Workshop Proposal

"Sharing Computable Knowledge"

Structuring of Teaching and Learning Situations in Architectural Education

Using and Integrating Digital Analysis within Interactive Genetic Algorithms

Matthias Kulcke[1], Wolfgang E. Lorenz[2], Gabriel Wurzer[2]

[1]Hamburg University of Technology/HafenCity University Hamburg,
[2]Vienna University of Technology; Institute of Architectural Sciences;
Digital Architecture and Planning

Title
Structuring of Teaching and Learning Situations in Architectural Education

Subtitle
Using and Integrating Digital Analysis within Interactive Genetic Algorithms

Objectives and contribution to the Conference
The main objective is to enable participants to develop their own design teaching processes and strategies utilizing interactive genetic algorithms in combination with computer aided analytic approaches on different layers of Gestalt.

In a given framework, participants will use the self-developed software "gradient analysis" to optimize and analyze (freehand) design objects in regards to their proportion complexity. The fitness value of a given object is determined by an interactive genetic algorithm (IGA), which evaluates the degree of proportion complexity and creates variations with an optimized degree of proportion complexity. After a brief introduction on gradient analysis, participants will work on an exemplary task in a freehand drawing session. The central issue of the workshop is the following optimization of those freehand designs by using "gradient analysis".

The members of the eCAADe community are particularly suited to test and work with "gradient analysis", since they bring along knowledge and experience in both, design and mathematical/computational understanding. Moreover, during the course of the final discussion, the organizers expect valuable input to benefit design education, since the software will be integrated in the learning environment. The eCAADe community on the other hand can enhance their skills in applying IGA and learn a new way of interacting with and optimizing their designs with respect to proportion.

Workshop size
"Half day" workshop (4 hours)

Maximum number of participants
20

Prerequisite skills
There are no prerequisite skills required. Laptop is not needed; however, participants may use the software on their own device.

Preliminary schedule

09.30	welcome remarks, (technical) set-up participants
09.45 - 10.15	presentation on gradient analysis and the use of IGA
10.15 - 10.45	presentation of exemplary task and freehand drawing session
10.45 - 11.45	optimization of freehand designs by using the gradient analysis IGA
12.00 - 12.15	coffee break
12.15 - 12.45	short presentation of participants, experience
12.45 - 13.15	discussion, process optimization, questionnaire
13.15 - 13.30	feedback on workshop
13.30	end of workshop

Logistic and technical requirements
We will need a projector. Furthermore, we will need access to a scanner and a printer.

Workshop organizers

1. Matthias Kulcke
   Hamburg University of Technology,
   HafenCity University Hamburg
2. Wolfgang E. Lorenz
   Vienna University of Technology, Institute of Architectural Sciences, Digital Architecture and Planning
3. Gabriel Wurzer
   Vienna University of Technology, Institute of Architectural Sciences, Digital Architecture and Planning

Workshop organizers biographies

1. Matthias Kulcke, born 14.12.1972 in Schleswig, Germany, studied “Architecture” at the University of applied sciences, Hamburg (1995-1999), “Multimedia Information Technology” at the University of applied sciences, Lueneburg (1999-2000, certified project manager) and “Stage Design” at the Berlin University of Technology Master of Arts (2000-2002). He was free-lance furniture and stage designer from 1996-2009. Since 2008 he is lecturer at the Hamburg University of Technology for furniture design and freehand drawing, since 2009 lecturer at the HafenCity University Hamburg for furniture design and temporary architecture and since 2010 scientific assistant at Hamburg University of Technology. Since 09/2013 he is a PhD candidate.
2. Wolfgang E. Lorenz, born in Vienna in 1972, studied Architecture at the University of Technology in Vienna, Austria. His diploma thesis on “Fractals and Fractal Architecture” was compiled under the supervision and in cooperation with the department of computer aided planning and architecture, where he has been employed since March 2004. The main focus of his research work lies on the examination and elaboration of the concept of applying fractal geometry to architecture. He holds a Doctor in Architecture for his thesis on “Analysis of Fractal Architecture using the Box-Counting Method” (Vienna UT, 2014). Since 2006 he holds lectures together with Gabriel Wurzer on programming for architects and agent-based simulation.
3. Gabriel Wurzer is a researcher at the Vienna University of Technology in Austria, focusing on architectural science, agent-based simulation in NetLogo and programming for architects. Furthermore, he is also excited to participate in simulation for archaeology (which he conducts together with the Natural History Museum Vienna, especially for the Hallstatt excavation site). Before going into full-time research, he has also been working on the Electronic Health Record of Lower Austria (NÖ-ELGA) and been in Healthcare IT. He has a degree in Computer Science (Dipl.-Ing.), a PhD in Architecture from Vienna UT, where he has also habilitated on the Subject of "Agent-Based Simulation for Early-Phase Planning of Complex Buildings".

