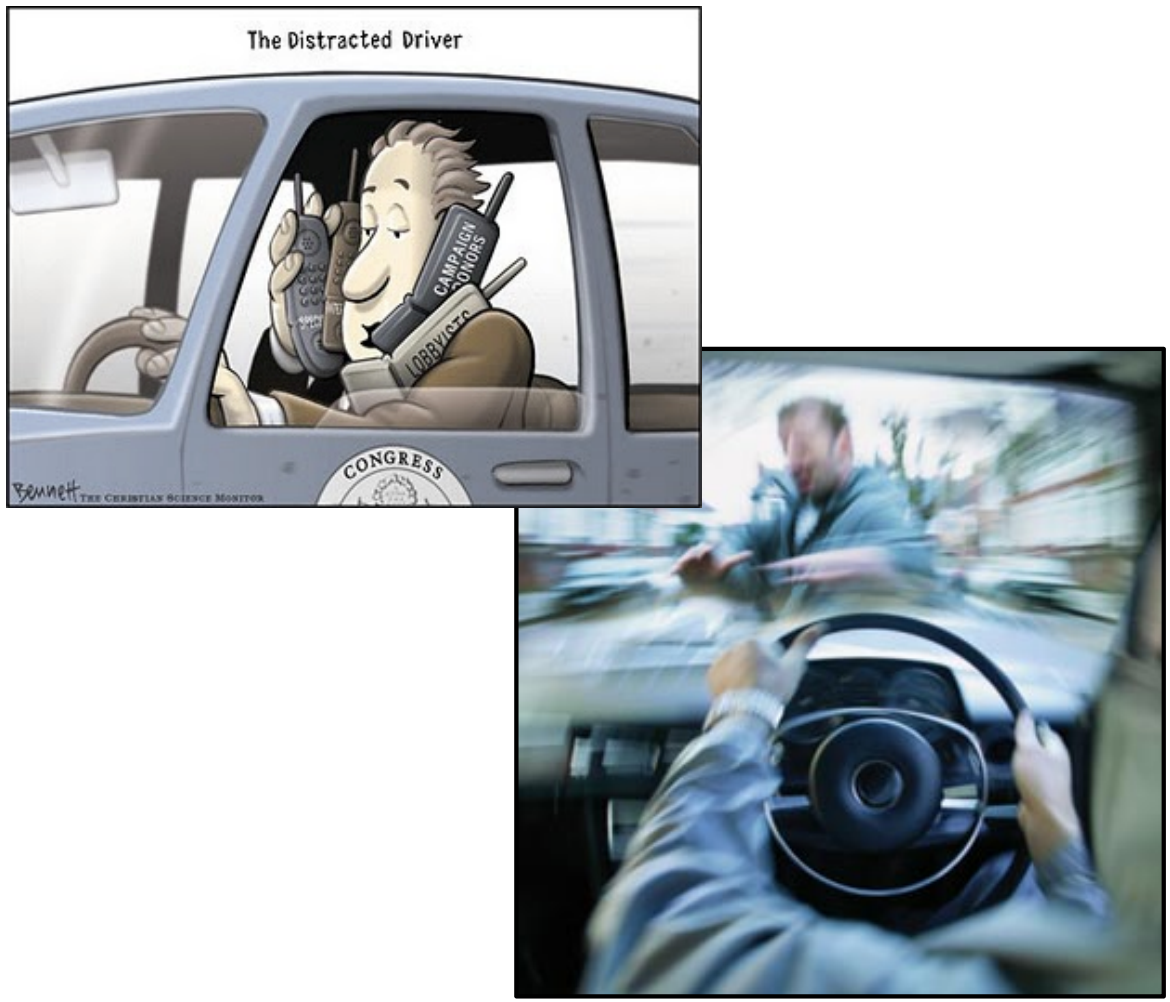
→ main task: **creating slides**

The main task should be driving.



A little too much guidance?

Commercial Navigation Systems vs. Humans

TomTom & Navigon

$\rightarrow$ *use the same level-of-detail*

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vs. **Humans**?

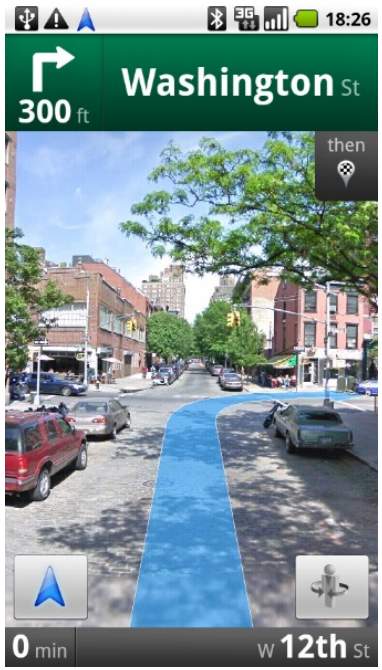
$\rightarrow$ depending on prior spatial knowledge (popular or personally known places) [5]

Route Description

Most common: **Turn-by-turn** instructions

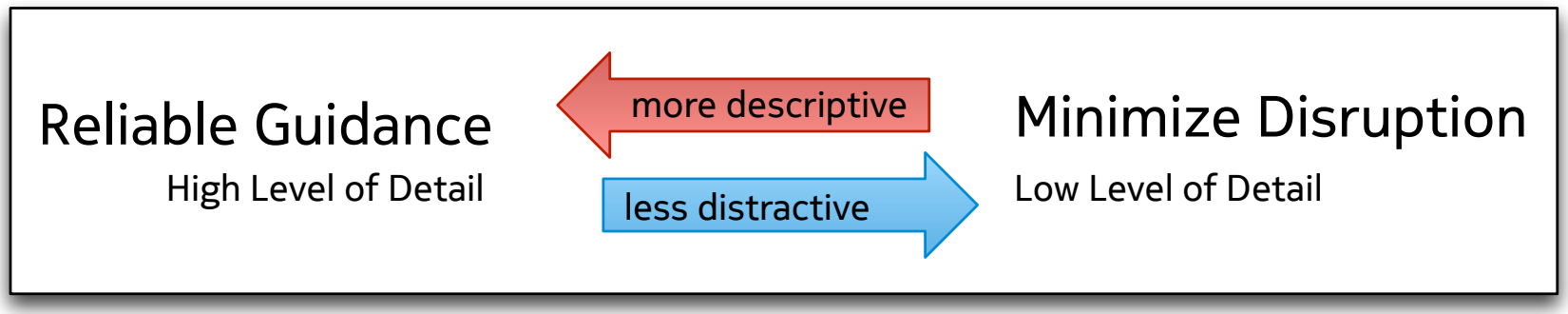
- give instruction at all *decision-points*
- good if there is *no prior knowledge*
- most routes
  either start or end in a familiar area

Better: **More detailed instructions** in a well known area and **rather coarse-grained instructions** in a unfamiliar region.



Google Navigation

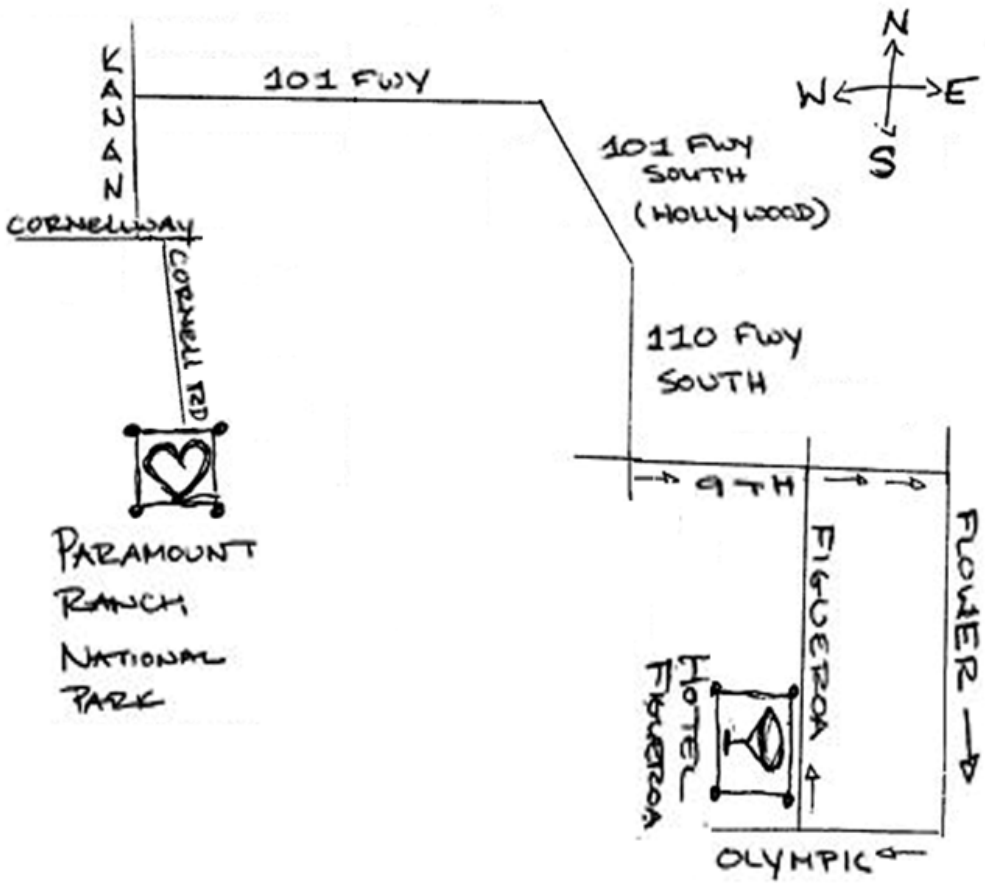
Driving is a critical task



Trade-off

→ Take personal *knowledge*, *experience*, *preferences* into account.

