EXPLORING RELATIONSHIPS OF AN URBAN SYSTEM; THE CASE OF BEYOGLU

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ABSTRACT
This paper introduces an ongoing research project addressing multi-dimensional and relational complexity of urban features by applying data mining as a methodology of knowledge discovery in urban feature analysis. A methodology is developed for formulation and analysis of an urban database by the complementary application of GIS (Geographical Information Systems) and data mining techniques in order to identify patterns and relationships among multiple urban attributes. The urban database is built upon real and official data of Beyoglu, a historical neighborhood of Istanbul. The paper also includes a specific application of knowledge discovery methodology into Beyoglu urban feature database.

BACKGROUND
With all its dimensions, urban is the most fundamental and complex work, performance, consequence of human kind. Not an object but a phenomenon extending in time and space both physically and socially. Thus the study of urban is multi-dimensional, very complex and speculative in its nature. It is very important to analyze this complexity, as the more we understand urban phenomenon the better we can intervene urban space. Understanding urban phenomenon is directly associated with the study of explanatory kind of urban knowledge.

The lack of explanatory urban knowledge is an issue in the area of urban research since 1960’s. As planning as a design-led practice seemed to fail to explain how urban processes occur, many urban theorists started to criticize analysis of urban system from the perspective of few interrelated factors, without considering the multi-dimensionality of the system, in a deductive fashion (Jacobs, 1961, Lefebvre, 1970 Harvey, 1973) This situation is mostly associated with the conception of cities as a simple object of design and this perspective’s deductive methods of analysis.

In reference to Alexander (1979), the kind of complexity found in cities comes from the interaction and relationships between the different parts at different scales, and over time. Hence, in this paper, an ongoing research project based on the conception of cities as a system of interrelations is introduced. Aiming to open up a way to approach explanatory urban knowledge, this research focus on the relationships between urban features in order to move beyond the simplistic descriptions of urban spaces based on singular and unrelated objects.
The emphasis on the idea of cities made of relations confronts with the idealization of cities as a simplistic object or made of simplistic unrelated objects. It is not possible to explain urban phenomenon without detecting the relational aspects of urban systems.

The type of knowledge that this research provides is a descriptive knowledge that goes beyond a description of solely appearances including what is beyond simple observations, the hidden facts that are not apparent to the naked eye. This type of knowledge can help us in formulating relevant questions about the internal and external dynamics operating in urban space. It can also provide clues to answer those questions and thus provide explanatory knowledge, which basically are these answers.

A framework for uncovering hidden patterns and relationships among urban features is developed, by using conventional thematic urban analysis maps based on the description of urban space made of unrelated singular objects. A particular urban context is chosen as a test area and a particular method of analysis is applied. This research applies data mining (on a GIS based database) as a methodology of knowledge discovery in urban feature analysis with a particular interest in exploring the patterns and relationships of micro-scale data in Beyoglu (a historical neighborhood of Istanbul). Knowledge discovery in databases (KDD) methodology is proposed as opposed to deductive methods of analysis. KDD methodologies are popularly referred as Data Mining, and can be defined as the synthesis of statistics, machine learning, information theory, and computing with a firm mathematical base, and with very powerful tools. (Gray, 2005)

In the paper, some of the outcomes of the analysis process in the form statements describing the relational particularities of Beyoglu historical district are introduced. In a further study, these relational particularities describing interrelations among various aspects of urban features in Beyoglu have great potential to lead to explanatory urban knowledge that can assist architects and urban planners at design, policy and strategy levels, by providing site-specific insight through deeper understanding of urban data. (Sokmenoglu, et al., 2011)

**METHODOLOGY OF THE RESEARCH**

To uncover hidden relationships and patterns of an urban system there is a need of simultaneous consideration of a great number of urban entities, which is almost impossible to operate manually. This particular need brings a need for an automated analysis and discovery method; a computational approach to urban analysis is therefore proposed. For this purpose, this research proposes to use a Geographic Information Systems (GIS) platform as a medium of data management, visualization and analysis and data mining as a method of knowledge discovery in the context of urban feature analysis.

