SPACEBOOK

Spatial &
Personal
Adaptive
Communication
Environment
Behaviours &
Objects &
Operations &
Knowledge

Mackaness, W.A. Boye J., Clark S., Fredriksson, M.,
Geffner H., Lemon O., Minock, M., Webber B.

Aim

- To showcase a mobile, hands-free and eyes-free city guide device that facilitates pedestrian exploration of the city.

Bartie, P. and Mackaness, W.A. (2006). "A Speech Based Augmented Reality System for City Tourists." Transactions in GIS (special issue) 10 (1): 63-86.

Umea universitet

Proactive response modelling, semantic grammars

Barcelona Media

Reinforcement learning/ proactive response modelling

The University of Cambridge

Natural language processing, proactive response modelling

Heriot Watt

Multimodal dialogues, context sensitive speech recognition

SpaceBook

The University of Edinburgh

Machine learning, speech synthesis, location aware technologies

Kungliga Tekniska Hoegskolan

Statistical learning in interaction management, systems integration

Liquid Media AB

Middleware, gaming/telecom applications

Challenge

Digital tourist guide for city environments:

- intuitive
- unobtrusive
- informative (engaging & meaningful)
- Unobstructive

- …the idea of ‘service’…

Design criteria

Digital tourist guide for city environments:

- voice ONLY presentation, dialogue ONLY interaction (via bluetooth headset)
- support very rich/detailed descriptions of the city and its services
- understand the goals of the tourist
- …gain meaning from their geographical context (mirror the visual senses)
- model tourist's familiarity with the city

Core components

Digital tourist guide for city environments:

- City model
- Viewshed model
- Pedestrian model
- Trajectories (past & current)
- Location aware device
- Spoken Dialogue System

….realtime delivery ….

City model

- Modelling geography as context: Strongly typed descriptions of space with rich attribution;
- …modelling Networks, Regions and Discrete objects..
- …at a granularity commensurate with task..
- Such as:
- Places of interest, landmark saliency, buildings (functional perspective), street furniture,
- Multi sourced: Ordnance Survey MasterMap, OSM, PointX,

City model

- A – B routing (shortest, most scenic, easiest to follow, most salient landmarks)
- SQL support
- Complemented by open ended Q & A:
  - RSS, gazetteers, Google Latitude, web services: transportation, weather,

Viewshed model

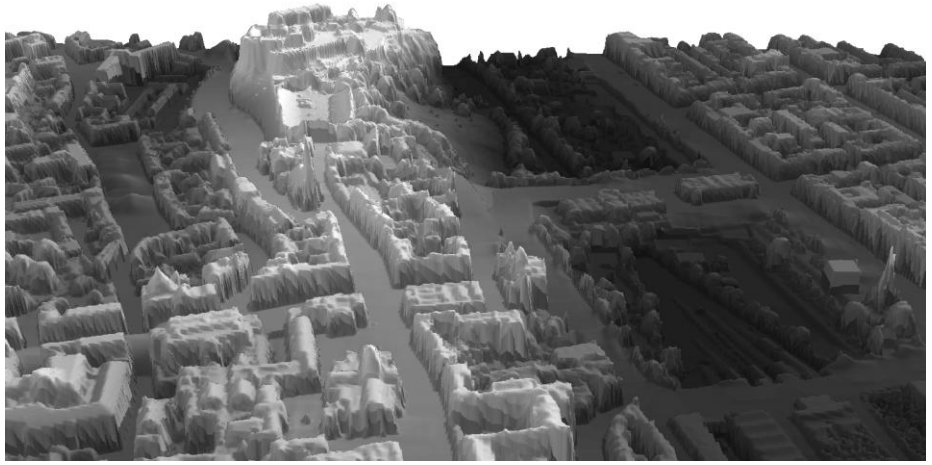
Euclidean space (200m radius)

Network space (200m travel distance)

Vista Space (all visible items)

