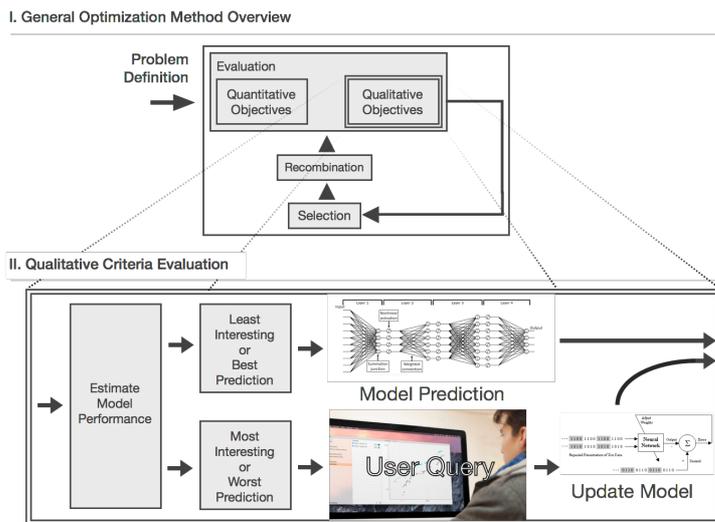


## Incorporating Qualitative Criteria in Multi-Objective Architectural Design Optimization through Interaction: An Adaptive, Cognitive Framework

**Keywords:** Qualitative Criteria, Interactivity, Evolutionary Computation, Multi-Objective Optimization, Cognition, Aesthetics

**Department of Architectural Engineering & Technology, Chair of Design Informatics**

**Area of Research: Computation & Performance**



**Research Summary:** Architectural design entails, to a large degree, criteria that are not easily quantifiable. Such criteria are related to psychological and cognitive aspects of design, such as spatial experience and aesthetics. Due to this fact, the use of computational optimization methods in architectural design, while having the potential to benefit design a great deal, is severely limited. The motivation behind this thesis is to facilitate the inclusion of qualitative criteria alongside quantitative objectives, in an integrated computational optimization framework. We consider as a starting point the proposition that decision maker input is invaluable in providing information regarding their preferences, and that the decision maker should be involved during the optimization process. Interactive optimization systems, such as Interactive Evolutionary Computation (IEC), are high on the modern scientific agenda, but encounter challenges dealing with human cognitive limitations. This thesis proposes an adaptive and cognition modeling framework, that can capture the preferences of the user, while complying to human cognitive limitations at hand. Furthermore, we address the issue of integration of the proposed framework to a multi-objective approach, with the aim of simultaneously tackling qualitative and quantitative objectives, in demanding real-world problems. Finally, we validate the proposed framework on a real-world design problem and conduct a user survey to evaluate the effectiveness of the proposed method.

**Research Methodology:** Identification of critical cognitive factors and limitations in decision maker involvement through review of the state of the art in Evolutionary Computation and Interaction; comparison and implementation of machine learning models for modeling user qualitative preferences; theoretical foundation, development and implementation of methods for progressive derivation of said machine learning models; integration with quantitative objectives in a multi-objective framework; identification of suitable user interaction methods; implementation of software tools and interfaces; appropriate metrics for evaluating method performance through user surveys.

**Key Publications:** I. Chatzikonstantinou and S. Sariyildiz, "Approximation of simulation-derived visual comfort indicators in office spaces: a comparative study in machine learning," *Archit. Sci. Rev.*, no. August 2015, pp. 1–16, Aug. 2015;

I. Chatzikonstantinou, "A Computational Intelligence Decision-Support Environment for Architectural and Building Design: CIDEA," in *IEEE Congress on Evolutionary Computation 2016*, 2016, pp. 3887–3894.



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### **Main Question:**

*How can qualitative and subjective criteria be successfully incorporated in computational optimization for architecture?*

**Deliverables:** 1. Novel method for incorporating qualitative criteria during optimization through user involvement. 2. Digital tools and interfaces implementing said method and state-of-the art multi-objective algorithms. 3. User study validating said method on real-world design problem.

**Updated: November 1, 2016**