KDD and data mining differ from classical statistics as a multidisciplinary field drawing work from areas including database technology, artificial intelligence, machine learning, neural networks, statistics, pattern recognition, knowledge-based systems, knowledge acquisition, information retrieval, high performance computing and data visualization. (Han & Kamber, 2001) Data Mining is widely applied in many fields of science, engineering and business but it has also applications in geographical information systems, remote sensing and many
other areas related to spatial data, under the name of spatial data mining. Recent applications of KDD and data mining in architectural and urban research can be found in the works of Demsar (2006), Reffat (2008), Behnisch and Ultsch (2008), Gil, Montenegro, Beirao, and Duarte (2009) and Christopoulou (2009). The ultimate goal of data mining is to provide evidence-based insight through deeper understanding of data (in the mind of the analyst) and to produce results that can be utilized at policy and strategy levels.

Data mining is defined as to extract important patterns and trends from raw data (Witten and Frank, 2005). When applied to discover relationships between urban attributes, data mining can constitute a methodology for the analysis of multi-dimensional relational complexity of urban environments. (Gil, Montenegro, Beirao and Duarte, 2009) Data Mining of multiple urban attributes is proposed as a promising alternative methodology next to the many multidimensional methods that has been developed during the seventies, which are extremely useful for data and decision analysis in urban and geographical research. (Nijkamp, 1980) The particularities of KDD and data mining methodologies which make them interesting for this research is that they are in opposition with the confirmatory techniques of analysis which requires a priori hypotheses that restrict the researcher and prevent the discovery of previously unknown information. (Miller, Han, 2001) They also provide analysis methods that have the capacity of incorporating various variables without restricting the analyst to a few ones, thus appropriate for dealing with a large number of diverse and interrelated factors simultaneously operating.

Most of the approaches that have been proposed for knowledge discovery process are mainly variations of a same scheme constituted of an iterative sequence of the following steps: data preparation, data mining and evaluation of the patterns extracted in the form of knowledge. Basic steps of knowledge discovery process defined by Fayyad et al. (1996) is shown in Figure 2.

Figure 1: Basic steps of knowledge discovery process defined by Fayyad et al. (1996)

An adaptation of knowledge discovery methodologies in urban analysis is developed for formulation and analysis of an urban database of Beyoglu. The analysis process has three main stages as adopted from Fayyad et al. (1996), seen in Figure 1. The adaptation of this process proposed in the scope of this research is depicted in the Figure 2 below.
Database formulation is the first stage consisting of building a dataset out of micro-scale urban data (data in the form of any facts, numbers, or text that can be processed by a computer) by using different data sources. The platform used in this stage is GIS, ArcGIS software.

Database analysis is the stage of analysis of the patterns, associations, or relationships among data by applying queries and appropriate data mining methodologies ranging from regression analysis and classification to clustering and exploratory data analysis, by a data mining software application. The platform used in this stage is Rapid Miner, an open source and widely applied and trusted Data Mining software.

Database evaluation and visualization stage consists of the evaluation of the obtained results in the form of correlation amongst variables, data groupings (clusters) or more complex hypotheses and visualization in the form of maps and diagrams. The platform used in this stage is ArcGIS for visualization in the form of maps, Rapid Miner for visualization in the form of scatter plots, etc. and MsExcel for visualization in the form of charts.

Above proposed methodology is also adaptable to a general framework for storing and representing urban entities as objects with properties (features or attributes) and analyzing their interrelations.

Briefly, what is done is to gather and transform various urban data (mainly the thematic urban analysis maps containing conventional one-dimensional and singular description of urban features’ attributes prepared by Istanbul Metropolitan Municipality) to construct an urban database of Beyoglu in GIS and analyze the relationships among these various themes by KDD and data mining methodologies.

