Creation and Comparison of Sustainable Neighbourhood Patterns

533C Project Proposal 10/30/09

Team

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Domain, Task & Dataset

The School of Architecture and Landscape Architecture group at UBC, lead by Dr. Ron Kellett, would like to have an application to facilitate collaboration while configuring groups of elements together to create a portion of a neighbourhood, or *pattern*. These elements could be buildings, open spaces, etc. and each element has numerical attributes, some of which are:

- **Surface coverage** – the amount of pervious or impervious surfaces that record water drainage
- **Population density** – the number of people that reside in a building
- **Building massing** – how much surface area is generated per floor area (e.g. flat vs. tall buildings)
- F**unctional land use** – the amount of residential/commercial/etc. space in a building

Dr. Kellett's group has an existing database of 3D SketchUp models representing elements with their corresponding input attributes. They were created based on design documentation, some field research, and validation from SketchUp's built-in reconciliation steps.

Once a pattern is created numerous quantitative outputs can be computed, including:

- **Energy consumption** – the amount of fuel the neighbourhood consumes
- **Transit density** – to determine if there are enough people in jobs to justify high density transit
- **Total population density** – how many people will live/work in the neighbourhood
- **Land use diversity –** how many different kinds of elements are there in a pattern
- **Pedestrian connectivity –** how easy is it for people to walk around

The group currently designs patterns using pieces of paper on a large table relative to the size of the pattern being created. They do not currently have a method of dynamically computing output values for ad hoc pattern creations.

Personal Expertise

This project will be directly related to my MSc research. It will serve as a first step in designing a collaborative pattern-creation application for a multi-touch table. This project will result in a single touch, single user application that in the future will be modified into a multi-touch/user system.

I have no previous experience in sustainability or architecture design, but I have a small amount of previous experience in working with the SMART Table SDK. I also have done a fair bit of background research on multi-touch technology in HCI as it relates to my thesis. Though this will not be a multi-touch application at this point I will be considering ways to develop it in order to easily migrate it to enable that functionality.

Proposed Infovis Solution

I intend to develop an infovis system with several components, the central one being a spatial display of a neighbourhood pattern. I will discuss each component in turn.

Pattern Display

This component will initially display a street layout of a portion of a neighbourhood where users will be able to add elements one by one into various empty lots. The elements will be displayed as a top-down view of their 2D models, coloured corresponding to their landuse (yellow = residential, red = commercial, orange = mixed, purple = industrial, blue = civic, green = open spaces). These are colours the group currently utilizes and they are already very accustomed to them.

Output Values Display

As a user adds elements to the pattern, the attributes of those elements contribute to the output values which will be visible on the screen in a bar chart. The values will be dynamically updated as each element is added. If the user has chosen to attempt to optimize for one or more output variables (e.g. energy consumption < n) then those variables will stand out in the chart and the user will be given affordances as to how close they are to meeting the optimization.