Workshop organizers experiences on conference/workshop organization

2010: 1-day Workshop “Build The Code Workshop”, ITU, Istanbul;
Sema Alacam, ITU; G. Wurzer, W. Lorenz

2011: 2-days Workshop “Agents In Archeology 2011 - NetLogo Workshop”, Naturhistorisches Museum Wien;
G. Wurzer, W Lorenz,

2012: 1-day Symposium “CAD/CAM, design and production strategies”, stilwerk Hamburg;
M. Ludolph, M. Kulcke

2012: 1-day Workshop “Build The Code Workshop”, Bialystok, Poland;
G. Wurzer, W. Lorenz

2012: 1-day Workshop “Netlogo & Agents 1: Netlogo Basics” and “Netlogo and Agents 2: Netlogo Simulation Exercise”, Prague, Czech Republic;
G. Wurzer, W. Lorenz, N. Popov

2013: 3-day Design-Workshop “Gamestorming”, Polytechnical University Kabul;
A. Naeim (Alma Terra e.V.), M. Kulcke (HafenCity University/Hamburg University of Technology)

2014: 1-day Workshop “PacMan, Meet Architecture”, eCAADe Regional Workshop, Bialystok;
G. Wurzer, W. Lorenz, C. Degendorfer

2015: Conference and Workshop “eCAADe 2015 - 33rd Annual Conference 16th-18th September 2015”
T. Grasl, W. Lorenz, B. Martens, R. Schaffranek, G. Wurzer

2016: 2-day Round Table Session “Life Cycles” European Cultural Center, Palazzo Mora, Venezia, Biennale Architettura;
B. Price (Prairie View University / USA), M. van Lidth de Jeude (A-01 / CR), O. Schuette (A-01 / CR), M. Kulcke (HafenCity University/Hamburg University of Technology / D)

"Sharing Computable Knowledge"

Structuring of Teaching and Learning Situations in Architectural Education

Using and Integrating Digital Analysis within Interactive Genetic Algorithms

Matthias Kulcke[1], Wolfgang E. Lorenz[2], Gabriel Wurzer[2]

[1]Hamburg University of Technology/HafenCity University Hamburg,
[2]Vienna University of Technology; Institute of Architectural Sciences;
Digital Architecture and Planning

In the workshop participants will extensively test a tool called “gradient analysis” in a given framework. “Gradient analysis” is the name of a continually developed computer software, which allows users to analyze and optimize design objects in regards to their proportion complexity (Kulcke et al 2015, 2016). Since the software is undergoing a process of permanent evolution, particular attention will be paid to the analysis and discussion of the results. Another focus is laid on the discussion of a possible integration into the learning environment.

In order to create a responsive system to be used within a design- or learning process the gradient analysis has been integrated in an interactive genetic algorithm (IGA). Within the IGA it serves to determine the fitness value of a given object evaluating the degree of proportion complexity and to create variations with an optimized degree of proportion complexity.

The presented method of analysis to evaluate a certain layer of design quality is used exemplary to test the integration of design analysis via an IGA into a design learning context. Alternative methods for evaluating design complexity, like easy access fractal analysis (see Wurzer and Lorenz 2017), may also be integrated into a similar design process. Participants are held to adapt the process to their analytical focus or expertise within their own teaching environment.

