Architectural Informatics
A brief Introduction and some Applications

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Background Dr. Bittermann

- Architect, born in Germany in 1976; field experience at 1100 Architect Manhattan and Oosterhuis NL, Rotterdam
- MSc in Architecture at TU Delft, in 2003
- PhD in Design Informatics at TU Delft 2009
- Awarded Post-Doctoral Fellowship Grant of University (80kEuro = 210kTL)
Background Dr. Bittermann – Recent Educational Activities

- Responsible tutor for five MSc courses and co-tutor of one BSc course

<table>
<thead>
<tr>
<th>Year</th>
<th>Course Code</th>
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<tbody>
<tr>
<td>2012/2013</td>
<td>AR4AC010</td>
<td>Computational Architecture: Graduation Studio (MSc semester 4)</td>
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<tr>
<td>2012/2013</td>
<td>AR3AC010</td>
<td>Computational Architecture Design Research (MSc semester 3)</td>
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<td>2012/2013</td>
<td>AR3AC045</td>
<td>Computational Architecture Graduation Studio: Graduation Preparation (MSc semester 3)</td>
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<td>2012/2013</td>
<td>AR3AC200</td>
<td>Computational Architecture Digital Design and Fabrication Technologies (MSc semester 3)</td>
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<td>2011/2012</td>
<td>BK4070</td>
<td>Informatica 3 (BSc semester 4)</td>
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<td>2011/2012</td>
<td>AR3AE020</td>
<td>Architectural Engineering: Design Theory (MSc semester 3)</td>
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I coordinated a Joint MSc program with METU.

Last semester six students graduated as MSc – one of them Cum Laude.
Challenge

Architectural design is complex, making it difficult to ensure its effectiveness. This is due to

- Soft, multi-facetted objectives
- Perceptual information
- Conflicting objectives
Definition

Informatics concerns understanding, and engineering of information processing systems.

Architectural Informatics regards design as such systemic information processing.


The Apropriate Methodologies

Due to design’s soft, perceptual, and multi-objective character, Architectural Informatics methodologies need to be modern and multi-disciplinary ones.

Namely, they comprise combinations of these computational methodologies:

- Probabilistic
- Possibilistic
- Neural
- Evolutionary

With reference to Biomimickry and similar notions, it might be needless to say that development of the methodologies presumably involved inspirations from nature.
An Example Application: Perceptual Density Analysis

The ‘Barcelona Pavillion’ by L. Mies-van der Rohe

Some references:


An Example Application: Perceptual Density Analysis cont’d
An Example Application: Perception-based Layout (MSc studio project) cont’d

Selected Pareto solution

Pareto optimal layouts obtained through multi-objective evolutionary search
An Example Application: Perception-based High-rise Design (MSc studio project)
An Example Application: Performance Analysis using Fuzzy Neural Tree

- Quantifying performance of architectural designs is necessary, however it is rather challenging, because criteria are soft. That is, they involve imprecision and uncertainty at the same time.

- The origin of the softness are the many detailed attributes of a design that influence performance simultaneously, while human can pay conscious attention to merely several abstract concepts at once.
Fuzzy probability-possibility computation for information aggregation, simulating human’s concept-based abstraction

Variation of the likelihood function $L(\theta)$ with respect to $\theta$ and $x$ jointly


An Example Application: Performance Analysis using Fuzzy Neural Tree
cont’d

A Fuzzy Neural Tree for performance analysis of a residence design
An Example Application: Performance Analysis using Fuzzy Neural Tree cont’d

\[ P_{\text{max}} = 0.73 \]

\[ P_{\text{max}} = 0.70 \]

Precision comparison of design alternatives based on the node outputs
An Example Application: Evaluation of Design Strategies (MSc studio project)

Environmental performance

$P_{\text{present}} = .83$

$P_{\text{renovation}} = .89$

$P_{\text{new}} = .95$
An Example Application: Design of a Multi-functional Complex

An Example Application: Design of a Multi-functional Complex cont’d

```
maximize p_{func}
functionality performance

maximize p_{energy}
energy performance

maximize p_{form}
form preferences
```

model inputs
model output

logic operation
An Example Application: Design of a Multi-functional Complex cont’d

$p_{D1} = .74$
functionality .74
energy .80
form .57

$p_{D3} = .65$
functionality .58
energy .52
form .80
Conclusions

- Effectiveness of Architectural design is enhanced through Architectural Informatics.

- For this, advanced computational methods are imperative, that are able to cope with the complexity issues of architectural design, namely
  - soft, multi-facetted knowledge
  - perceptual information
  - conflicting objectives
Conclusions

- Through architectural informatics, design professionals use their creativity and intuitive knowing with less risk of producing designs that have some undesirable, yet avoidable properties.

- From a scientific viewpoint, deeper insight into design is gained through the computational modelling.

- This may have some relevance also to other scientific areas, where design still remains largely a mysterious phenomenon.
Acknowledgement

- The Architectural Informatics developments presented above could only be achieved through the unique importing of multi-disciplinary knowledge from exact sciences to a soft domain, which was due to Professor Özer Ciftcioglu’s research activities in the last decades.

- His generosity, providing his knowledge to Architecture and to architects, for instance through our collaboration that has been going on for one decade, is gratefully acknowledged.
Thank you.

The publications are available at http://akademik.maltepe.edu.tr/~m.s.bittermann/