Pattern Comparisons

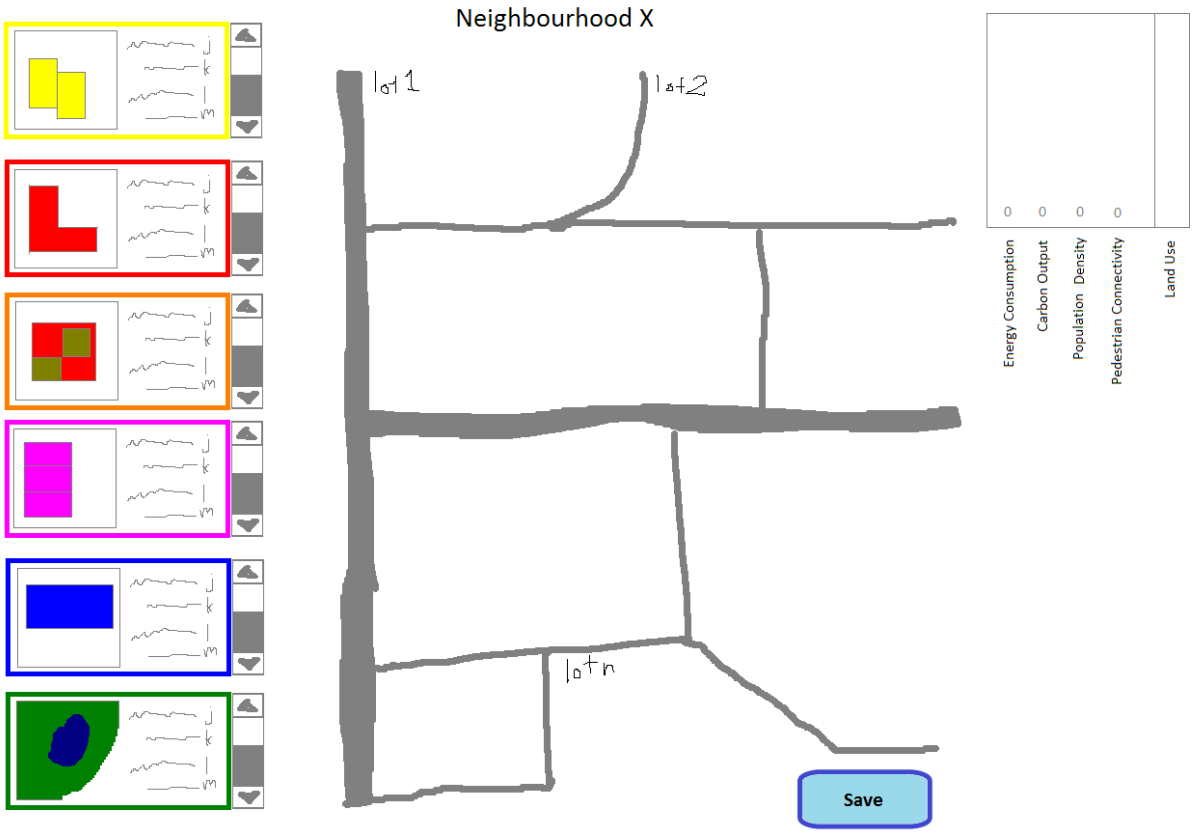
To facilitate the iteration of creating multiple patterns and comparing their respective charts of output values, I will create a small multiples component that will present scaled-down bar charts of output values for the patterns created thus far. At any time a user could save the current pattern they are working on and its small multiples representation will be added to the component's list. A user could also click on one of the small multiples icons to bring up that pattern's layout in the pattern display component.

Element Selection Menu

I will create 6 small scrolling menus, one for each element type, which will allow users to scroll though and select the element they wish to place in the pattern. The top-down view of the element will be present along with its most important attributes. Affordances will be present to indicate the strength of an element's candidacy based on its attributes; for instance, if a user wished to minimize the transit density while scrolling through residential buildings, those with a high housing density would have that attribute highlighted in red to indicate that they would not help contribute to that optimization.

Scenario of Use

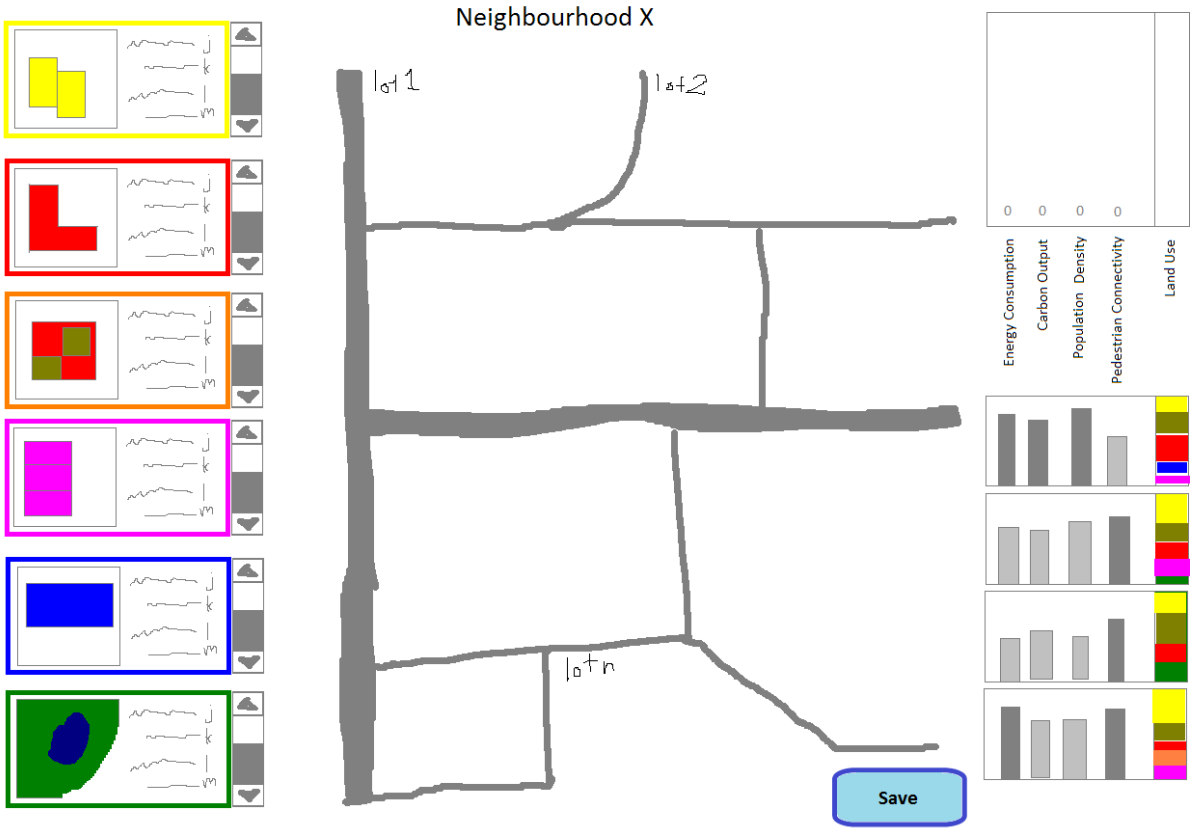
The user wishes to create a pattern for a pre-defined street layout. They first load the system and are presented with an empty street layout for a section of a neighbourhood with several empty lots. The left hand side has menus full of elements, one for each of the 6 types. On the right side there is a bar chart for the output values, though none have been calculated yet. (For the purposes of this project I will not go into design of the street layout.)



