REINTERPRETING THE ROLE OF COMPUTATION DESIGN MODELS IN HOUSING DESIGN

By Integrating Qualitative and Topological Dimensions through Syntactic Methods

***Keywords**: housing design, topological model, qualitative analysis, reinterpreting computation design*

1 Introduction

Parametric design is a computational method utilized for understanding the logic and the language used in the architectural design procedure algorithmically and scientifically. Recently, the application of computational models is constrained to building performance, optimization, and the functional aspects of the design problem only. However, qualitative elements, for example, social, and contextual aspects which are additionally significant in tackling architectural issues are normally ignored.

Incorporating the qualitative aspects of an architectural design problem has consistently remained as a challenge in the computational design process. Therefore, feeding the parametric model with subjective/quantitative information needs additional modes of examination. This investigation embraces 'topology' as an instrumental device of examination, related with various formal and generative techniques such as space syntax and descriptive grammars.

There is a misconception of computational processes leading to technologically advanced forms only. They are never perceived as an aid for the inherent traditional process. This study aims to break this notion in this research. The paper proposes a 'structured analytical framework' that combines the geometric and topological properties of the design process that understand the spatial, social, and environmental patterns of a design.

2 Methods

The investigation created relies upon consolidating the syntactic model with three aspects of design that can be uncovered in a floor plan : (a) geometric qualities (e.g. shapes, areas, and proportions); (b) social markers (e.g. relationships, connections, users, privacy); and (c) environmental aspects (e.g. orientation and climatic region of site).

The main larger contributions of the work include:

- One larger intent of this framework is to design a code to capture the style of design of any architect / built form not in terms of the construction detailing aspect but in terms of topological and statistical aspects so that people who do not know about the inner workings of the code can also use such an application.

- The other intent is to translate the qualitative observations that are made with the help of the syntactic analysis to generate speculative forms of housing adhering to such principles with the help of generative algorithm which learns from the previous analysis.

Topological studies actually emphasize on the relationship between the different spaces than the actual spaces themselves. The model combines the descriptive aspects with syntactic relationships to describe the geometric properties of spaces that are identified with its subjective qualities.

By discretizing the code into two parts and made on the same interface (i.e. Grasshopper/Python), it provides the autonomy to be used separately as an analysis code only and also in tandem with another generative algorithm that can interpret the analysis as shown in this paper.

The standards of examination are interpreted into 20 variables that can be measured to characterize social, spatial, and environmental constraints (see Table 1) that are utilized by Charles Correa in his works (see Figure 2).

4 Results and Discussion

Few observations from the Syntactic Analysis done are as follows:

- The general proportion of the area occupied by the units in the projects by Correa are either 1:1 or 3:1. The reason has directly to do with the climatic region of the project. If the region is hot and dry, then the unit is linear, allowing for cross ventilation. If the region is hot and humid, the standard courtyard type housing unit is used.

- The ratio of mass to void within a unit usually ranges between **1:1 to 1.5:1**.

- The courtyard is the most public part of the house. (in 15 of 17 units). These courtyards become activity hot spots for the family and is the spiritual center of the house.

- The entrance is usually near one of the corners of the plot **and always through a courtyard**. (in 6 of the 7 cases). Thus, the courtyard acts as the buffer between the private part of the house and the road.

- The open space of the cluster is shaded for most of the day because of the massing around the units through self-shading.

- The adjacency distance between each function in the units is between 4 to 5m.

- The hall is the most accessible space in square shaped units with a mode contiguity value of 5 and hence reduces the need of the secondary circulation space since it cuts down the construction cost.

The generations done using the generative design interface of Grasshopper brought forth certain results.

- Overall, the rules derived are a direct manifestation of Correa's ideologies. He has a certain fixed notion about growth, personalization, climatic responses and communities. The similarity between the ones generated and the ones done by him can be seen in the figure 6.

- The generational framework itself using Grasshopper has the following limitations:

i) The exhibited geometries are not exactly repeatable from one session to the other even when the variables input is the same. However, this may be a limitation of the generative interface used.

ii) The topological indicators, as explained earlier does not depend on the form directly. Hence the resultant form can be cubes or spheres or any random geometrical form. In this case, square shaped forms are adopted due to similarity with the projects of Correa.