The way humans explain it



Hand-Drawn Map [1]

$\rightarrow$ humans intuitively leave unnecessary details out

Spatial Chunking

Leverage spatial knowledge of surroundings

Chunking: several consecutive instructions are combined into higher-level instructions.

Identify and structure only relevant information in verbalized form.

- **Numerical chunking**
  - aggregation of object of the same type
  - Example: Turn right at the third traffic light.
- **Chunking based upon landmarks**
  - distinctive buildings, popular landmarks, highways
  - Example: Drive to Highway A1.

Destination descriptions

Leverage hierarchical organization of spatial knowledge

- if one has a **good general understanding** of the area
- to locate it in his **personal spatial hierarchy**

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Examples:

- name the district: Feldmannstraße, St. Johann, Saarbrücken

Destination descriptions

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- at the big mormon temple, 1676 Manning Avenue Los Angeles CA 90024

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→ Techniques *spatial chunking* and *destination description* used to avoid unnecessary cognitive load

Objectives

Only provide information that is *inherently necessary* to reach the destination.

Leverage:

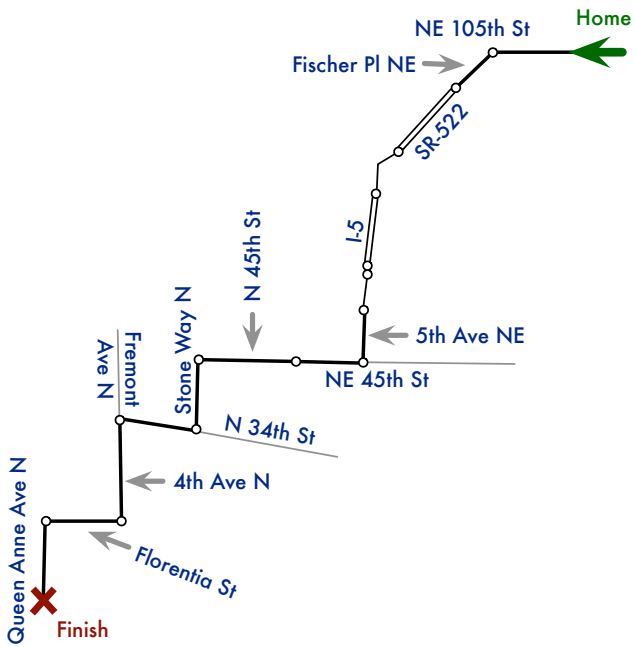
- **familiarity** with specific areas
- personal **geospatial knowledge**

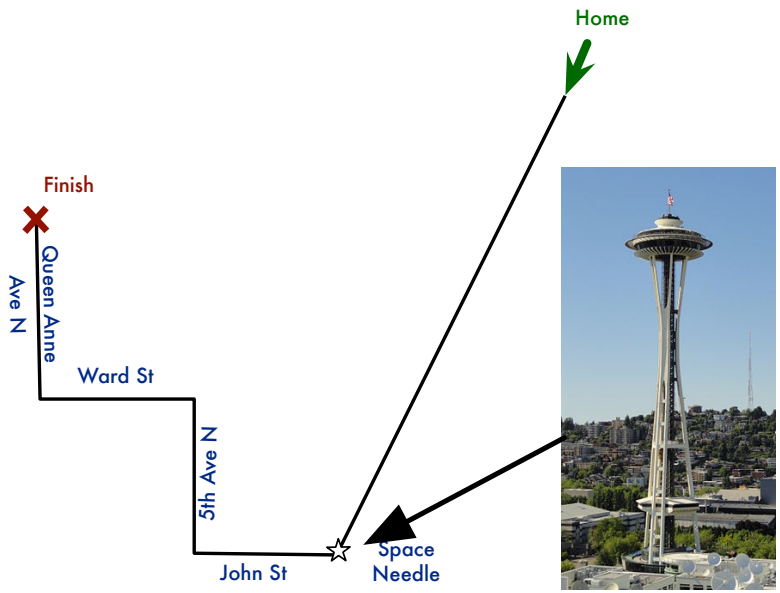
$\rightarrow$ detailed turn-by-turn instructions *even decrease* familiarity

Other Systems / Related Work

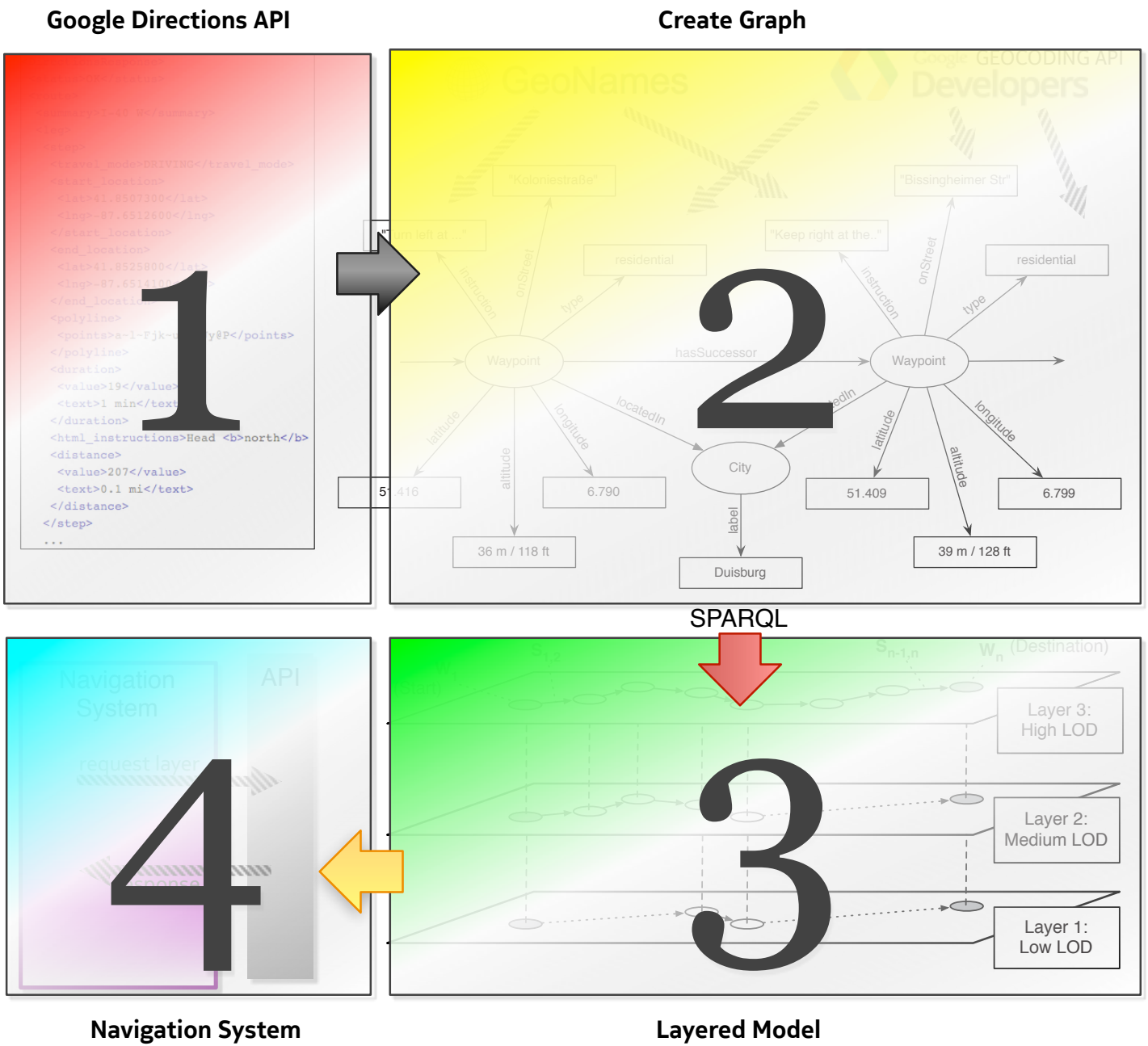
MyRoute 2006 [6]