In the scope of the Beyoglu district analysis process, a database containing 11,985 buildings with a variety of attributes (forty-five different attributes) is constructed and named as Beyoglu urban feature database. Urban attributes are distinct physical, economical, morphological, demographic...etc. properties of locations (such as built-up area, land-use, land value, slope, density and so
Attributes of Beyoglu urban feature database are collected from a variety of official data sources including Istanbul Metropolitan Municipality, Beyoglu Municipality and some of them constructed by means of GIS tools. These attributes are obtained associated with different levels of observation (building floors, buildings, building blocks, streets and mahalle; formally bordered neighborhoods) but the level of analysis is fixed to the building level. In The Figure 3 below there is a section from Beyoglu, represented in GIS, in the form of a cartographic map, associated with its datatable.

![GIS based representation of Beyoglu](image)

Figure 3: a GIS based representation of Beyoglu, a cartographic map, associated with its datatable.

Building is the basic object of analysis in the scope of this research. Building is an entity with a unique ID and attributes, as seen for instance for buildings ID.8971 and ID.8972, in the Figure 3 above.

Next section introduces an application of the KDD and data mining methodologies into Beyoglu urban feature database; a data mining analysis experiment exploring a particular type of relationship among selected attributes.

**AN APPLICATION OF KNOWLEDGE DISCOVERY IN URBAN FEATURE ANALYSIS**

There are a variety of data mining methods applied in scientific research such as; characterization and discrimination (concept/class description), association analysis, classification and prediction, clustering, outlier analysis, evolution analysis. (Han and Kamber, 2001). The method to be applied is chosen depending on the nature of the analysis problem that the researcher wants to explore.
In the scope of the analysis experiment that we want to introduce in this paper, we want to explore and identify associations and links among land use values of the three floors (ground, 1st, 2nd floors) of the buildings, land price and building footprints, within the district of Beyoglu. We want to explore if and how much these factors are related to each other. For the analysis of this particular problem, we apply association analysis.

Association analysis is the discovery of association rules showing attribute-value conditions that occur frequently together in a given set of data. Association Rules analysis is widely used for market basket or transaction data analysis, which studies the buying habits of customers by searching sets of items that are frequently purchased together (or in sequence). (Han and Kamber, 2001)

Support and confidence are two important basic measures for association rules. Support of an association rule is defined as the percentage/fraction of records that contain X and Y together to the total number of records in the database. Confidence of an association rule is defined as the percentage/fraction of the number of transactions that contain X and Y together to the total number of records that contain X. Confidence is a measure of strength of the association rules. (Kotsiantis and Kanellopoulos, 2006)

Below in Figure 4, there is a workflow diagram illustrating the process of data mining. This process consists of applying a FP-Growth (frequent pattern growth) Learner algorithm to calculate all frequent items sets from the data set and to apply an operator of Association Rule Generator to generate a set of association rules for a given set of frequent item sets.

![Workflow diagram](image)

Figure 4: Process of data mining by means of Association Rules in Rapid Miner

Fifty-six association rules are found by the association rule algorithm, as a result of the analysis process, depicted in Figure 4, above. The results given in Figure 5 below do not contain all the rules that are found by the association rule algorithm. The threshold level for evaluating if a rule is significant is defined based on the confidence of the rule. Rules having a confidence over 0.7 are considered as considerable thus included in the Figure 5. On the other hand, not all of the rules are interesting to display here. Hence among the fifty-six rules only the selected ones are given as the final result of this analysis process of finding association rules between land use values of the three floors (ground, 1st, 2nd floors) of the buildings, land price and building footprints. The results are given in the table below in Figure 5, in descending order based on...
their support value. Higher the support value more likely is the occurrence of the rule within the database.