5 Conclusion

In light of the syntactic-discursive model of examination, it has become clear that the human-spatial conduct, the public activity inside the house, the hierarchy of spaces can be determined by a collection of syntactic components which can be measured by algorithms.

This method of investigation for encoding the traditional cases enables the designer to uncover spatial topologies that can be understood by them and can be incorporated in an increasingly effective way in their designs utilizing a generative algorithm to reinterpret them for the increasing density of the built environment in the global cities today.

Hence, introducing aspects of topological and statistical thinking in a digital design process offers a potential to tap into the often-described intangible aspects of a design process as discovered in the progress of the research and not just stand as form optimizers as seen in the computer world.

Table 1: The variables that are measured by the model developed to characterize social, spatial, and environmental constraints

Features Examined	Variables		
Morphology	V1	Overall profile shape (l/w ratio)	Square, (0.85<1.25), Rectangular (>1.25), Irregular
	V2	Total width, length of plot	m
	V3	Ratio of length to width	<number>
	V4	Plot area of unit	m^2
Spatial Topology	V5	Name of interior spaces	Name (SpaceID)
	V6	Number of courtyards	<number>
	V7	Area of outdoor spaces	m^2
	V8	Percentage of indoor to outdoor spaces	<%>
	V9	Total number of rooms	<number>
	V10	Number of Courtyards/open spaces	<number>
	V11	Percentage of area occupied by each space in the unit	<%>
Spatial Relationship	V12	Contiguity of each space	<number>
	V13	(number of connections to adjacent spaces from a given space)	<number>
	V14	Adjacency distance	m
		(distance between the center of the space considered to the space that is accessed by it)	Private, semi private, semipublic, public
	V15	Integration value	<number>
	V16	Isovist from centroid	<number>
	V17	Depth value of spaces (topological distance of one space to all other)	
Environmental considerations	V18	Climatic Region of site	Name (hot dry, hot humid, wet)
	V19	Orientation of unit with respect to site	Name (N, E, W, S, NE, SE, NW, SW)
	V20	Size of the courtyard of unit	