- landmarks are entered manually
- landmarks presented in a graph
- incorporate subset of the landmarks into the route
- route changes & longer driving distance





LayerGenerator



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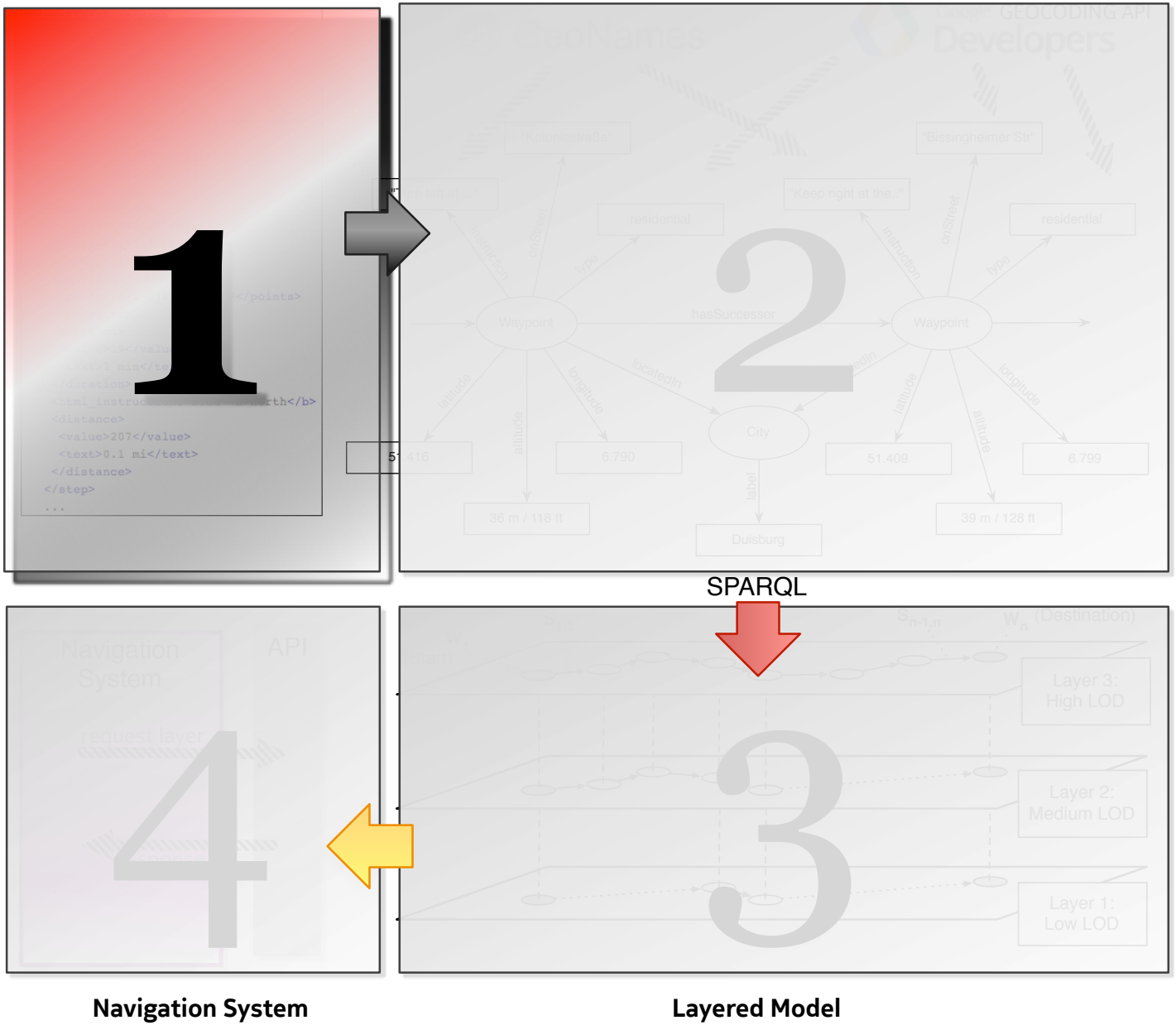