LiDAR sourced DSM, DTM

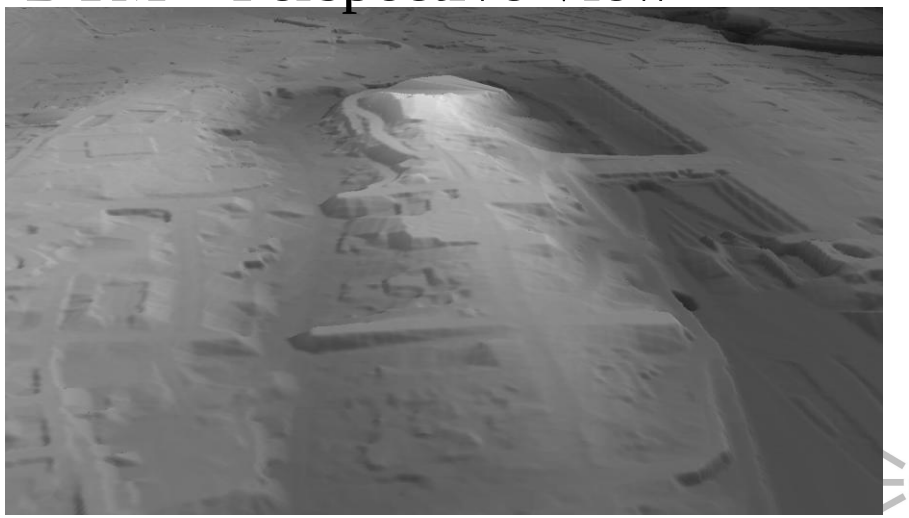
DSM

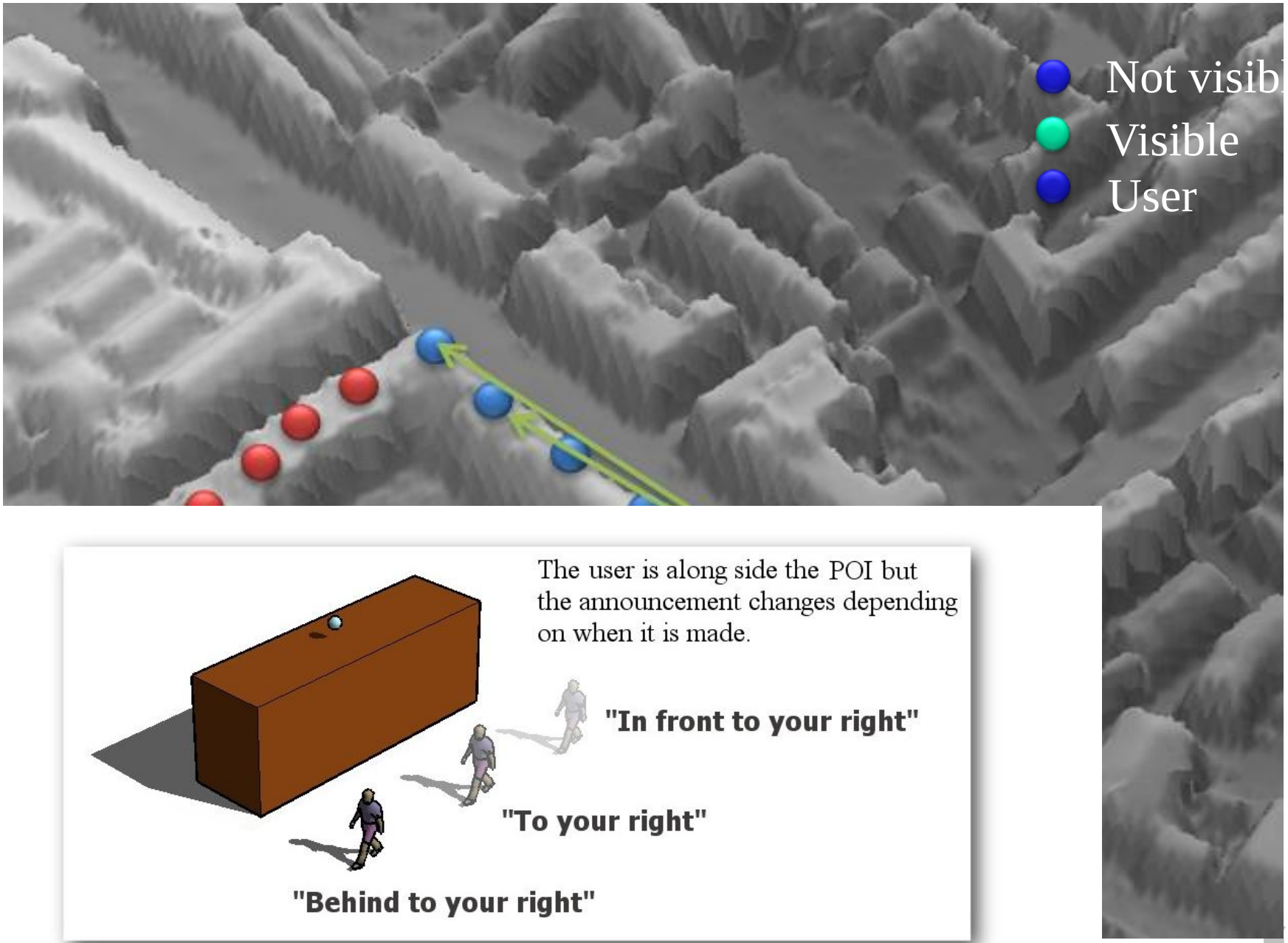


DSM – Perspective View

DTM

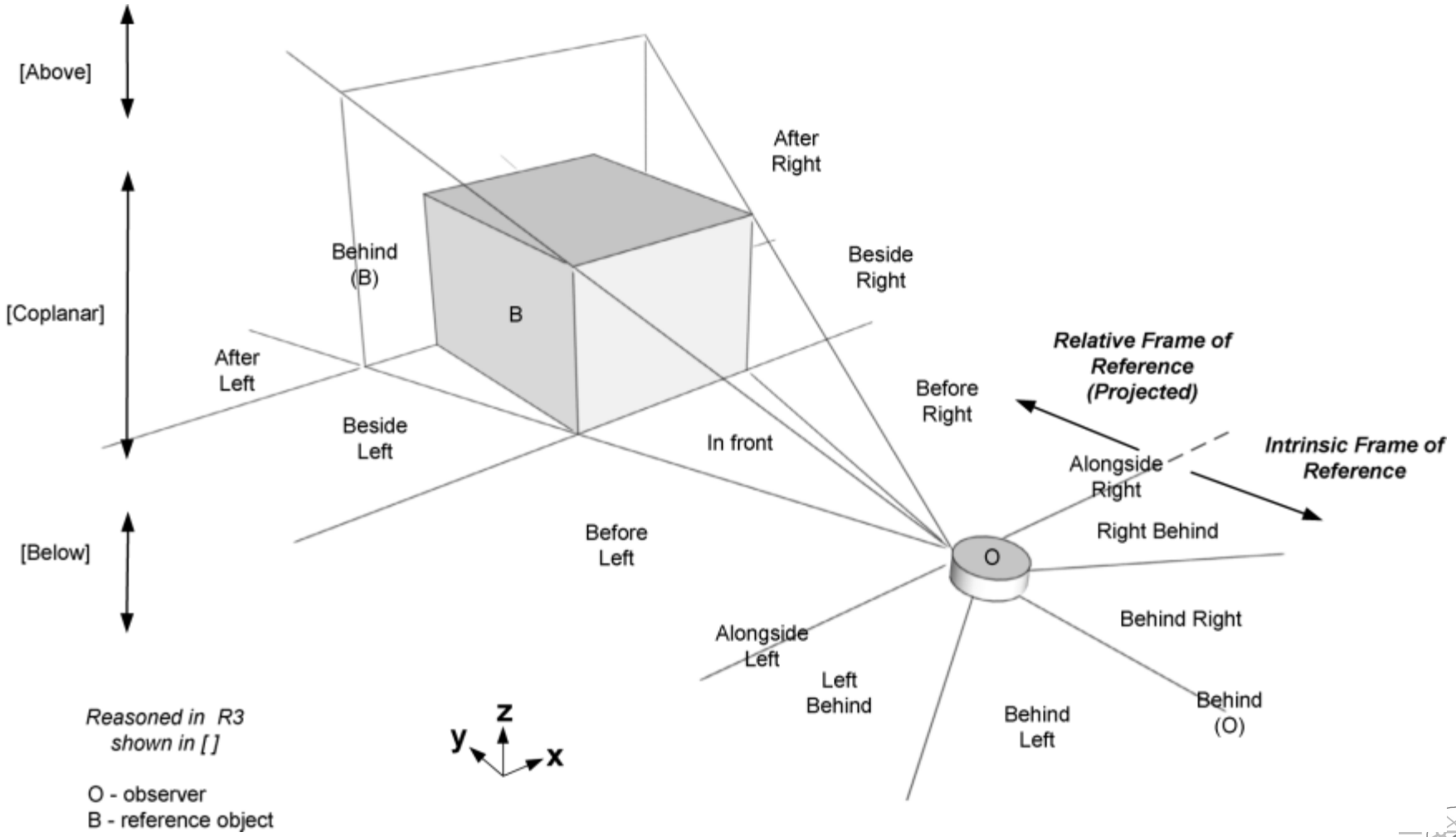
DTM – Perspective View



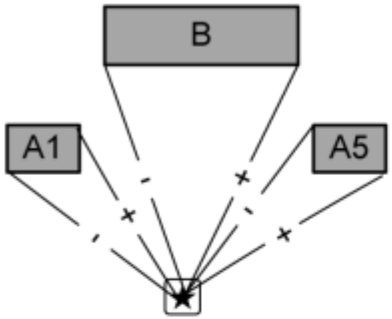

Not visibl
Visible
User

The user is along side the POI but the announcement changes depending on when it is made.
"In front to your right"
"To your right"
"Behind to your right"

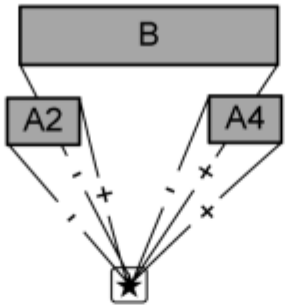
A combined model...