The process

The design process as considered in the workshop consists of three phases:

1. Freehand form development by sketching objects into a given rectangular field plus image enhancement and measurement extraction (Fig.1).
2. Evaluating the intuitively chosen proportions by using the gradient analysis IGA and semi-automatically producing alternative versions on the basis of proportion analysis (Fig.2).
3. Comparing and choosing the final version, thus optimizing or confirming the initial design gained by sketching.

The workshop content

As preparatory steps the participants are familiarized with the general theoretical approach of proportion complexity and proportion optimization. Then they are taught to use scanning and an image enhancing process allowing to feed the intuitively reached object into the web application to apply the IGA for proportion optimization. The actual task is presented as a design task to develop a prefabricated concrete façade module with two openings, especially focusing on a pleasing design considering the placement and size of the windows or doors. The height and width of the desired element are given, participants are asked to choose the openings boundaries as parallels to the rectangular boundary of the overall object. The participants are advised to draw a minimum of six variations and encouraged to optimize a favoured first design by iteration i.e. by sketching it again with alteration of measurement, but preserving the general idea of the previous design. After choosing two favourite designs from the sketching phase, these are scanned and opened within the image enhancing software. The sketched and digitalized rectangles receive an overlay of digital rectangles as a means to retrieve the measurements of the openings. These are chosen by the participants who visually control the process, especially regarding if the overlay rectangles still represents or even betters their design aim. The measurements of the favoured two variants can now be entered into the user interface of the gradient analysis IGA to serve as parents, as the starting point for the interactive genetic algorithm. Again in several cycles the proportions of the openings within the facade element are optimized, chosen by the numerical gradient quotient and visual appearance. After several cycles the participants receive an output of the favoured solution of each cycle out of which again two favoured designs can be chosen. These are then put to comparison to the top design solution from the first phase of sketching. Finally each participant presents his or her work and voices the choices he or she has made on the way toward the final design.

Advanced Task

The integration of user choices remains an important focus as the developers intend the tool to be utilized as a cognitive and analytic aid during the design process and not as an automatic design generator. For the workshop the software will be developed further in order to allow users to manipulate elements of the IGA themselves while producing design variations e.g. implementing their own cross over masks (see Coates 2010, König 2010).

In a further step the genetic algorithm will be adapted by the participants and implemented, e.g. including random values for cross-over. Such an adaption is related to the individual design process and preference.

Previous Test cases – The implementation in the learning environment

The approach has undergone first testing with students in the winter 2016/17 and the students feedback is taken into account to optimize the process and the interactive algorithm (see Poirson et al 2010) for further implementation in design education. A crucial point is the carefully adjusted use of different media (sketching in combination with analyzing/choosing within the GUI of the IGA). On the basis of testing the IGA within the learning environment changes have been made to the algorithm to optimize the design process. The comparability of the task is significantly changed by seemingly small alterations in regards to given rules and constraints.

To gather and evaluate student feedback a qualitative approach is in development. The status quo is using narrative interview technique and computer aided qualitative content analysis. It is part of the workshop to discuss the optimization of and alternatives to this feedback-process.

Discussion

Allowing participants to use edges that are not parallel to the boundaries of the rectangle, using rounded corners or organic freeform is of course possible. But this should be done in a way that every participant is aware of that possibility, to ensure comparability for later discussion of the results. A possible variation is also to allow for teamwork and to propose to participants to marry their own favourite design from sketching to one chosen from a colleague, thus building the initial pair for the IGA.

References

Burke, A, 2008, Reframing "Intelligence" in Computational Design Environments. First International Conference on Critical Digital: What Matter(s)?