<table>
<thead>
<tr>
<th>Rule</th>
<th>Premise</th>
<th>Conclusion</th>
<th>Support</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Land use 1st floor = Residential</td>
<td>Land use 2nd floor = Residential</td>
<td>0.04</td>
<td>0.81</td>
</tr>
<tr>
<td>2</td>
<td>Land use 2nd floor = Residential</td>
<td>Land use 1st floor = Residential</td>
<td>0.06</td>
<td>0.85</td>
</tr>
<tr>
<td>3</td>
<td>Land use ground floor = Residential</td>
<td>Land use 2nd floor = Residential</td>
<td>0.21</td>
<td>0.77</td>
</tr>
<tr>
<td>4</td>
<td>Land use 1st floor = Residential, Land use ground floor = Residential</td>
<td>Land use 2nd floor = Residential</td>
<td>0.21</td>
<td>0.76</td>
</tr>
<tr>
<td>5</td>
<td>Land use 2nd floor = Residential, Land use ground floor = Residential</td>
<td>Land use 1st floor = Residential</td>
<td>0.25</td>
<td>0.89</td>
</tr>
<tr>
<td>6</td>
<td>Buildings having only ground and 1st floor</td>
<td>Building footprint = 74.60-152.24 m²</td>
<td>0.20</td>
<td>0.71</td>
</tr>
<tr>
<td>7</td>
<td>Building footprint = 74.60-152.24 m², Land use ground floor = Residential</td>
<td>Land use 1st floor = Residential</td>
<td>0.19</td>
<td>0.94</td>
</tr>
<tr>
<td>8</td>
<td>Building footprint = 74.60-152.24 m², Land use 1st floor = Residential</td>
<td>Land use 2nd floor = Residential</td>
<td>0.19</td>
<td>0.76</td>
</tr>
<tr>
<td>9</td>
<td>Land use 1st floor = Business-Shopping</td>
<td>Land use 2nd floor = Residential</td>
<td>0.18</td>
<td>0.71</td>
</tr>
<tr>
<td>10</td>
<td>Land use ground floor = Business-Shopping, Land use 1st floor = Business-Shopping</td>
<td>Land use 2nd floor = Residential</td>
<td>0.17</td>
<td>0.71</td>
</tr>
<tr>
<td>11</td>
<td>Land use ground floor = Business-Shopping, Land use 2nd floor = Business-Shopping</td>
<td>Land use 1st floor = Residential</td>
<td>0.17</td>
<td>0.97</td>
</tr>
<tr>
<td>12</td>
<td>Land use 1st floor = Residential</td>
<td>Land use 2nd floor = Residential</td>
<td>0.19</td>
<td>0.70</td>
</tr>
<tr>
<td>13</td>
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<td>Land use 1st floor = Residential</td>
<td>0.14</td>
<td>0.73</td>
</tr>
<tr>
<td>14</td>
<td>Land use ground floor = Residential, Land use 1st floor = Residential, Land use 2nd floor = Residential</td>
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<td>0.14</td>
<td>1.00</td>
</tr>
<tr>
<td>15</td>
<td>Land use ground floor = Residential, Land use 1st floor = Residential</td>
<td>Land use 1st floor = Residential, Land use 2nd floor = Residential</td>
<td>0.13</td>
<td>0.95</td>
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<td>16</td>
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<td>0.13</td>
<td>0.79</td>
</tr>
<tr>
<td>17</td>
<td>Land use 1st floor = Residential, Land use 1st floor = Residential, Land use 1st floor = Residential</td>
<td>Building footprint = 74.60-152.24 m²</td>
<td>0.13</td>
<td>0.80</td>
</tr>
<tr>
<td>18</td>
<td>Land use 1st floor = Residential, Building footprint = 74.60-152.24 m²</td>
<td>Land use 1st floor = Residential</td>
<td>0.11</td>
<td>0.88</td>
</tr>
<tr>
<td>19</td>
<td>Buildings having only ground floor</td>
<td>Building footprint = 74.60-152.24 m²</td>
<td>0.10</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Figure 5: Selected association rules are found by the association rule algorithm

Association Rule 19 given in Figure 5 above is explained below to exemplify how the rules in this table should be described. Rule 19 describes a link between specific values of land use of 1st floor, building footprint and land use of 2nd floor.