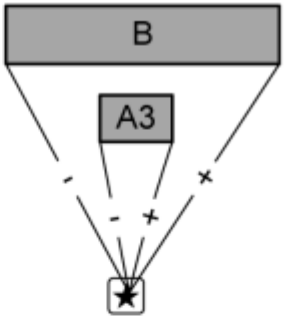
(a) Main Six Cases



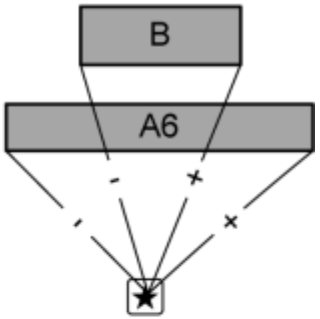
(i) Aside
[Case 1 + 5]



(ii) Partially Aside/
Partially Collinear
[Cases 2+4]

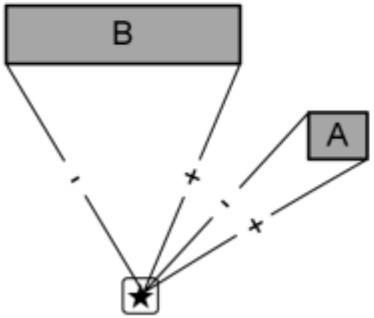


(iii) Nested
[Case 3]



(iv) Total Overlap
[Case 6]

(b) Graded Examples for Right



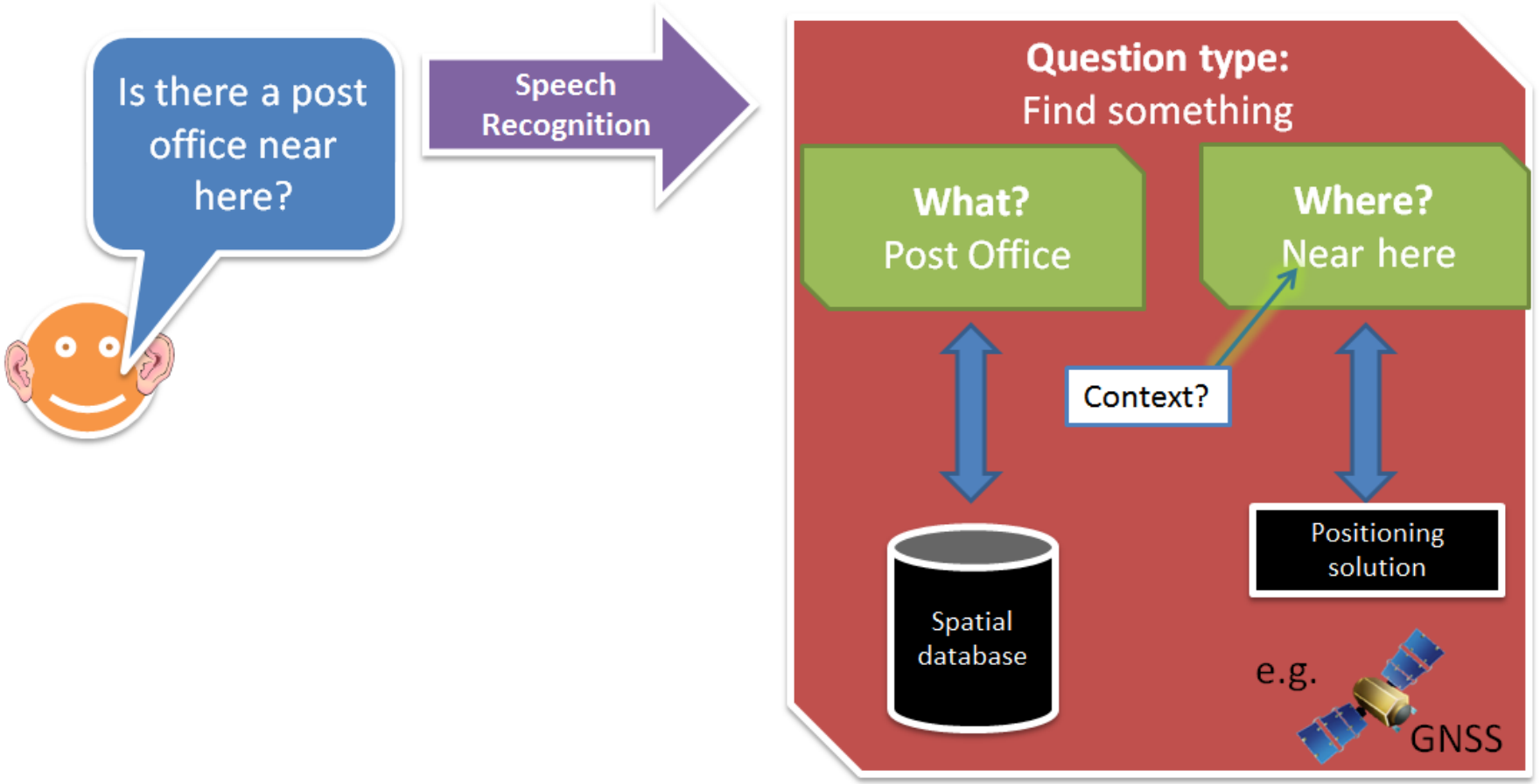
(i) Right
[Case 5]