Step 1: Get route description from conventional service

```
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 <status>OK</status>
 <route>
  <summary>I-40 W</summary>
  <leg>
   <step>
    <travel_mode>DRIVING</travel_mode>
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     <lat>41.8507300</lat>
     <lng>-87.6512600</lng>
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```
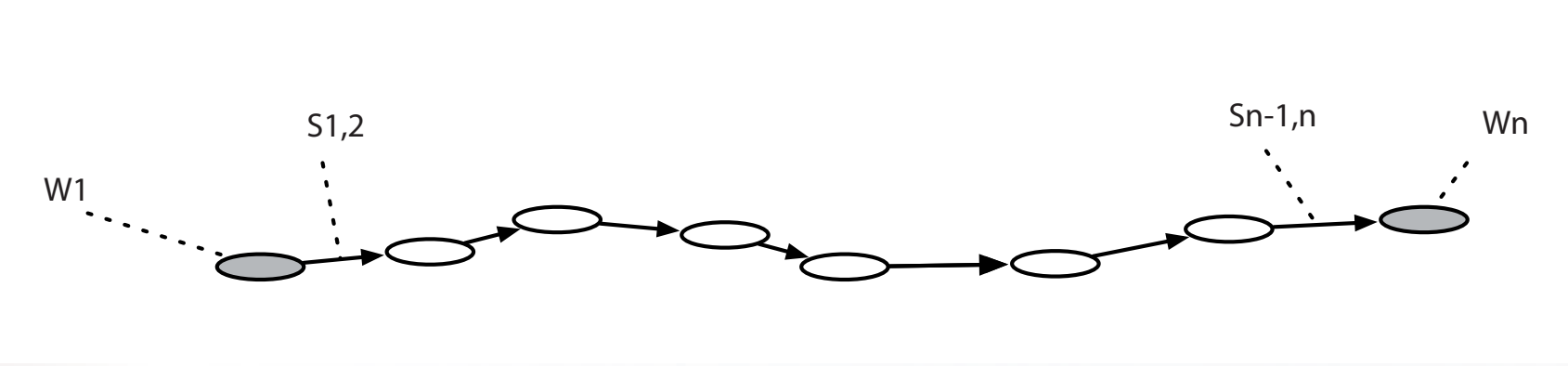

- contains individual waypoints $W_0 \ldots W_t$ and $S_{i,j}$
- *Idea:* layer $L_k \rightarrow$ route description at different *level of detail* (LOD)
- *Given:* Waypoints $W_0 \ldots W_t$ with steps $S_{i,j}$ containing the instruction

$\rightarrow$ **represents the highest LOD**

Step 1: Get route description from conventional service

Original Data represented as a graph



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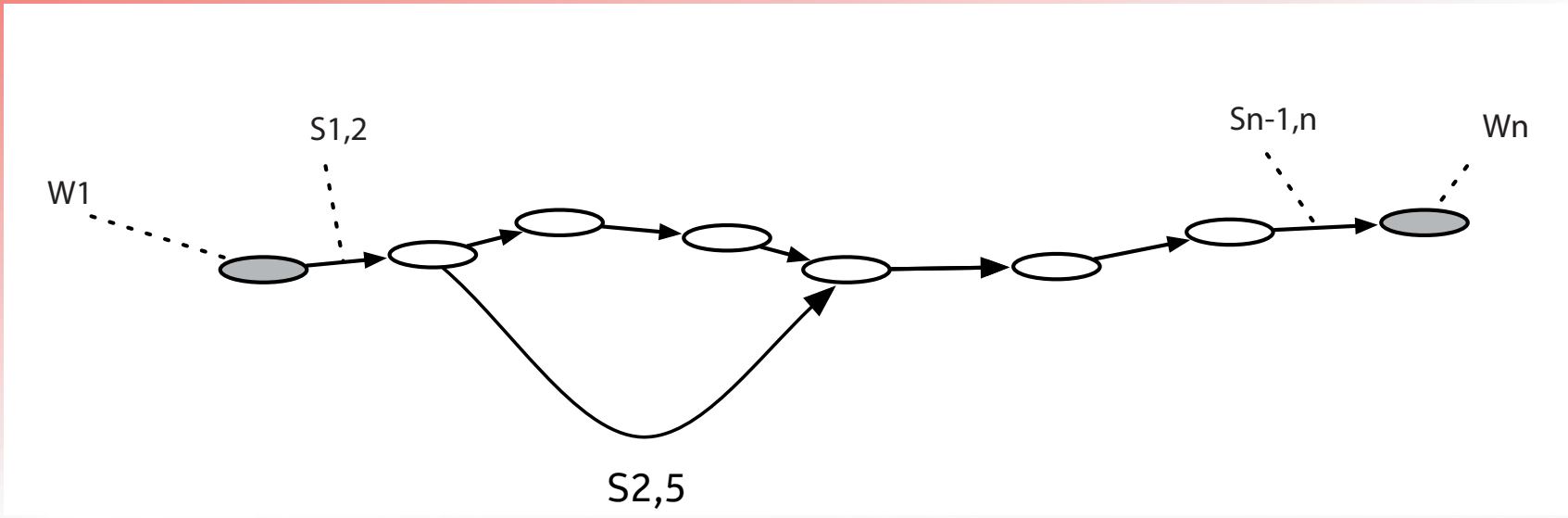