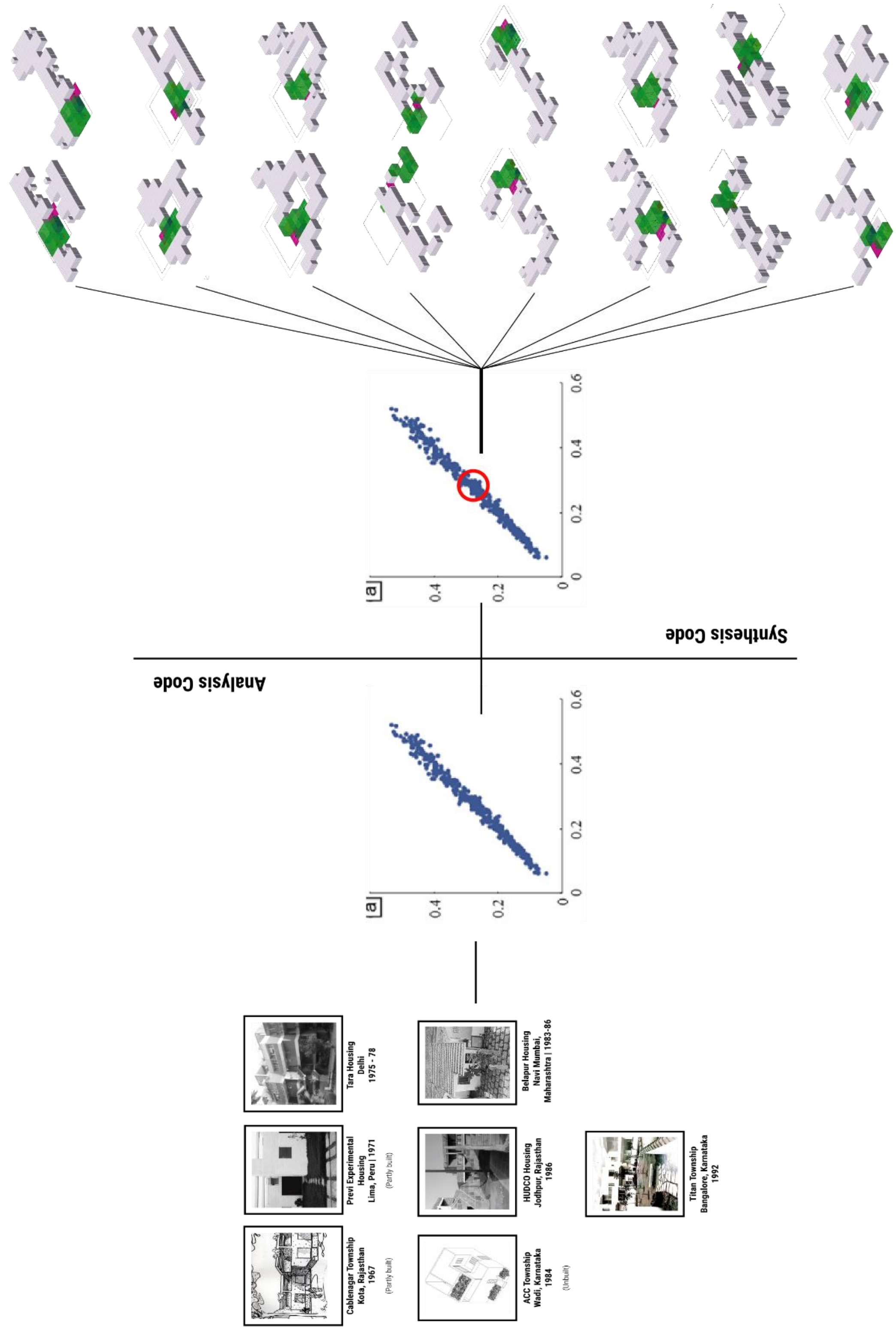

Figure 1. Diagrammatic explanation of the syntactic discursive model used for the analysis and the synthesis of Correa's ideologies