(ii) Immediate
[Case 4

Case1(A,O,B)	$\forall x \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [ls(x,y,z)]]]$
Case2a(A,O,B)	$coll(x_{+ve},y,z_{-ve}) \wedge x\text{-}_{ve} \in A\ [\exists y \in (O)\ [\exists z \in CH(B^\circ)\ [ls(x_{-ve},y,z)]]]$
Case2b(A,O,B)	$x_{+ve} \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [coll(x_{+ve},y,z)]]]$ $\wedge\ x\text{-}_{ve} \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [ls(x_{-ve},y,z)]]]$
Case2c(A,O,B)	$coll(x_{+ve},y,z_{+ve}) \wedge x_{-ve} \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [ls(x_{-ve},y,z)]]]$
Case3a(A,O,B)	$coll(x_{-ve},y,z_{-ve}) \wedge coll(x_{+ve},y,z_{+ve})$
Case3b(A,O,B)	$coll(x_{-ve},y,z_{-ve}) \wedge x_{+ve} \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [coll(x_{-ve},y,z)]]]$
Case3c(A,O,B)	$\forall x \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [coll(x,y,z)]]]$ $\wedge \neg coll(x_{-ve},y,z_{-ve}) \wedge \neg coll(x_{+ve},y,z_{+ve})$
Case3d(A,O,B)	$coll(x_{+ve},y,z_{+ve}) \wedge x_{-ve} \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [coll(x_{-ve},y,z)]]]$
Case4a(A,O,B)	$coll(x_{-ve},y,z_{-ve}) \wedge x_{+ve} \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [rs(x_{+ve},y,z)]]]$
Case4b(A,O,B)	$x_{-ve} \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [coll(x_{-ve},y,z)]]]$ $\wedge\ x_{+ve} \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [rs(x_{+ve},y,z)]]]$
Case4c(A,O,B)	$coll(x_{-ve},y,z_{+ve}) \wedge x_{+ve} \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [rs(x_{+ve},y,z)]]]$
Case5(A,O,B)	$\forall x \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [rs(x,y,z)]]]$
Case6(A,O,B)	$x_{-ve} \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [ls(x_{-ve},y,z)]]]$ $\wedge\ x_{+ve} \in A\ [\exists y \in O\ [\exists z \in CH(B^\circ)\ [rs(x_{+ve},y,z)]]]$
Coll = collinear LS = left side RS= right side CH = convex hull *x,y,z are points in regions AOB respectively* *Extreme points are denoted by suffix $_{-ve}$ or $_{+ve}$*	

Pedestrian model

- Wizard of Oz experiments



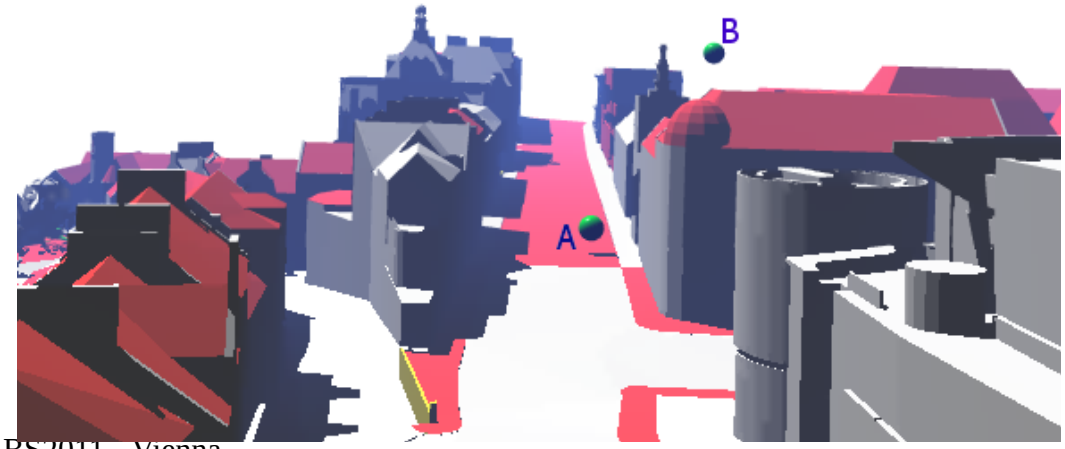
- User: So, where am I?
- SpaceBook: You are on the Royal Mile, not far from your hotel.
- User: OK… so what's happening in Edinburgh today?
- SpaceBook: Well, most of the tourist attractions are open as usual.. The galleries, museums, cinema, shops… what time do you have available?
- User: Oh, all day.
- SpaceBook: The weather's nice – how about a walk in the Botanics.
- User: Nah – I hate walking. Right now I'm feeling thirsty.
- SpaceBook: There is a nice café just around the corner from where you are.
- User: Sounds good
- SpaceBook: Turn to your left, walk straight ahead 100m towards the large glass fronted building you can see in front of you. Can you see it?