When high-level instructions are created, some **edges are skipped**.
How do we generate $S_{2,5}$?

LayerGenerator

Google Directions API

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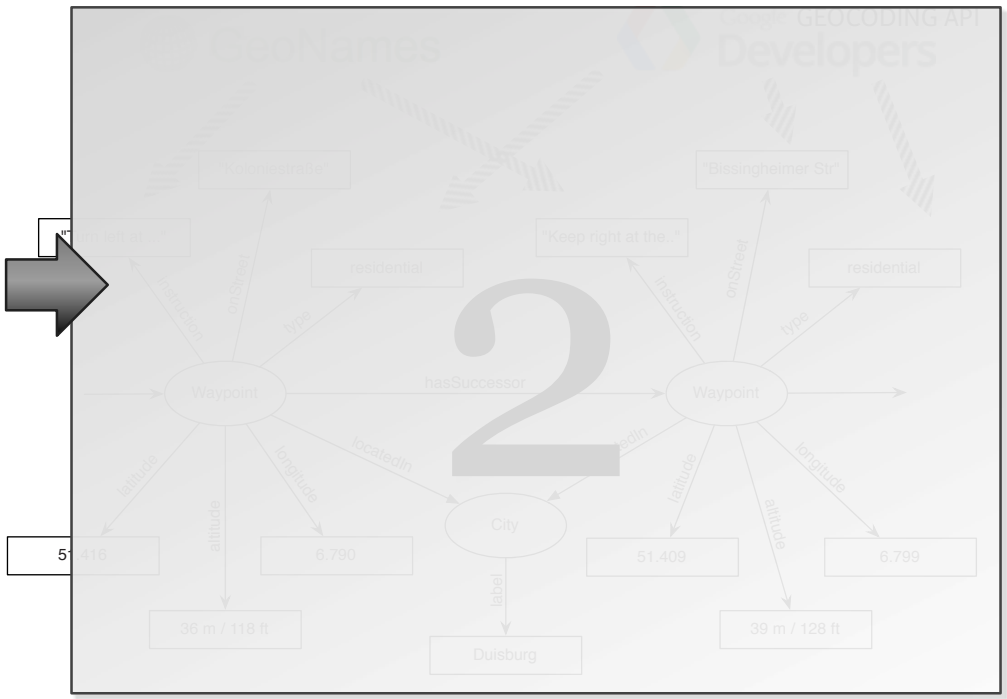
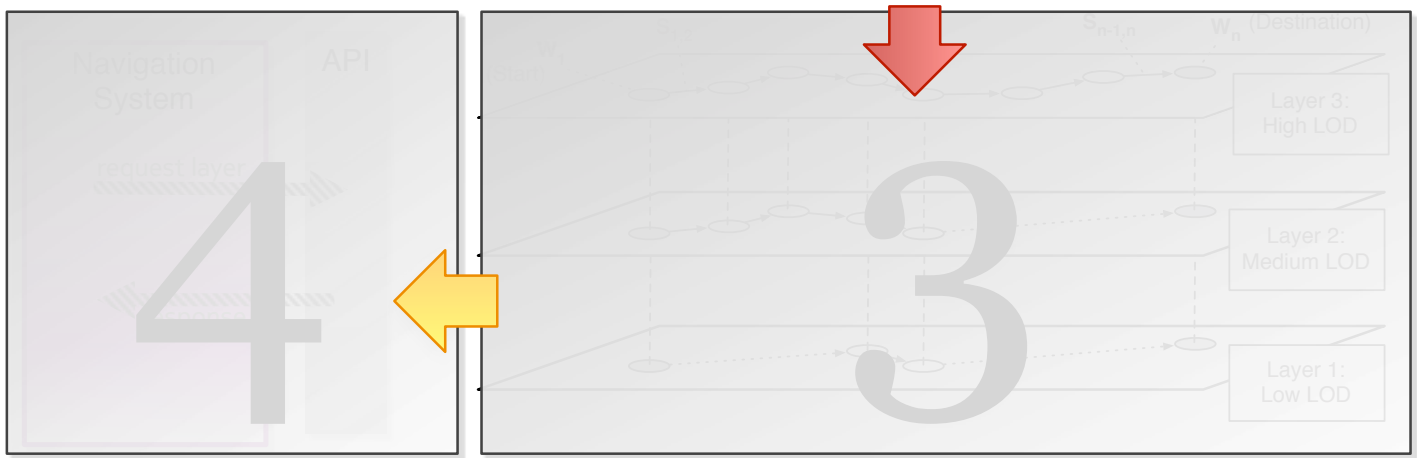


SPARQL



Navigation System **Layered Model**

LayerGenerator

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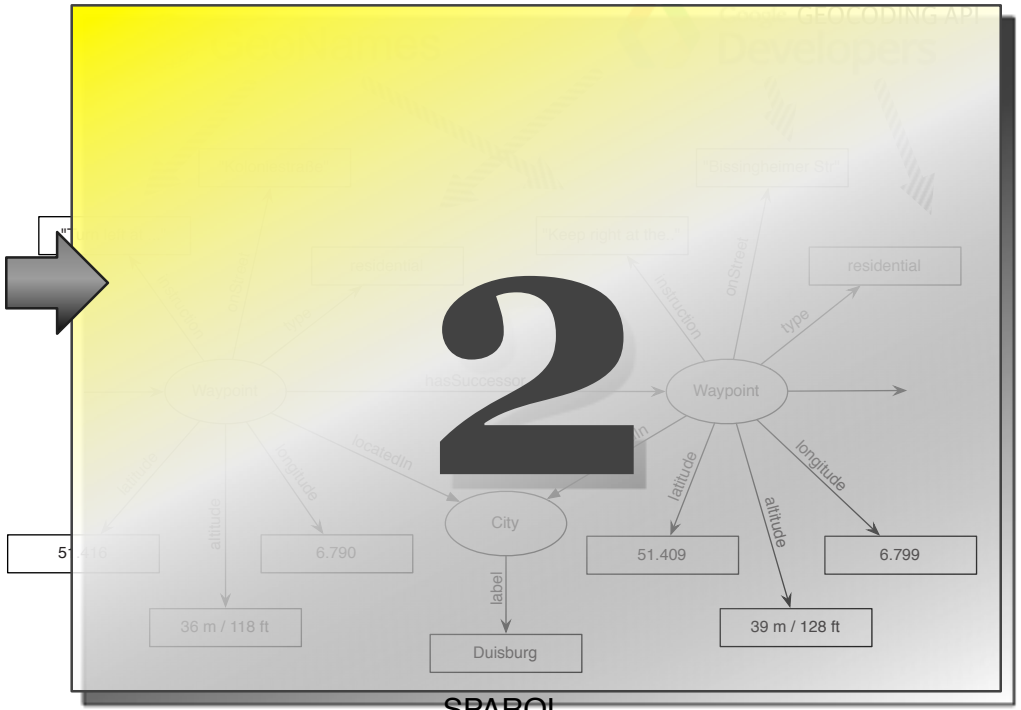

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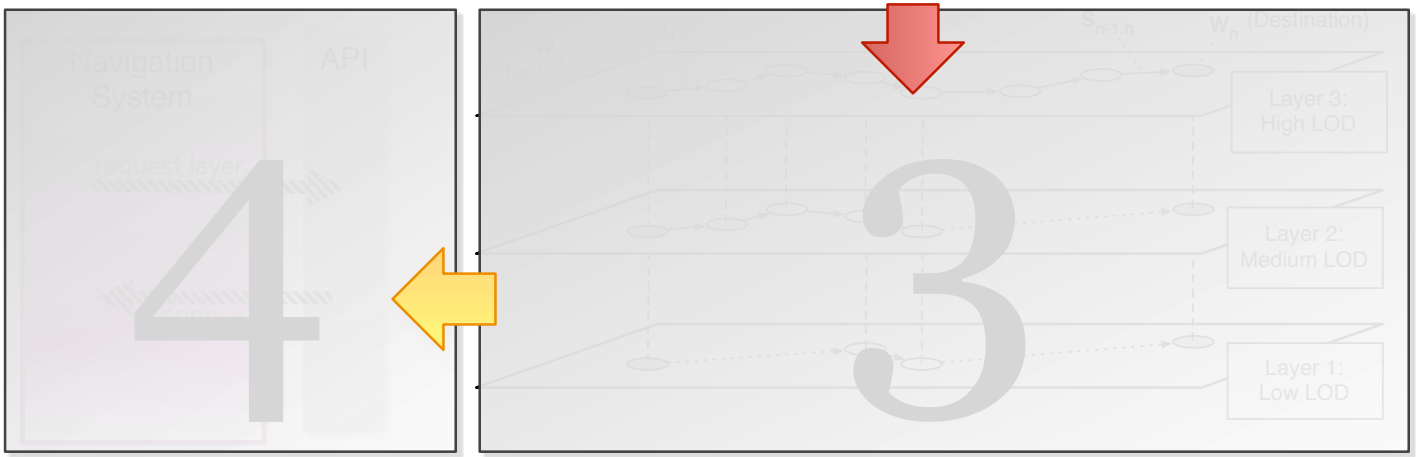


Navigation System **Layered Model**

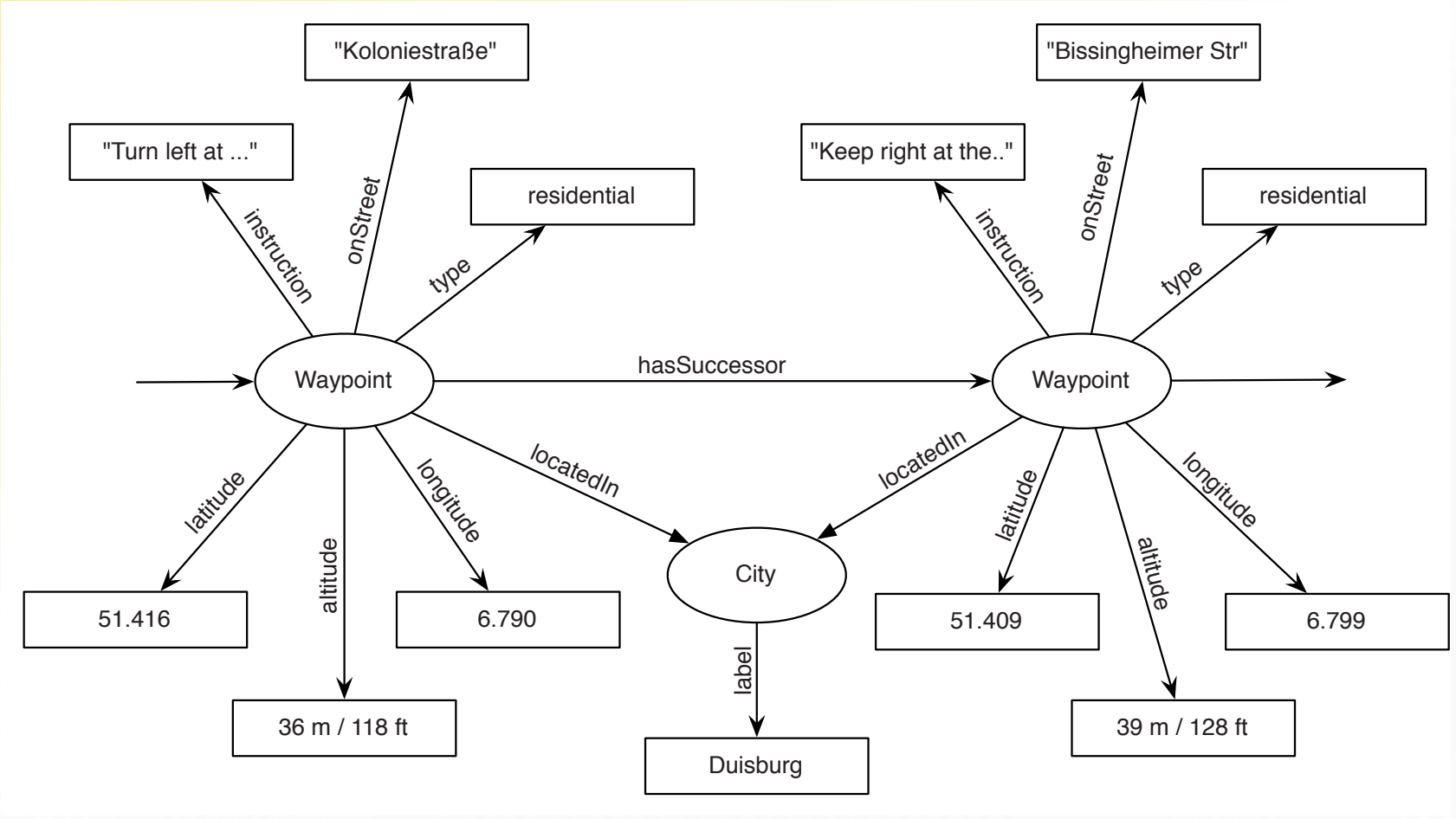
Step 2: Create graph

Semantically enrich data from step before [2]

- *classification* based in its geographical properties
- town, city, park, or connection between two places

[2] data provided by web services: `http://www.geonames.org/`, Google Geocoding API, `http://linkedgeodata.org/`, `http://topocoding.com/`

