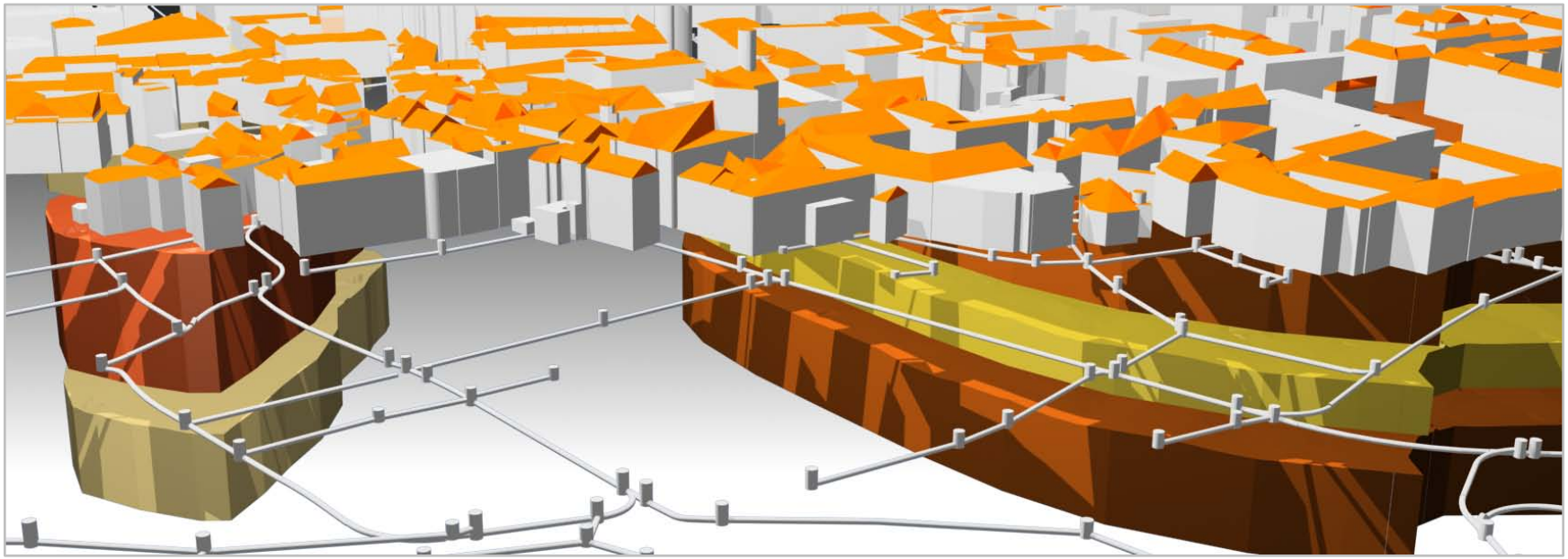
Tackling Uncertainty in Combined Visualizations of Underground Information and 3D City Models



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Motivation

- The data structures of city models is very different from those of underground models
- Information on underground structures is often too vague, outdated or even completely wrong
- Information about geology is known only at certain points. Approximation schemes are necessary

Motivation

- An integration of underground structures in city models would yield large benefits in terms of orientation and navigation.

- Visualization of uncertainty would help decision makers by adding valuable information.

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What?

Development of a **3D visualization software** that processes standardized information on underground and city models.

Why?

Sustainable development of cities regarding urban planning, environmental protection and disaster management.

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Source categories of uncertainty

Category	Attribute Examples	Location Examples	Time Examples
Accuracy/error	counts, magnitudes	coordinates, buildings	+/- 1 day
Precision	nearest 1000	1 degree	once per day
Completeness	75% of people reporting	20% of photos flown	2004 daily/12 missing
Consistency	multiple classifiers	from / for a place	5 say Mon; 2 say Tues
Lineage	transformations	#/quality of input sources	# of steps
Currency	census data	age of maps	$C = T_{present} - T_{info}$
Credibility	U.S. analyst interpretation of financial records <…> informant report of financial transaction	direct observation of training camp <…> e-mail interception with reference to training camp	time series air photos indicating event time <…> anonymous call predicting event time
Subjectivity	fact <…> guess	local <…> outsider	expert <…> trainee
Interrelatedness	all info from same author	source proximity	time proximity

Sources of uncertainty (MacEachren et al. 2005)

Visualization of uncertainty

Possible concepts:

- **Add glyphs**
- Add geometry
- Modify geometry
- Modify attributes
- Animation