Trajectory modelling

- Interpretation of trajectory by linking to city model:
  - ‘journey to work’, (where home is, where work is)
- Analysing patterns of movement:
  - lost, shopping, ambling
  - mode of transport (taxi, bus, foot, bike)
- Modelling familiarity (of places, of route repetition)
- Linking to previously learnt places of interest

Location / ‘facing’ aware device

- Smartphone locational technologies:
  - x, y, z, digital compass, accelerometers, GNSS (GPS, Glonass), or direction from GNSS vectors…
- Variable precision: Pedestrian accessibility model

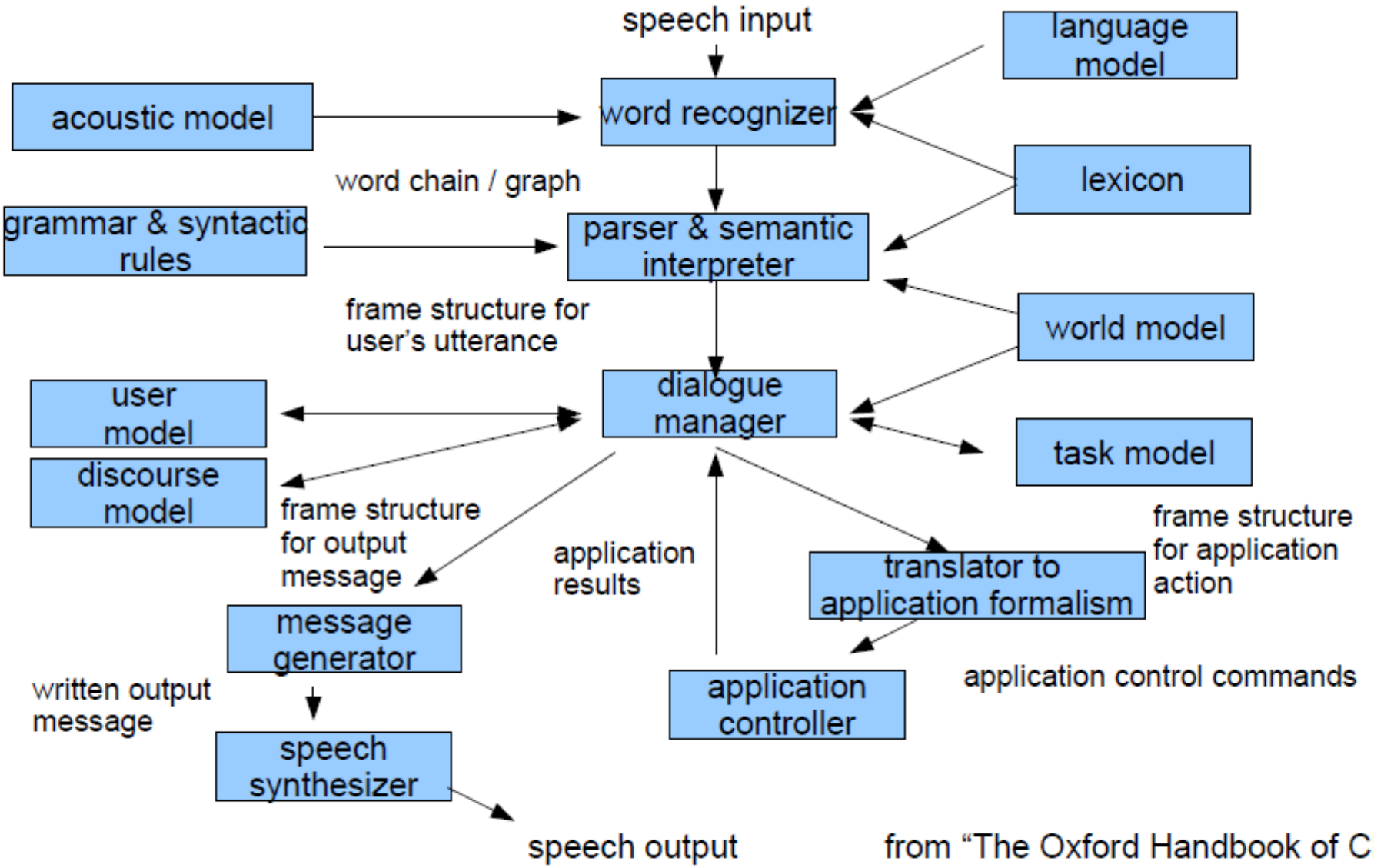


Spoken Dialogue System

Requires various speech and language technologies:

