Artificial Plan Designing

THE PARADIGM OF LEARNING CONTROL COORDINATION

What is a plan

A Plan is the design of future changes.
A Plan represents how we will or we should meet current and future needs.
A Plan describes decisions to be implemented.

We focus on spatial decisions and hence spatial plans: architectural plans and urban plans (e.g. building layout, building form, land use plan, facility location-allocation). Plans are not always good representations of our future needs but are always part of the dynamic of change in cities.

Floor plan design.
www.mit.edu/~celani/color-grammar/index.html

Land use plan

What is artificial plan designing

Artificial plan designing refers to the use of computational models to generate plan descriptions. Sometimes it is referred to as “automatic plan generation” or “creative design”.

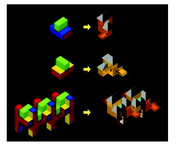
Artificial plan designing is designing:
by machines and computational models
by human-machine interaction
by human- machine network interaction

Motivation for artificial plan designing research

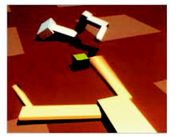
Designing and planning are cyclic processes. Artificial Plan Design supports the generation of solutions and evaluations all the way through the different stages of design.

Designing and planning are collective and multidisciplinary processes. Artificial Plan Design can be used to explore diverse requirements and interdependencies in order to support collective decision making and conflict resolution.

Design and planning are creative processes. Artificial Plan Design makes all trivial computations for us. But it may also reveal unforeseen solutions.



Color shape grammar.
www.mit.edu/~celani/color-grammar/index.html



Karl Sim's evolving creatures.
www.genarts.com/karl

Typical methodological approaches

Optimization: considers design as a search for optimum solutions- uses various optimization techniques to find best solutions under certain constraints.

Evolutionary Design: considers design as a selective and creative process- uses genetic algorithms to create evolving design forms.

Shape Grammars: considers design as a compositional process based on shape vocabularies - generates designs based on the creation and reproduction of grammatical rules.

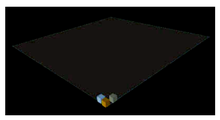
Case-Based Reasoning: considers design as a creative process- focuses on the adaptation and reuse of previous knowledge incorporated in design cases to solve similar problems.

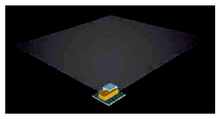
Multi-Agent Coordination: considers design as a search for coordinated solutions that satisfy distributed domain requirements and views.

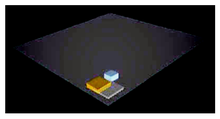
A model for artificial plan designing by “learning control coordination”

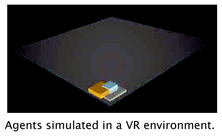
We propose a model-tool that learns by user interaction and then uses this knowledge to generate plan designs.

The problem is defined as a search for locations and physical layout proposals that satisfy distributed and time-variant targets. Expert knowledge for this search is not explicitly incorporated in the model but a Neural Network is used instead to discover and represent interdependencies among decision variables(e.g. among building shape and energy consumption) expressed by distributed sources (decision makers and their domain models).









Agents simulated in a VR environment.

The design problem as multi-agent coordination

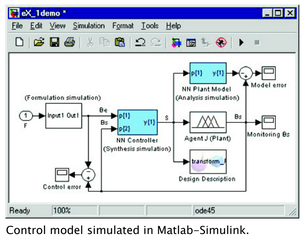
We consider that plan descriptions are built on distributed domain problems and partial proposals developed by agents (human or artificial). For this model plan descriptions are generated within a virtual reality (VR) world and are composed by aggregated objects introduced by users. The specifications of these objects are dynamically identified and modified by human actors directly or via the use of formal models.

The design problem is formulated as a coordination problem among self-interest agents (which are represented as cubes in the VR world) and is addressed via a distributed learning control methodology. Plan descriptions represent coordinated solutions (changes) that satisfy distributed domain requirements and views.

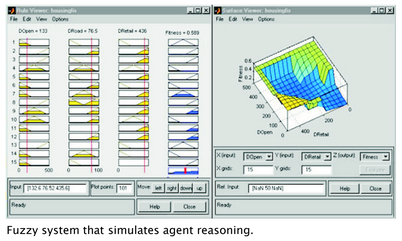
Control based coordination method

The purpose of design based on the control methodology is to find solutions that can direct partial descriptions produced by agents, to follow their dynamically defined targets -despite conflicting requirements.

Control is the process of self-adaptation of agents that leads to coordination of their distributed descriptions.



Control model simulated in Matlab-Simulink.



Fuzzy system that simulates agent reasoning.

Experimentation

A control model has been built based on Adaptive Backthrough Control architectures.
These structures typically use two neural networks: the Controller (the system that controls) and the Plant Model (a model of the system to be controlled). First, the plant model is trained to approximate the plant by learning on line or off-line input-output patterns of the agent behaviour. Then, these patterns are used “backwards” as a guideline for the controller.

We have experimented with mathematical formulations that model agent behaviour (like motion, shape transformation and costs) based on state space methodology, as well as with fuzzy systems.

THEODORE ZAMENOPOULOS AND KATERINA ALEXIOU, CENTRE FOR ADVANCED SPATIAL ANALYSIS, BARTLETT SCHOOL OF GRADUATE STUDIES
1-19 torrington place, london wc1e 6bt, tel 020 7679 5901, http://www.casa.ucl.ac.uk/theodore and www.casa.ucl.ac.uk/katerina, e-mail: t.zamenopoulos@ucl.ac.uk and a.alexiou@ucl.ac.uk