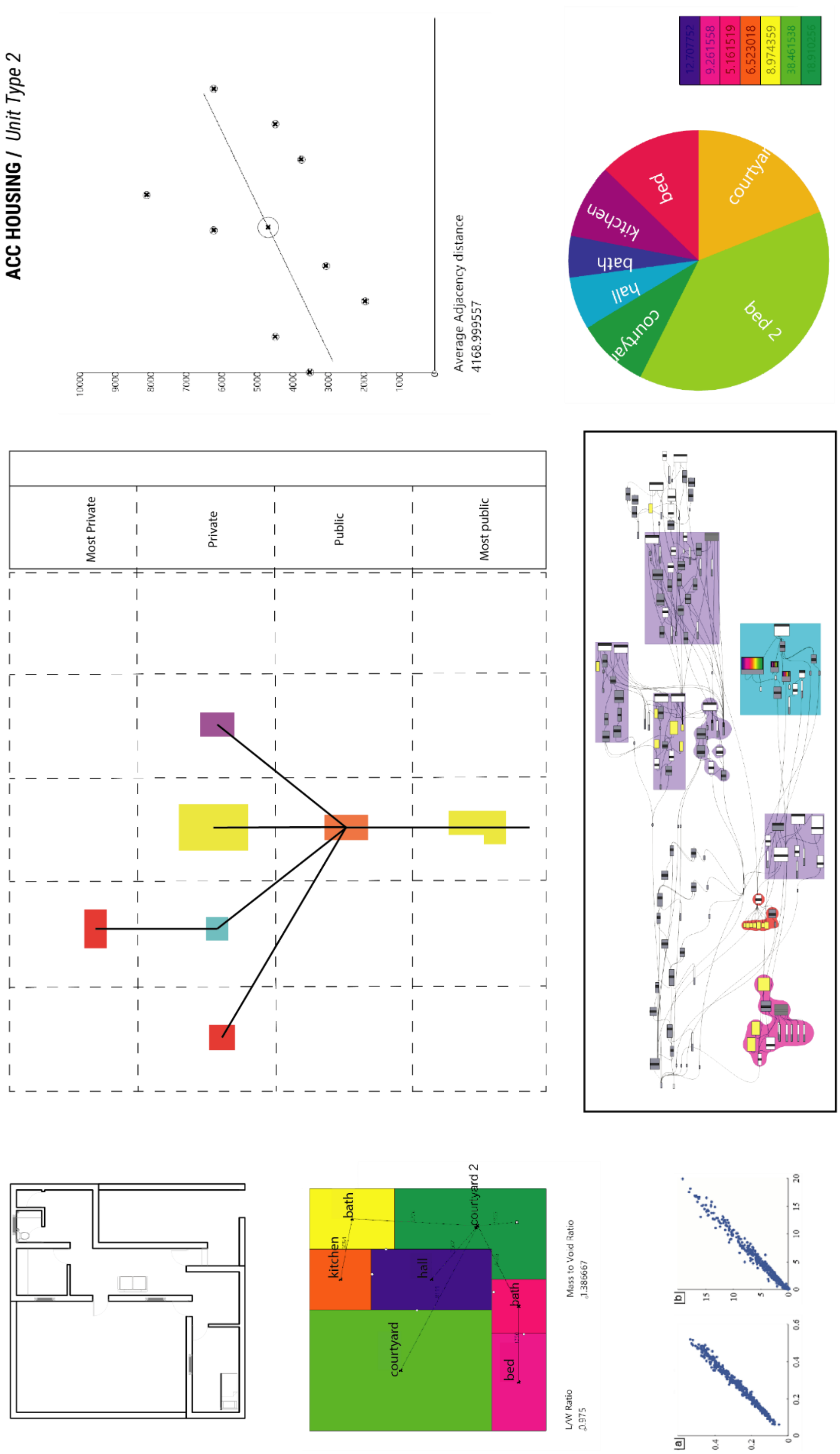

Figure 2. View of the analysis done by the syntactic discursive model in Grasshopper/Python