- Automatic speech recognition – convert audio signals of human speech into text strings
- Language understanding – to interpret meaning of recognized utterances
- Dialogue processing and response planning – to generate cooperative and useful system replies
- Text to speech synthesis – convert answer into speech output

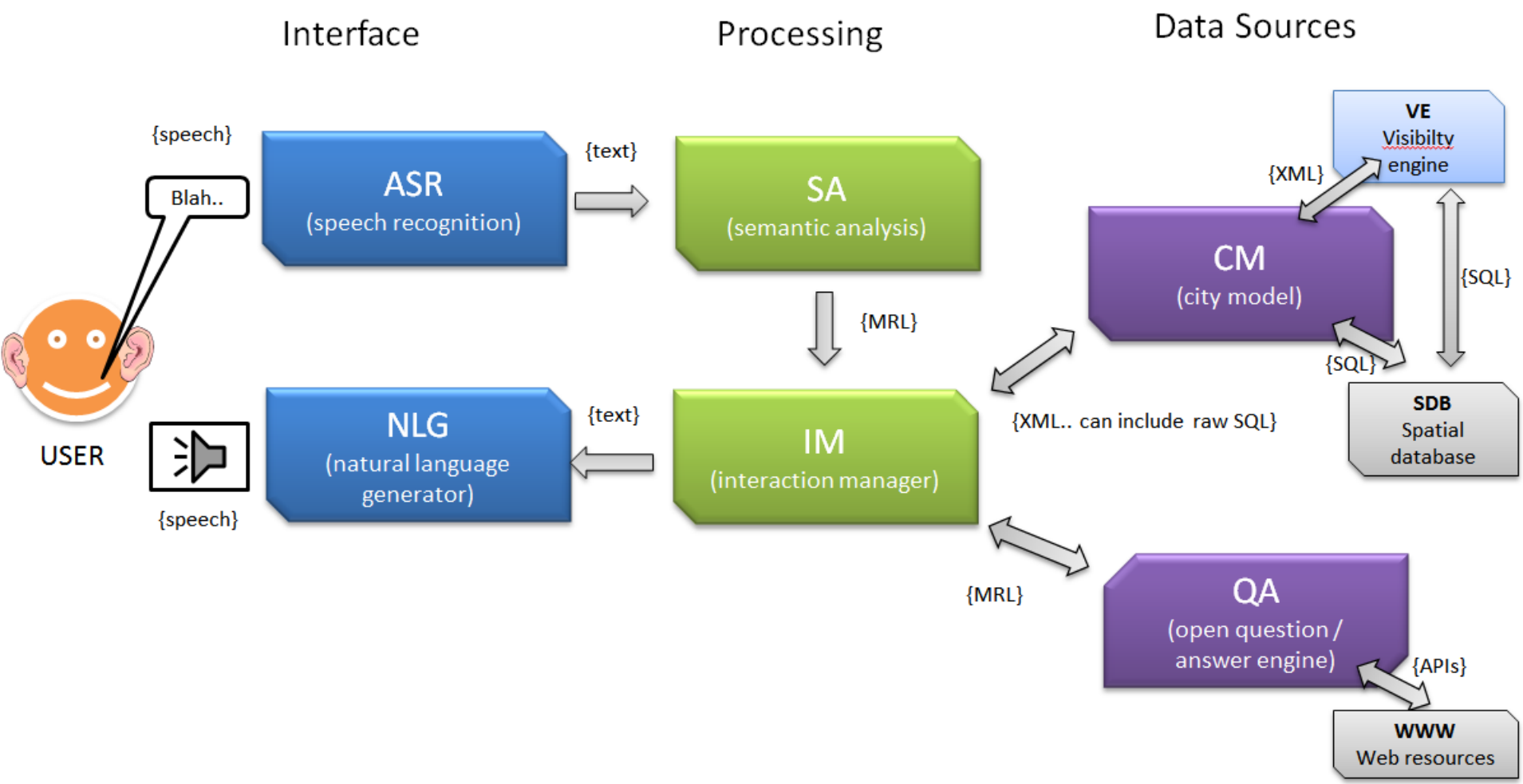
SDS Architecture



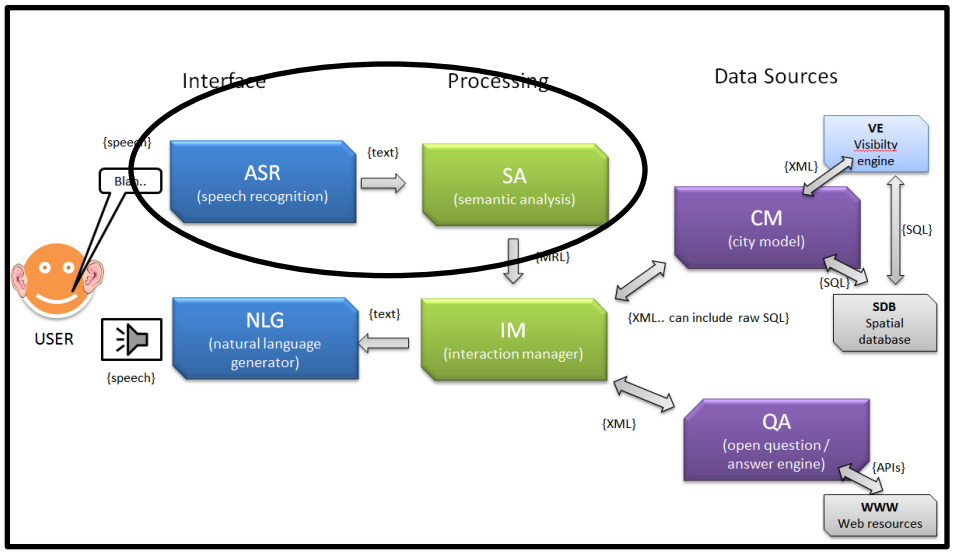
from "The Oxford Handbook of CL"

Bring the pieces together…

SpaceBook Components



MRL – meaning representation language

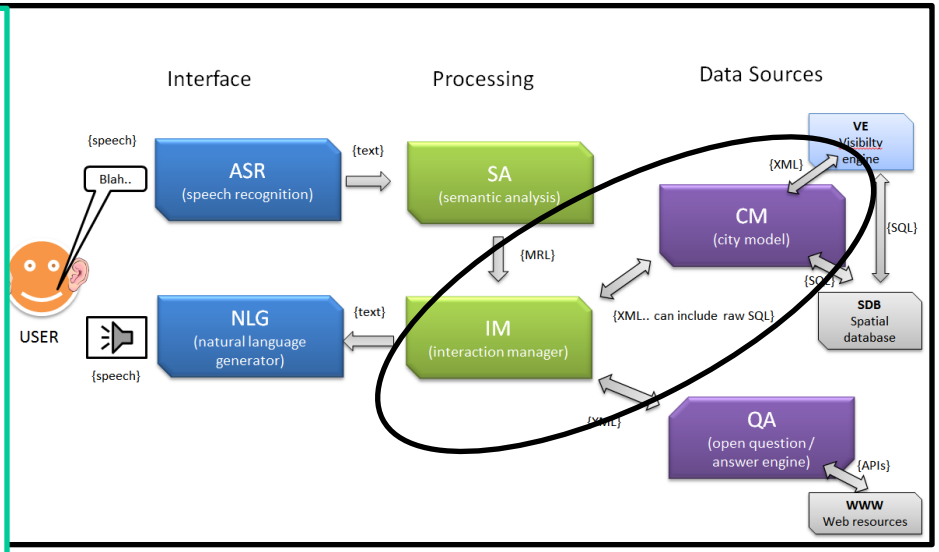



```
dialog_act('request', H),
H:route(T, from:@USER, to: R),
isNamed(id:R, name:'Vapiano\'s')
isA(id:R, type:'restaurant'),
hasCuisineType(id:R,'italian')
```

City model

MRL – meaning representation language

Goal: Route (not necessarily to be navigated now)
From: current location
To: Vapiano's Restaurant
Sells: Italian food

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isA(id:R, type:'restaurant'),
hasCuisineType(id:R,'italian')
```

City model

Conclusion

- Innovative
  - High dimensional city modelling
  - Pedestrian modelling
  - Augments information via speech based interaction / conversational – ‘Hands free eye free’
  - Real time / high speed retrieval from large databases using spatial indexing techniques
- Broader applications:
  - hill walking, Visually Impaired, Spatial Note Taker, Military, Gaming, social networking (SpaceBook-FaceBook)

Conclusion

- Dialogue based digital assistants – the future?

- “The most profound technologies are those which disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it” Marc Weiser

- instantaneously responds, in a non intrusive, non prescriptive manner – ‘dynamically context-aware’ (Stephanidis, 2003)

Questions

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