In this case the user wishes to minimize Energy Consumption and maximize Population Density, so they select those two options in the output component. They then begin designing the pattern, dragging elements from the menus, rotating and placing them in various lots. The output values are automatically updated as each element is added. Since each output is at a different scale from the others, their values are displayed on top of the bars, except for Land Use which is displays the percentage of use of each type of element.

The user can keep an eye on the output values as they create the pattern: high brightness indicates that the values are low (and likely within acceptable levels) and darkness indicates the values are high (and may be problematic). The bar charts will be coloured in grey scale since colour will be heavily used in the spatial component. There are also affordances to help the user decide which elements to place next; those which have attributes which could help/hinder the desired outcome are displayed with a green/red colour.

The user continues to build up the pattern to completion, saving it when they're finished. The pattern is then minimized into a small multiples icon below the output component. The user iterates and creates a few more patterns, saving them as well until they have a collection of small multiples they can easily compare. The bars in the small multiples graphs still line up with the labels in the main graph so they're easy to decipher.



If a user wants to review the layout of a pattern, they can simply click on its small multiples representation and its layout will be loaded in the spatial component and its outputs will be loaded into the main output graph.

Proposed Implementation Approach

I will be using the Haaf's Game Engine (HGE) 2D game engine libraries to draw graphics, sprites, and other screen components. The entire application will be created in C++, as required by both HGE and the SMART Table SDK. I will utilize the SketchUp SDK in order to read the existing SketchUp files in the elementsDB database.

Milestones

User Group Interactions

- Perform user observation in a mock session (Nov 13)
    - This is later than desired due to scheduling conflicts of Ron Kellett's group
- Code data and modify design as needed (Nov 17)

Implementation

- Coding architecture design (Nov 9)
- Integrate with the elementsDB database (Nov 10)

- Implementation: create and display the road layout (Nov 12)
- Implementation: create the side menus (Nov 16)
- Implementation: allow users to drag elements and place them on the street layout (Nov 20)
- Implementation: create the output graphs and link them to the attributes (Nov 27)
- Implementation: allow users to save their current layout (Dec 2)
- Implementation: display small multiples and link them to their saved data (Dec 9)

Previous Work

The Landscape Architecture group has done a great deal of field work to calculate the attribute values and make numerous detailed 3D SketchUp models. A portion of the database can be viewed at http://elementsdb.sala.ubc.ca/

Tory, M. and Staub-French, S. (2008). "Qualitative Analysis of Visualization: A Building Design Field Study," in BEyond time and errors: novel evaLuation methods for Information Visualization (BELIV '08), Workshop at ACM Conference on Human Factors in Computing Systems (CHI) 2008, April 5-10, Florence, Italy, 8 pp.

> This paper has some really good information on how to conduct a qualitative user study of designers as well as insight into good data coding methods.

The QuestVis paper draft that you gave me has some really good ideas of doing small multiples to display a "history" of previous approaches.

Liston, K., Fischer, M. and Kunz, J. (2000). "Designing and Evaluating Visualization Techniques for Construction Planning". In Proceedings of the 8th International Conference on Computing in Civil and Building Engineering (Stanford University, CA, USA, Aug. 14-16, 2000), 1293-1300.