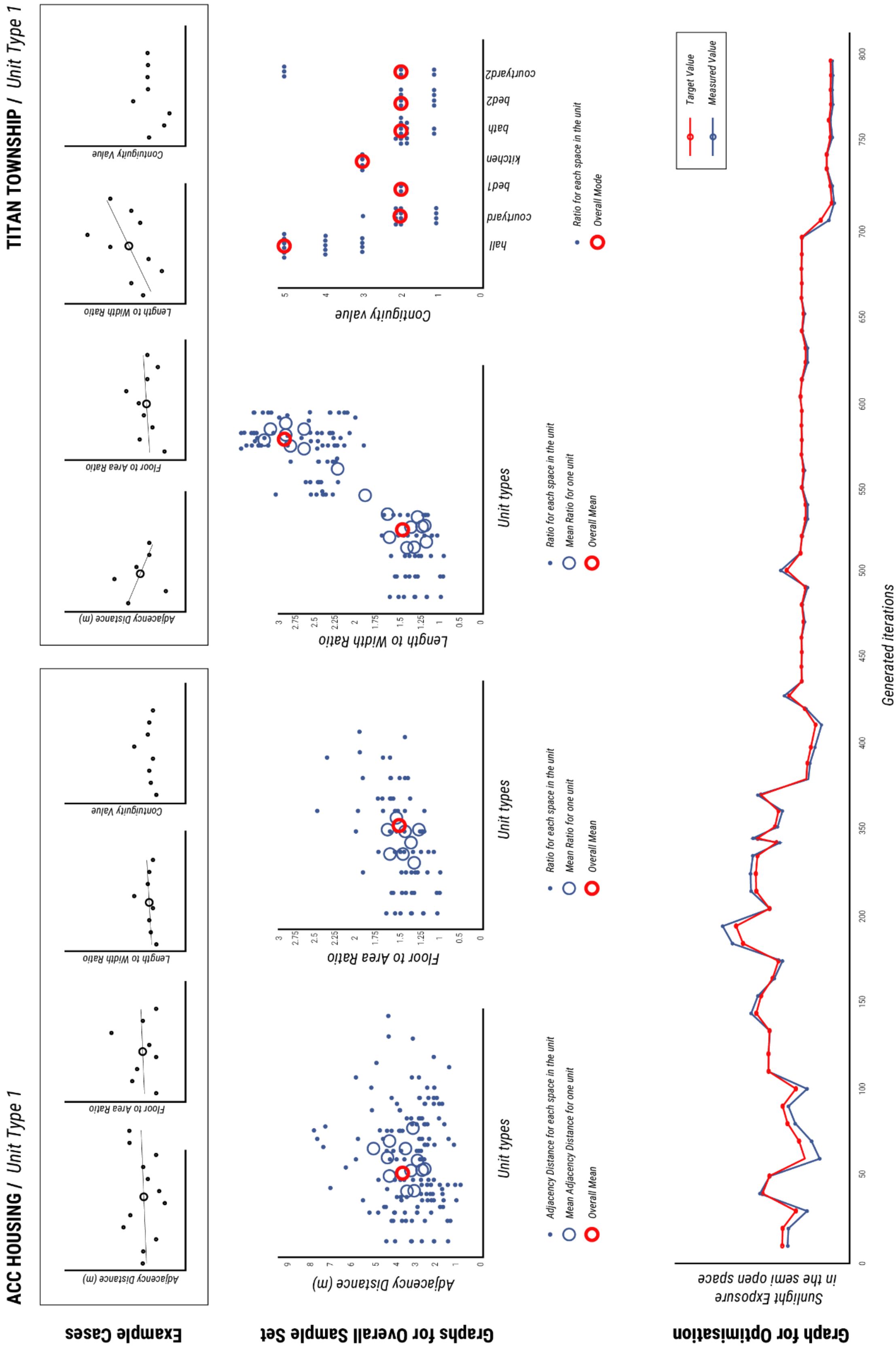

Figure 3. Graph plotted from the analysis done by the syntactic discursive model in Grasshopper/Python