Support of the association rule 19 is 0.11, meaning that 11% of the buildings in the database satisfy both of the conditions, premise (Land use of 1st floor as Residential, Building footprint between 74.64-152.24 m²) and conclusion (Land use of 2nd floor as Residential) as defined in Figure 5. As seen in this figure, confidence of the association rule 19 is 0.88, which is the fraction of buildings satisfying both of the conditions ((Land use of 1st floor as Residential, Building footprint between 74.64-152.24 m² and Land use of 2nd floor as Residential) to the total number of buildings that satisfy only the premise of the rule (Land use of 1st floor as Residential, Building footprint between 74.64-152.24 m²) which can also be read as 88%. Confidence is a measure of strength of the association rules and can also be interpreted as an estimate of the probability P(Conclusion/Premise), the probability of finding the conclusion of the rule in the items of the database under the condition that these items also contain the premise of the rule. Hence based on the ranking scheme given below rule 19 has a very strong possibility of occurring if the premise of the rule is satisfied. In other words, if the first floor of the building is residential and the footprint of the building is between 74.64-152.24 m² than there is a very strong possibility with an estimate probability of 88% that 2nd floor of this building is
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residential too. And the percentage of the buildings satisfying these conditions is 11% of buildings in the database.

The distribution of the buildings satisfying rule 19 is visualized in Rapid Miner in the form of a scatter plot given in Figure 6 below. The x axis represents land use of ground floor as residential (true and false cases), the y axis represents the building footprint values between 74.64-152.24 m² (true and false cases), the red color represents land use of 1st floor as residential, the blue color represents land use of 1st floor not residential. Therefore red dots inside the region of the rounded rectangle are representing the buildings that satisfy the premise and the conclusion of the rule 19. And the blue dots in the same region are the buildings that do satisfy the premise of the rule but not the conclusion (12%)

Below description of all the association rules contained in Figure 5 are given classified based on their conclusions.

**Conclusion: Land use of 1st floor is Residential**

If the ground floor of a building is used as residential than its 1st floor is used as residential too for an estimated probability of 95%. Number of buildings that satisfy this statement is 31% of the whole Beyoglu district. (Rule 2)

If a building in Beyoglu has its ground and 2nd floors used as residential then its 1st floor is also used as residential for an estimated probability of 99%. Number of buildings that satisfy this statement is 25% of the whole Beyoglu district. (Rule 6)

If the footprint of a building in Beyoglu is less than 74.60 m² and its ground floors used as residential then its 1st floor is also used as residential for an estimated probability of 94%. Number of buildings that satisfy this statement is 19% of the whole Beyoglu district. (Rule 8)
If a building in Beyoglu has a land price between 118-194 TL/m² then its 1st floor is used as residential for an estimated probability around 70%. Number of buildings that satisfy this statement is 16% of the whole Beyoglu district. (Rule 13)

If the footprint of a building in Beyoglu is less than 74.60 m² and its 2nd and ground floors used as residential then its 1st floor is also used as residential for an estimated probability of 100%. Number of buildings that satisfy this statement is 14% of the whole Beyoglu district. (Rule 15)

If the ground floor of a building is used as residential and its land price is between 118-194 TL/m² than its 1st floor is used as residential too for an estimated probability of 95%. Number of buildings that satisfy this statement is 13% of the whole Beyoglu district. (Rule 16)

Conclusion: Land use of 2nd floor is Residential

If the 1st floor of a building in Beyoglu is used as residential than its 2nd floor is used as residential too for an estimated probability of 81%. Number of buildings that satisfy this statement is 34% of the whole Beyoglu district. (Rule 1)

If the ground floor of a building in Beyoglu is used as residential than its 2nd floor is used as residential too for an estimated probability of 77%. Number of buildings that satisfy this statement is 25% of the whole Beyoglu district. (Rule 3)

If the 1st floor and ground of a building in Beyoglu is used as residential and then its 2nd floor is used as residential too for an estimated probability of 80%. Number of buildings that satisfy this statement is 25% of the whole Beyoglu district. (Rule 5)

If the footprint of a building in Beyoglu is less than 74.60 m² and its 1st floor is used as residential then its 2nd floor is used as residential too for an estimated probability of 76%. Number of buildings that satisfy this statement is 19% of the whole Beyoglu district. (Rule 9)

If the footprint of a building in Beyoglu is less than 74.60 m² and its 1st and ground floors are used as residential then its 2nd floor is used as residential too for an estimated probability of 73%. Number of buildings that satisfy this statement is 14% of the whole Beyoglu district. (Rule 14)