Coates, P 2010, The Programming of Architecture, Routledge, New York

Herr, C M and Karakiewicz, J 2008, Towards an Understanding of Design Tutoring A grounded study of presentation materials used in tutorial conversations, CAADRIA, Proceedings

Kulcke, M, Lorenz W 2015, Gradient-Analysis: Method and Software to Compare Different Degrees of Complexity in the Design of Architecture and Designobjects, eCAADe 2015 - 33rd Annual Conference of education and research in computer-aided architectural design in Europe; Real Time, At Vienna, Volume: 1

Kulcke, M, Lorenz W 2016, Utilizing Gradient Analysis within Interactive Genetic Algorithms, eCAADe 2016, 34th International Conference on Education and research in Computer Aided Architectural Design in Europe, At Oulu, Volume: 2

König, R 2010, Simulation und Visualisierung der Dynamik räumlicher Prozesse, VS Verlag für Sozialwissenschaften, Wiesbaden

Poirson, E, Petiot, J, Aliouat, E, Boivin, L and Blumenthal, D 2010 'Study of the convergence of Interactive Genetic Algorithm in iterative user's tests: application to car dashboard design', Proceedings of IDMME - Virtual Concept 2010, Bordeaux

Wurzer, G and Lorenz, W 2017, Cell Phone Application to Measure Box Counting Dimension, CAADRIA 2017, Proceedings, Protocols, Flows and Glitches, Suzhou, China