Step 2: Create graph



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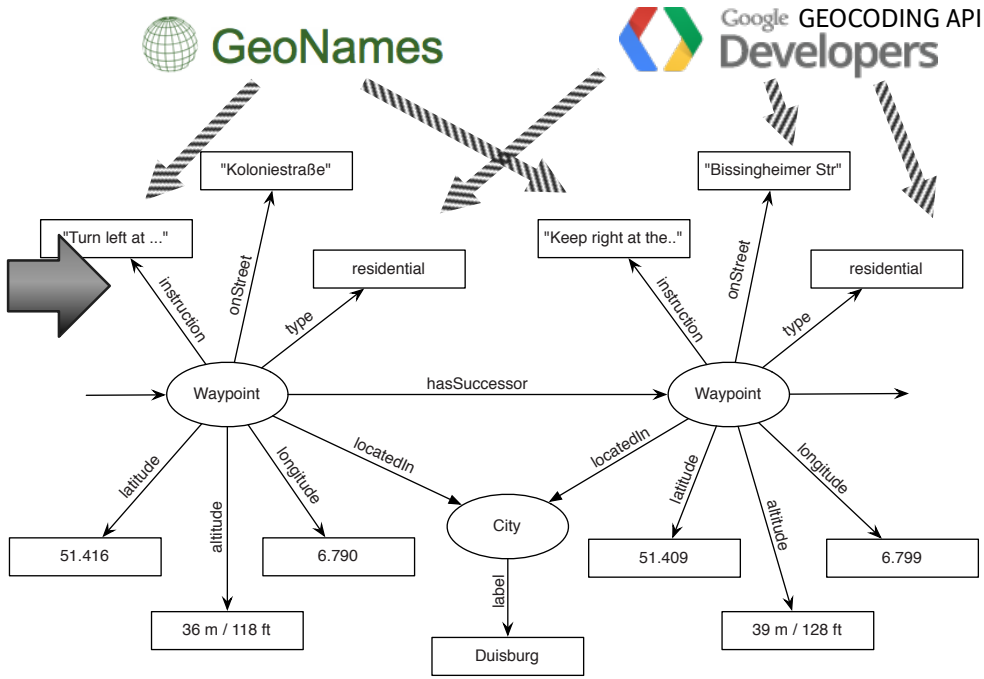
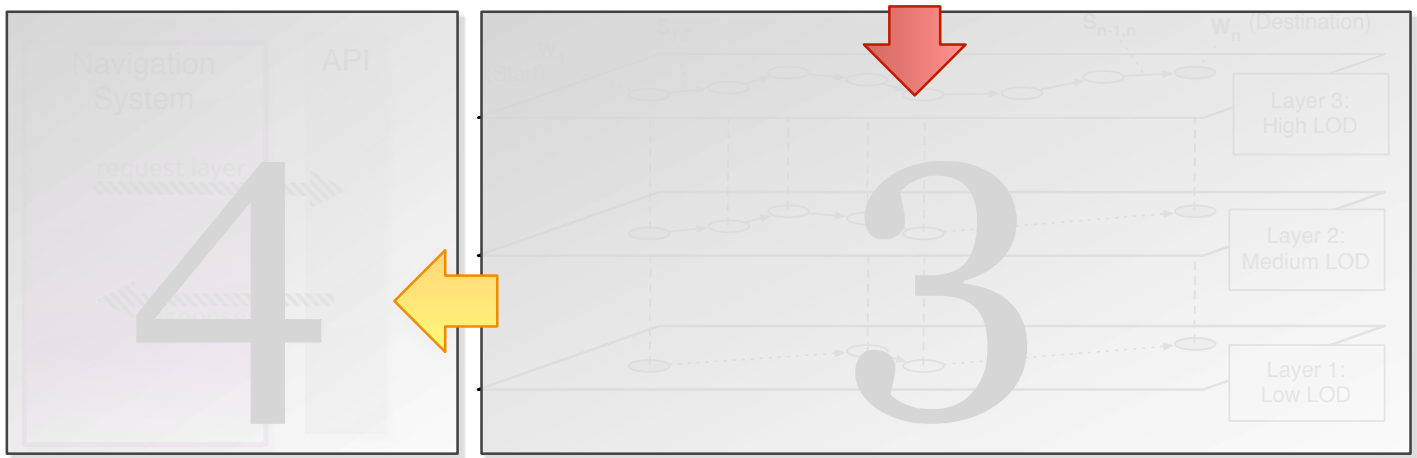


SPARQL



Navigation System **Layered Model**

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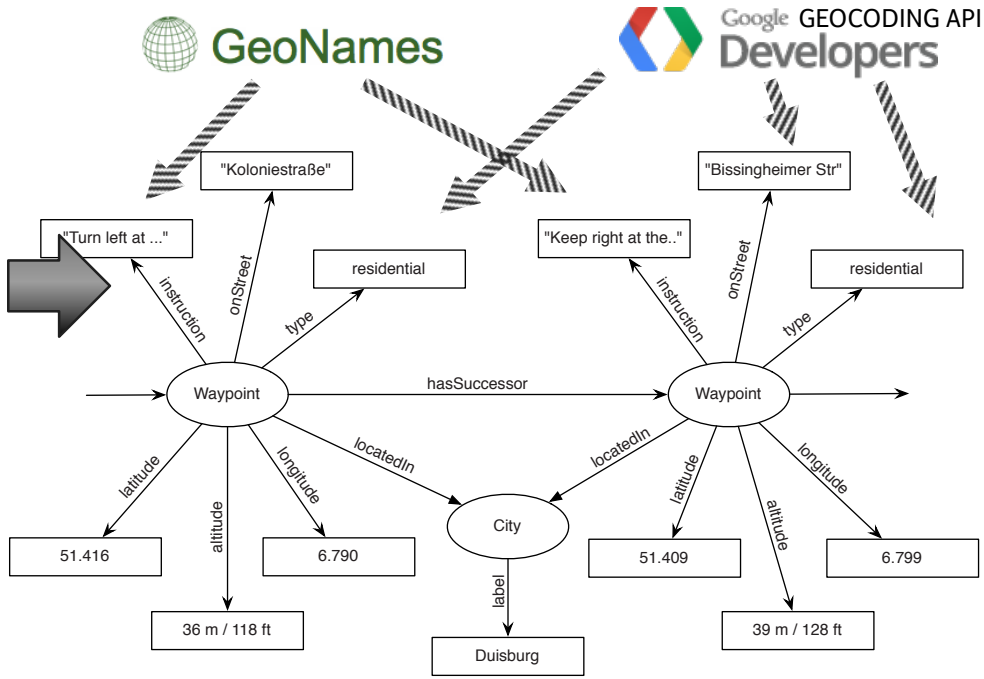

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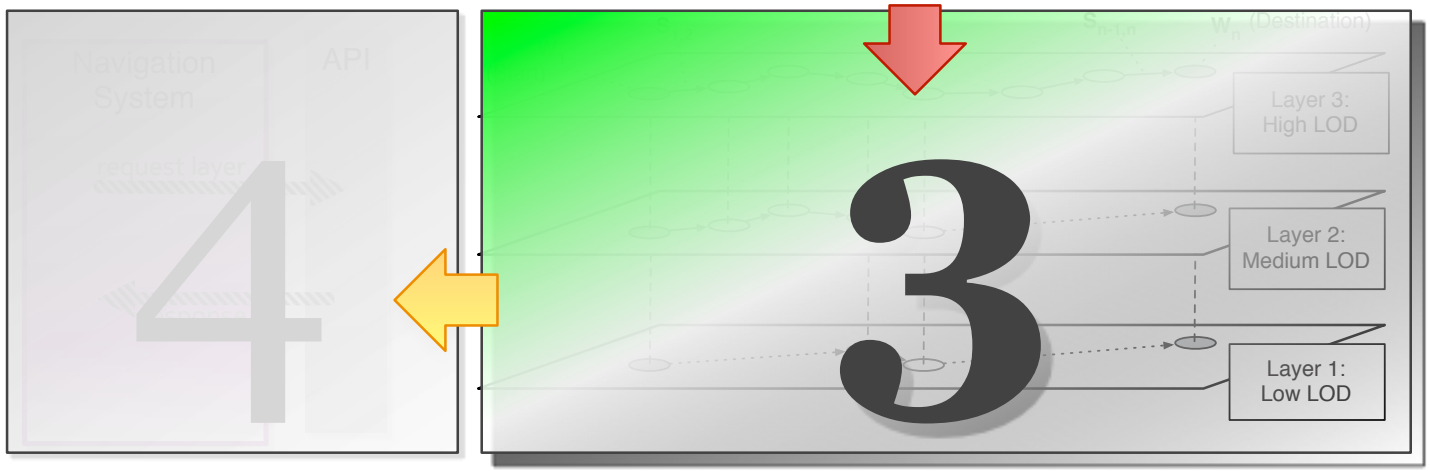

Navigation System **Layered Model**

Step 3: Filter according to Level of Detail

Filter according to the requested LOD

- summarize using destination descriptions
- chunking

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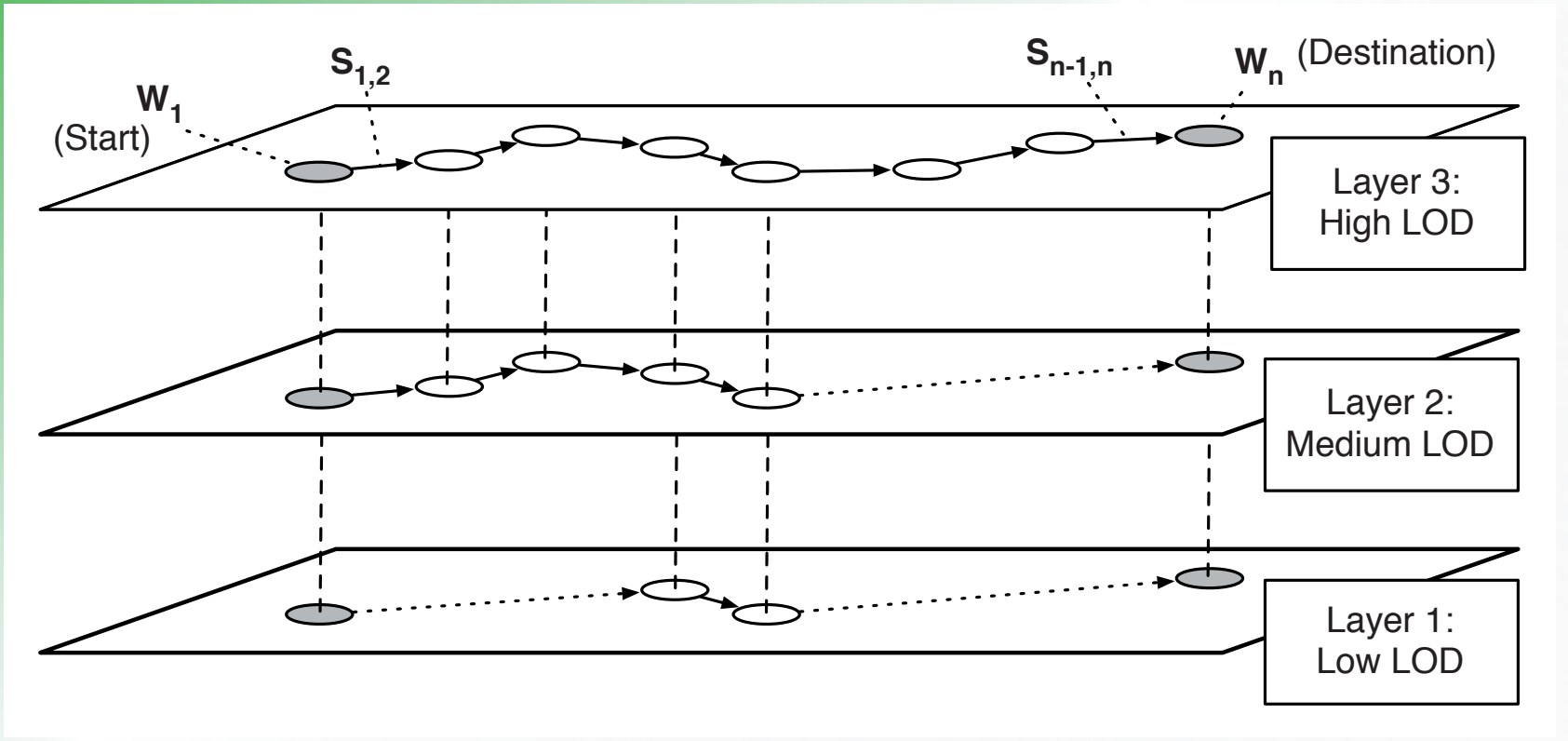

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Filter according to the requested LOD

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- chunking