If the 1st floor of a building in Beyoglu is used as residential and the land price is between 118 and 194 TL/m² then its 2nd floor is used as residential too for an estimated probability of 79%. Number of buildings that satisfy this statement is 13% of the whole Beyoglu district. (Rule 17)

If the 1st floor of a building in Beyoglu is used as residential and its footprint is between 74.64 and 152.24 m² than its 2nd floor is used as residential too for an estimated probability of 88%. Number of buildings that satisfy this statement is 11% of the whole Beyoglu district. (Rule 19)

Conclusion: Land use of 1st floor is Business-shopping

If a building in Beyoglu has its ground and 2nd floors used as business-shopping then its 1st floor is also used as business-shopping for an estimated probability
97%. Number of buildings that satisfy this statement is 17% of the whole Beyoglu district. (Rule 12)

**Conclusion: Land use of 2nd floor is Business-shopping**

If the 1st floor of a building in Beyoglu is used as business-shopping than its 2nd floor is used as business-shopping too for an estimated probability of 71%. Number of buildings that satisfy this statement is 18% of the whole Beyoglu district. (Rule 10)

If the ground and 1st floors of a building in Beyoglu is used as business shopping than its 2nd floor is used as business-shopping too for an estimated probability of 71%. Number of buildings that satisfy this statement is 17% of the whole Beyoglu district. (Rule 11)

**Conclusion: Land uses of 1st and 2nd floors are Business-shopping**

If the ground floor of a building is used as residential than its 1st and 2nd floors are used as residential too for an estimated probability of 76%. Number of buildings that satisfy this statement is 25% of the whole Beyoglu district. (Rule 4)

**Conclusion: Footprint of the building less than 74.60 m²**

If a building in Beyoglu has only two first floors then its footprint is less then 74.60 m² for an estimated probability of 71%. Number of buildings that satisfy this statement is 20% of the whole Beyoglu district. (Rule 7)

If the land price of a building in Beyoglu is between 43-113 TL per m² then its footprint is less then 74.60 m² for an estimated probability of 80%. Number of buildings that satisfy this statement is 12% of the whole Beyoglu district. (Rule 18)

If a building in Beyoglu has only ground floor then its footprint is less than 74.60 m² for an estimated probability of 75%. Number of buildings that satisfy this statement is 10% of the whole Beyoglu district. (Rule 20)

The rules that are described above are all conclusion of this analysis, given evidence on the composition of the Beyoglu urban feature database in a relational manner. But a more general conclusion of this analysis should also be formulated. We perceive that the rules that are associating specific values for land use of ground, 1st and 2nd floors are dominating in Figure 5. This gives us a strong evidence of clustering of same land uses within the buildings; clusters of 3 floors of residential buildings and 3 floors of business-shopping buildings. Also we conclude that certain values of building footprint and land price are also frequently occurring within buildings having residential use in Beyoglu. More we don’t find such an association for the case for business-shopping use, meaning that, building footprint and land price are not effective factors of business-shopping use. And finally there is also a link between certain values of building footprint and land price, independent from the land-use.

As a general evaluation, out of these results we detect that certain values of certain attributes have an effect on the occurrence of the certain values of certain attributes. These results give information about the composition of Beyoglu urban feature database. Data mining provides us evidence-based insight through deeper understanding of Beyoglu urban feature database. By the
interpretation of the association rules found within the database we start to
discover frequent attribute-value conditions of the buildings, in other words,
we identify relationships between various attributes of the buildings within
Beyoglu district. This type of relationships formulated in the form of association
rules cannot be found by simple queries (usual SQL syntax) and more
conventional analysis methods of grouping, it results from a more complex
algorithm based process. These relationships contain previously unknown
relationships and patterns hidden in Beyoglu urban feature database.