Pang et al. 1996

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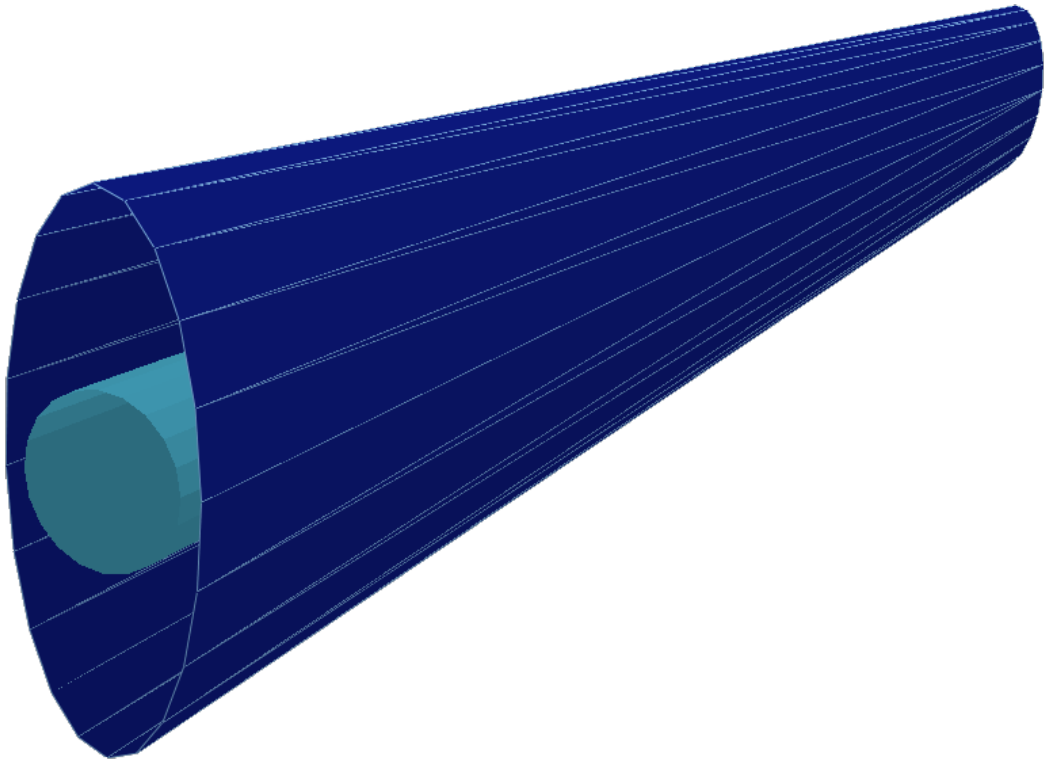
Visualization of uncertainty

Example of uncertainty visualization in geometry data



Visualization of uncertainty

What about uncertainty in other attributes?

➔ Visualization is difficult for qualitative data

<u>A workshop with domain experts helped us:</u>

- For most attributes only two degrees of uncertainty are necessary: certain or uncertain
- Only the expert can decide
- Visualization using color categories looks very promising

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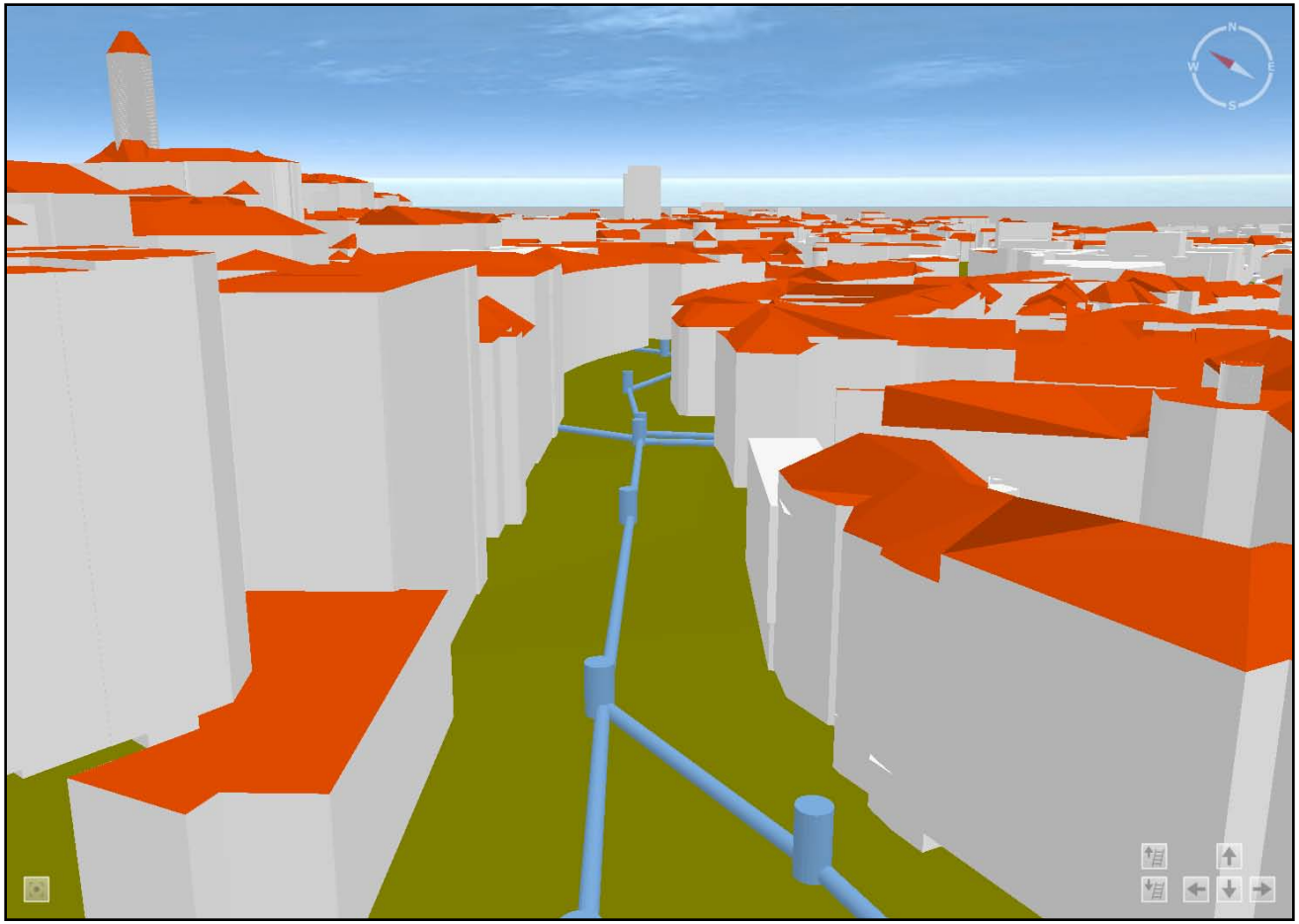
Combining different techniques



Thank you for your attention!

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