```
SELECT DISTINCT * WHERE {
 ?waypoint rdf:type waypoint:WayPoint ;
   waypoint:index ?index ;
   waypoint:latitude ?latitude ;
   waypoint:longitude ?longitude ;
   waypoint:onStreet ?street ;
   waypoint:streetNumber ?streetNumber ;
   waypoint:locatedIn ?city .
 ?street street:streetType ?streetType
 FILTER ( ?streetType > PRIMARY )
 ?street rdfs:label ?streetName .
 ?city rdfs:label ?cityName .
 ...
}
```

LayerGenerator

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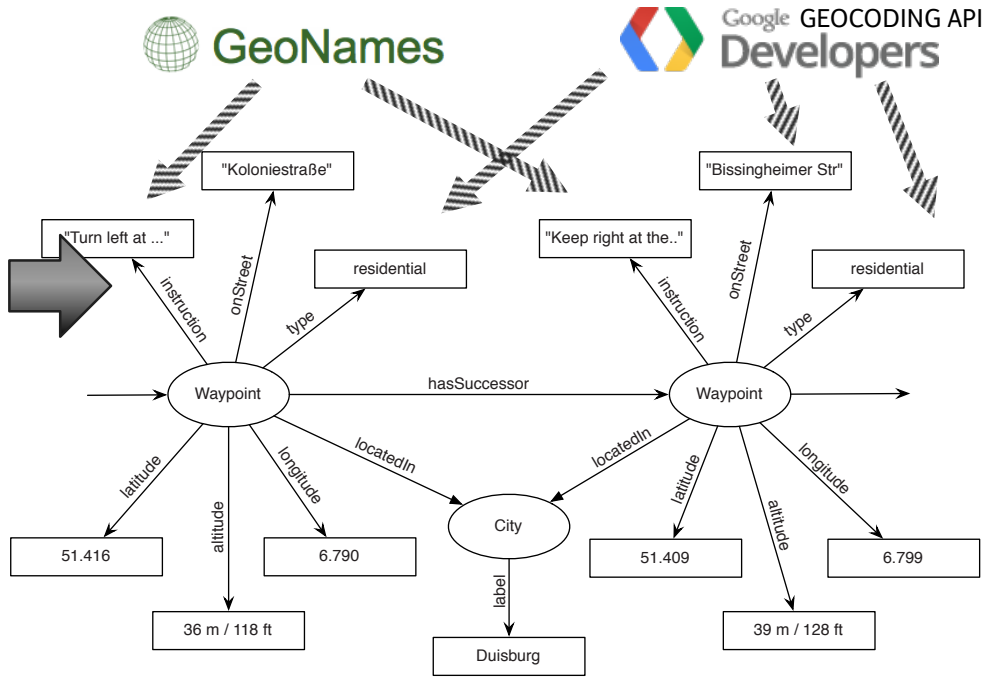
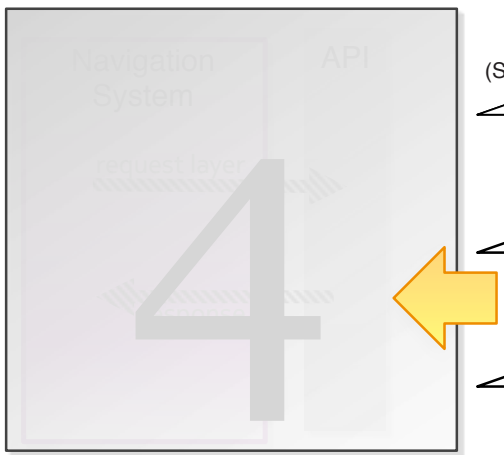
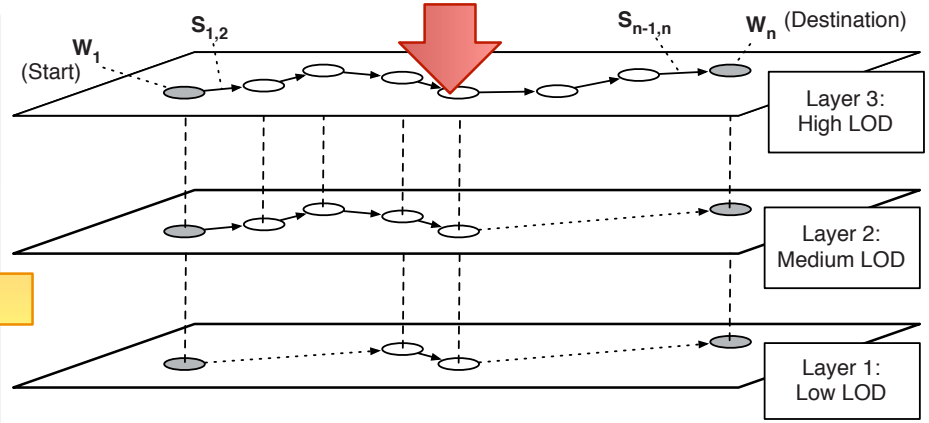


SPARQL





Navigation System

Layered Model

LayerGenerator

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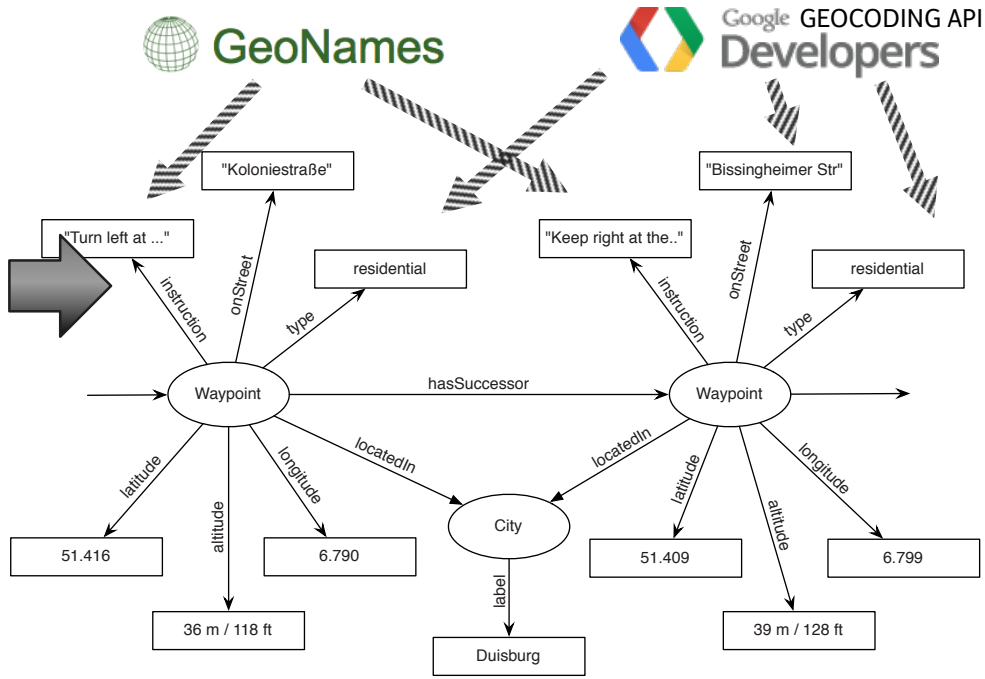

Navigation System

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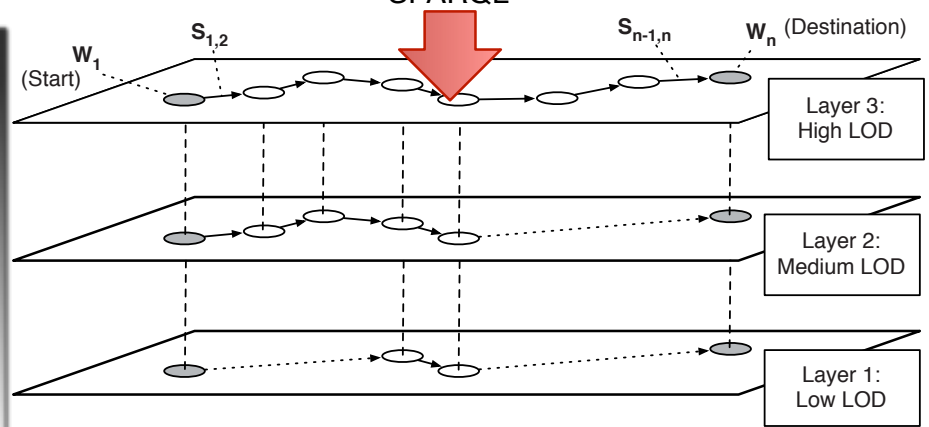


Layered Model

Step 4: Connecting to Navigation System

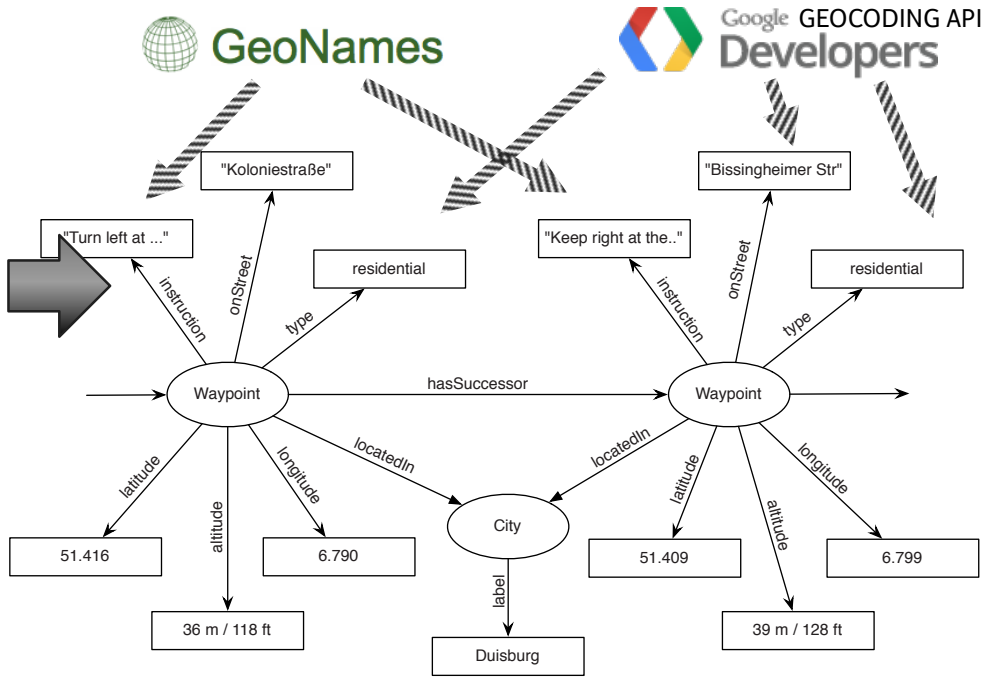
- provide appropriate API to the navigation system
- navigation system determines LOD
- directions response is is generated by the Layered Model

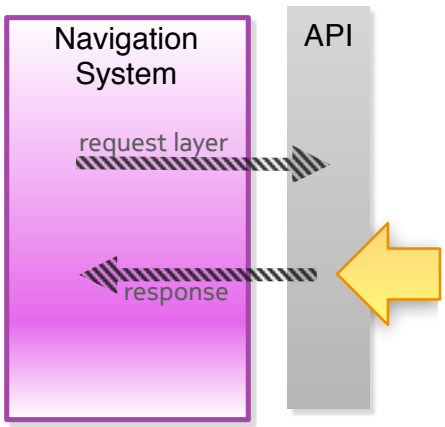
LayerGenerator: The Big Picture

Google Directions API