EVALUATION OF THE RESEARCH FRAMEWORK

These analysis results are not apparent to naked eye while looking at the maps
or at the database or they cannot be detected by means of simple queries or
conventional methods of analysis. Association Rule Analysis provides a
formulation of the existing situation based on relationships, which we claim is
very important and relevant to decode the complexity of urban space. Mainly,
what we claim is that to find answers to why certain things are happening in
urban space (the answers to why questions are what we call explanatory urban
knowledge) demand to detect the interrelations among the elements of urban
space by including multi-dimensional aspects in multi-scales, in a time-based
manner. Due to the lack of time based data and also social data, the framework
that we provide in this research is not completely covering these aspects of the
system. But what we propose is an open framework of an urban feature
database where any data can be added as it becomes available. Therefore this
framework is independent from any existing theoretical perspective of urban
analysis limited by selected specific properties of urban entities. This is a data-
driven approach and suggesting a context-specific analysis.

This kind of a data-driven and context-specific approach in urban analysis is
very important for urban designers, in order to acknowledge the characteristics
of an environment, and evaluate their design’s ability of adaptation to this
particular environment. Usually, one of the most important failures of urban
design and planning is to ignore site-specific particularities of urban spaces. On
those cases, most of the times, urban design projects result with unintended
consequences such as the failure of design interventions in adapting to their
environments. The conflict of design projects with the existing interrelations of
an urban environment can be minimized within the light of relational
knowledge that will be gathered from this particular environment.
(Sokmenoglu, et. al., 2011)

POSSIBLE CONTRIBUTIONS TO URBAN DESIGN, PLANNING OR
DECISION-MAKING

There is no doubt that the ability to obtain and manage the contextual informa-
tion of the site is absolutely needed to propose an urban plan or to take an
urban decision. As shown in this paper, if we have relevant data, we now have
the tools and technologies to gather hidden relationships of complex urban
systems, a more sophisticated type of contextual information than thematic
maps or basic statistical relationships.
This is an ongoing research, thus we do not have any completed study yet to exemplify how this specific approach of urban analysis can contribute to urban design, planning or decision-making. But still by describing possible scenarios we can provide clues of how this type of data driven urban analysis by data mining can contribute to urban design, planning or decision-making processes.

One possible scenario is to build micro-scale urban simulation model of Beyoglu based on the analysis results. By including more attributes on how buildings are related to their urban context such as proximity, adjacency and topographical relationships, we can also include the external/urban factors that influence the attributes of buildings in Beyoglu. After the analysis process, by selecting the relevant relationships with the strongest accuracy, we can determine the factors that lead to specific urban configurations. By using these significant factors we can build a probabilistic micro-scale urban simulation model for Beyoglu. To test and evaluate our planning approach we can manipulate this model by means of what if scenarios.

Secondly, by interpreting found patterns and relationships of building in Beyoglu we can formulate typologies that describe the character of the buildings in Beyoglu. We can then use these typologies as urban design rules if we have a design approach based on precedents. A similar approach is applied by Gil, Montenegro, Beirao, and Duarte (2009).

Thirdly, we can use this analysis method to evaluate new planning approaches and decision-making processes. By using the method proposed in this research, we can compare different planning approaches by evaluating the patterns and relationships that they produce and also evaluate how these approaches differ from the existing real situation.

Another possible scenario would be to run a comparative study. We can use our analysis framework in different urban settings and compare the most relevant factors that lead to specific urban settings. We can afterwards evaluate how are the conditions of different urban settings operate and why they operate in such way. This type of comparative study can provide a way to generalize the knowledge of how urban configurations are formed and contribute to our theoretical knowledge on cities.

More, another possible scenario would be to test this model of the research in a different setting where temporal data is available. By including temporal data into the model, we can detect changes in terms of patterns and relationships. By using the knowledge of how the system changes we can predict future scenarios. A similar approach is applied by Liu and Seto (2008). Also by evaluating these changes in regard to economic, political, physical interventions into the urban system we can contribute on the knowledge of how urban transformations occur and why.

As seen through the given scenarios there are many possible and promising ways of using the urban analysis approach of this research to support urban design, planning or decision-making processes. Further research is required to integrate this framework with urban design, planning and decision making by focusing on one of these scenarios.
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