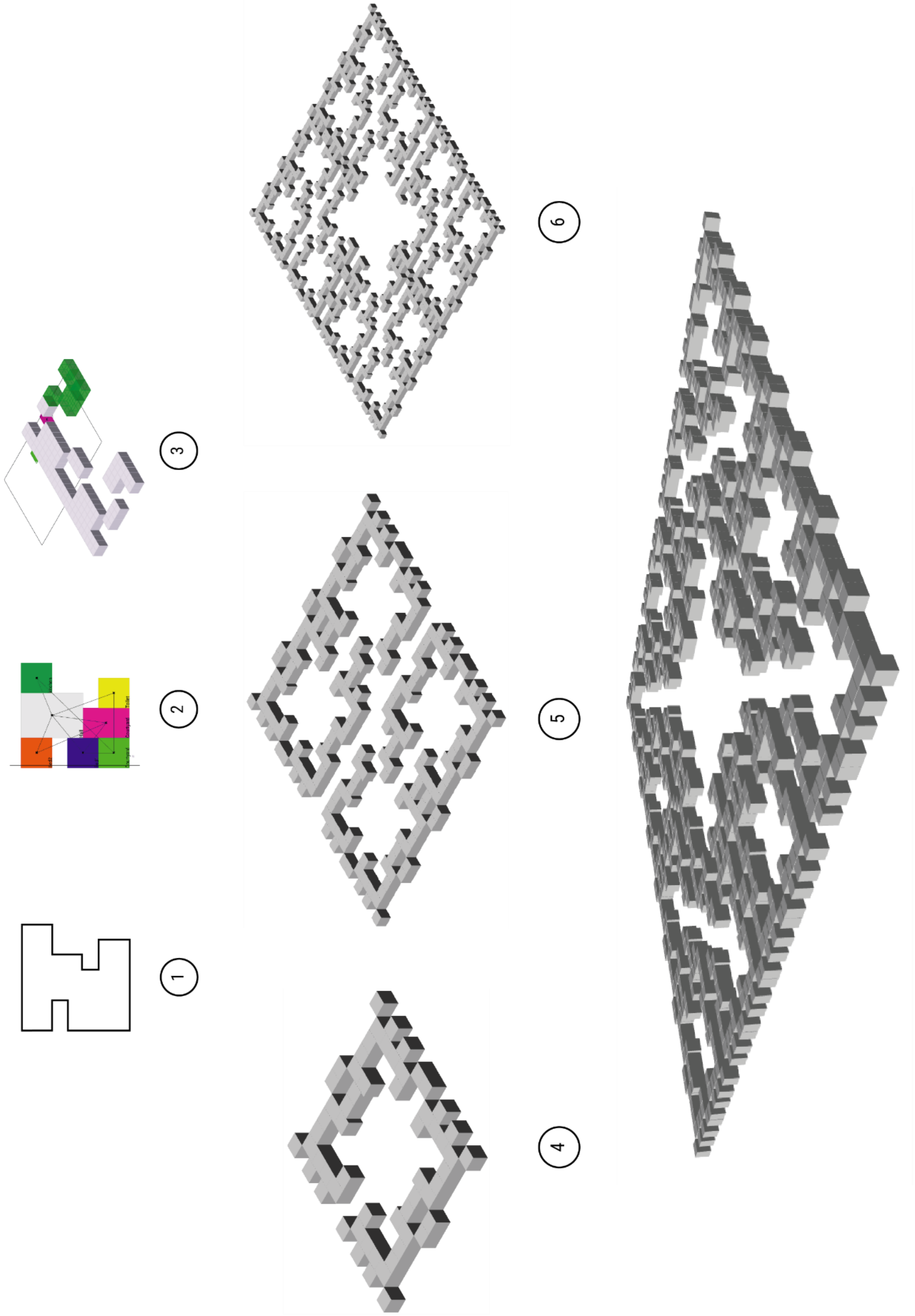

Figure 4. The aggregation strategy used by the code developed in order to

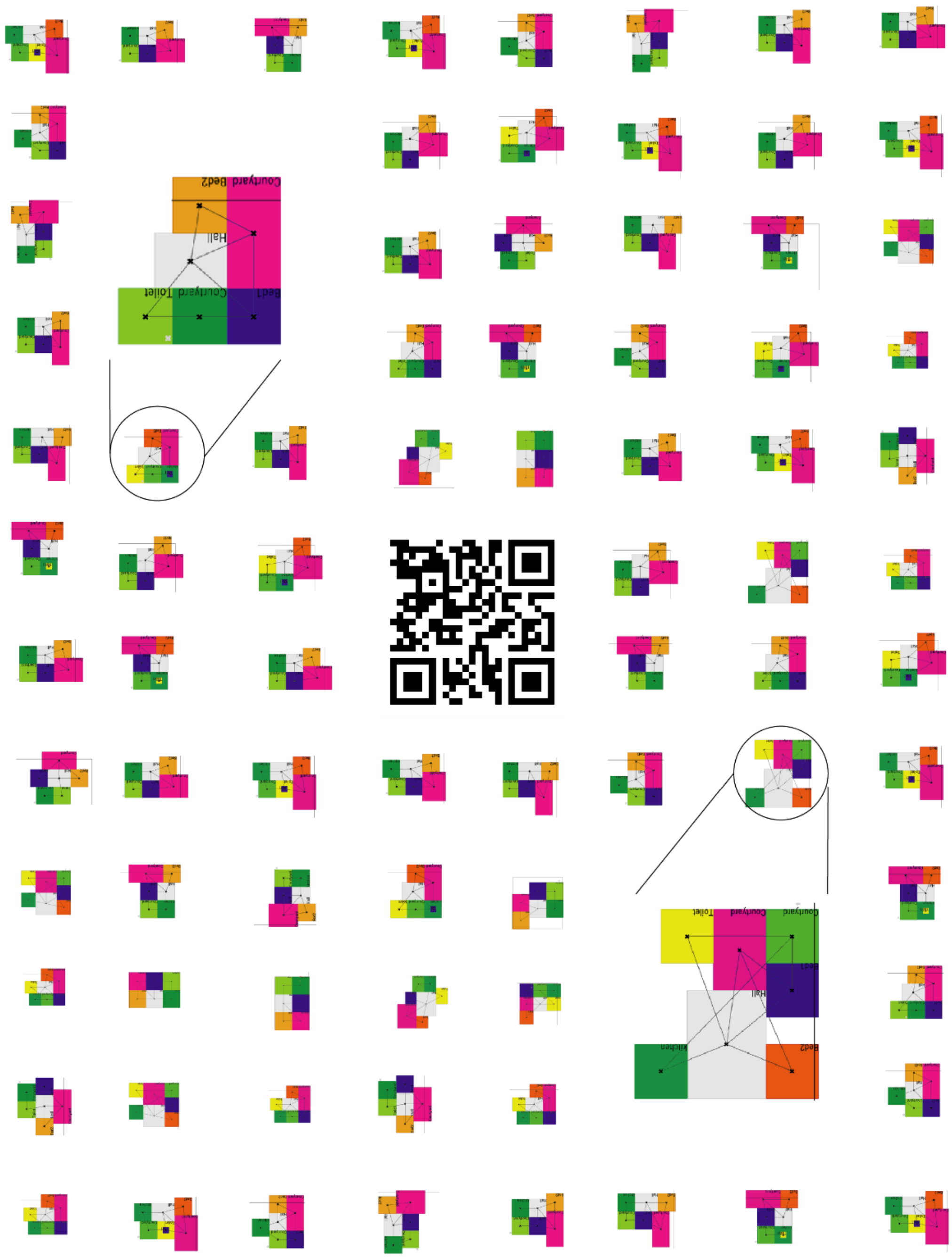

Figure 5. The unit plans generated by the