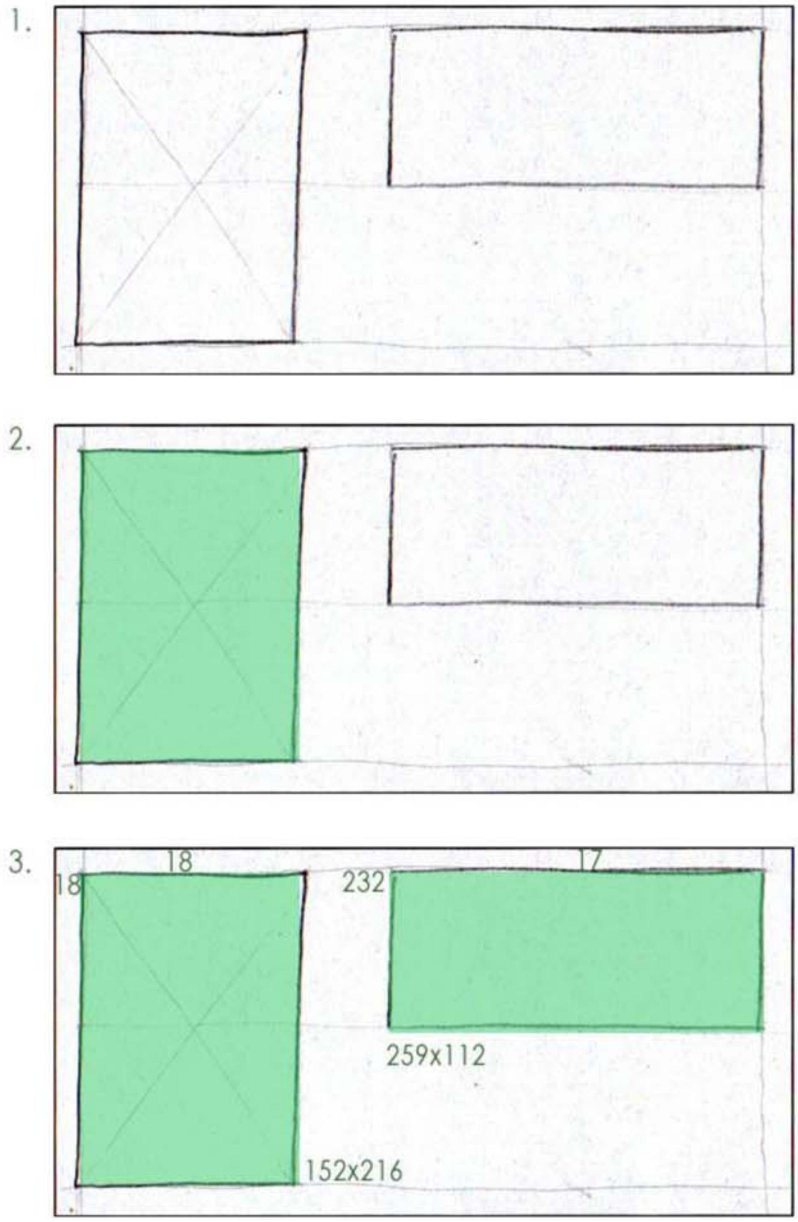

Fig. 1 scan and retrieving rectangle measurements

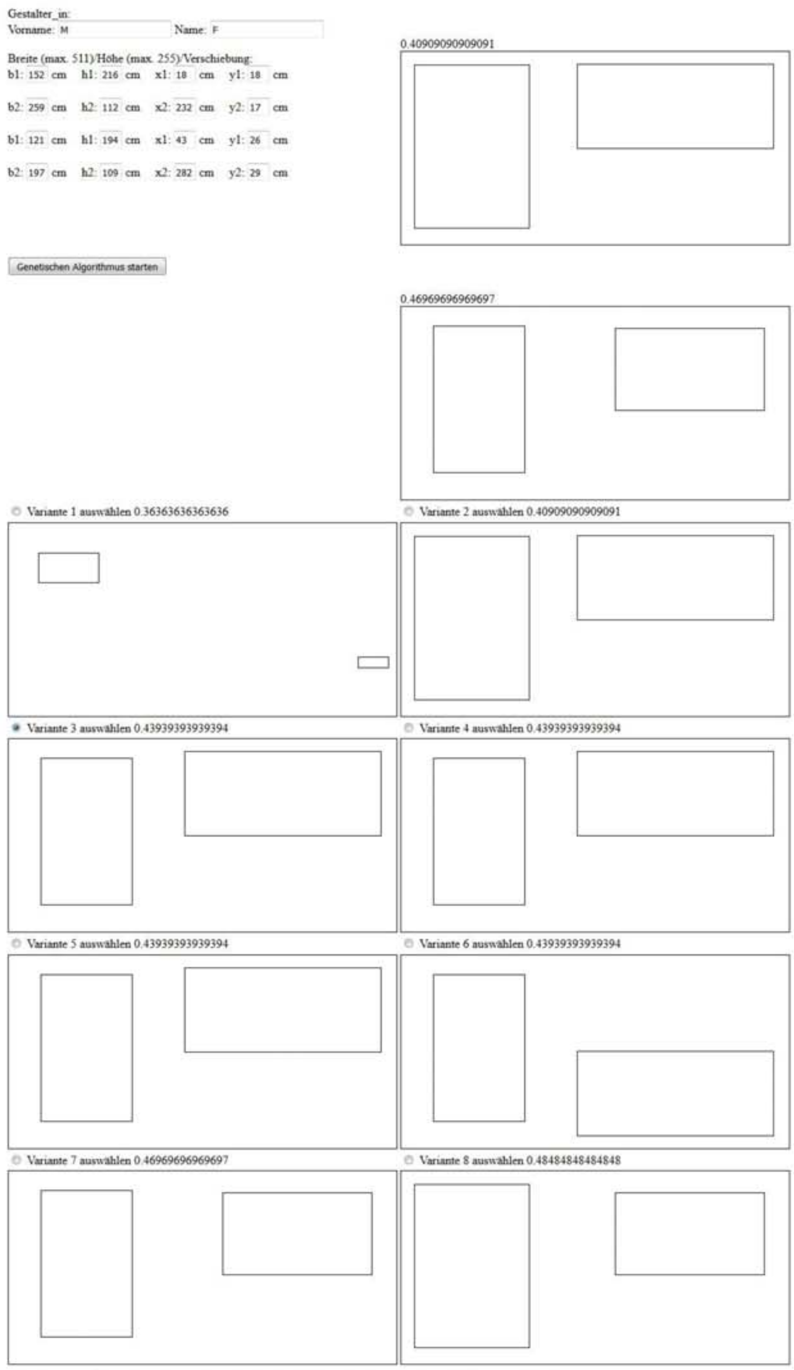

Fig. 2 IGA, first cycle and user choice for next cycle, displaying fitness values