```
<DirectionsResponse>
 <status>OK</status>
 <route>
  <summary>I-40 W</summary>
  <leg>
   <step>
    <travel_mode>DRIVING</travel_mode>
    <start_location>
     <lat>41.8507300</lat>
     <lng>-87.6512600</lng>
    </start_location>
    <end_location>
     <lat>41.8525800</lat>
     <lng>-87.6514100</lng>
    </end_location>
    <polyline>
     <points>a~l~Fjk~uOwHJy@P</points>
    </polyline>
    <duration>
     <value>19</value>
     <text>1 min</text>
    </duration>
    <html_instructions>Head <b>north</b>
    <distance>
     <value>207</value>
     <text>0.1 mi</text>
    </distance>
   </step>
   ...
```

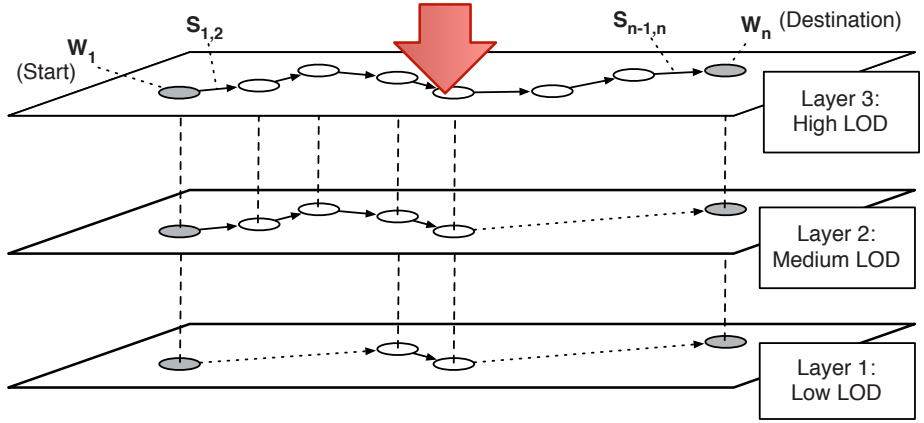
Create Graph





Navigation System

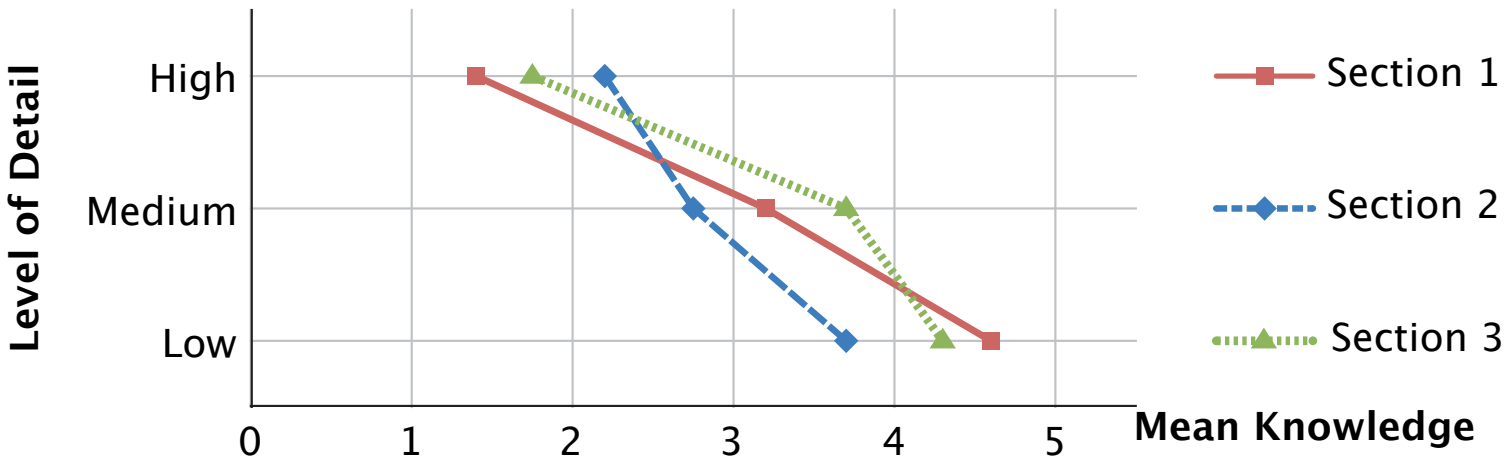
SPARQL



Layered Model

Evaluation Results

- wasn't integrated into real system
- 2 studies
  - Study 1: front-seat passenger provided the driver with instructions
  - Study 2: Online



Discussion

- Real Challenge: how to determine the **appropriate LOD**?
- How to dynamically generate **intelligent summaries and instructions**, maybe spoken instructions?
  - paper only mentions a "simplified linguistic rule"
  - AI methods: **data mining**, knowledge base, automated reasoning
- Should the route that has been optimized in many ways be changed?

Q & A

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Thank you!