algorithm as per the rules of Correa

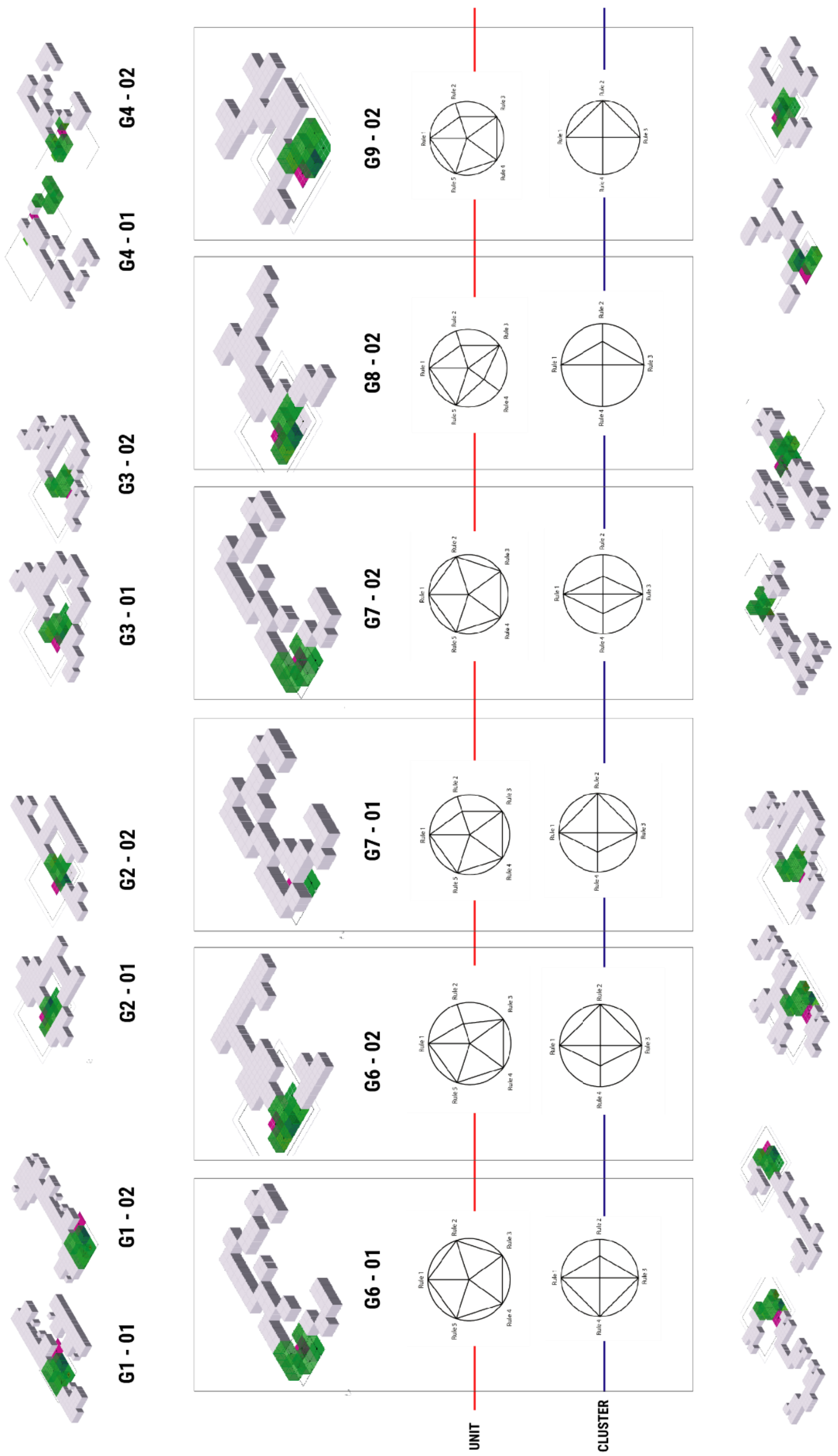

Figure 6. Analysis of the iterations generated by the algorithm

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