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Generative Facade Elements Recommendation for Diyarbakır Traditional U Plan Type Residences

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Abstract

Genetic algorithm (GA) are based on the continuation of fitter ones' lives considering the natural evolution. Data are coded as genes in the genetic algorithms. Optimal solutions can be achieved through the methods of crossing and mutation performed on these coded genes. Facade elements of the buildings with an architectural design in this study are independent of sustainability-related concerns, suggesting a great issue for the new buildings to be constructed in the traditional pattern. Accordingly, using the genetic algorithm method, proposals were presented for the new door and window typologies with genetic fitness for the architectural designing process of the buildings to be constructed in Suriçi Region, Diyarbakır, Turkey. Shape grammar, fractal and genetic algorithm, three generative designing systems, were used as the methods. Utilizing the genetic algorithm method, a field study was performed for the proposal of new door and window typologies with the fitness value. The field study was assessed through the plans and facade analyses regarding six Diyarbakır traditional houses with U plan type in Suriçi region of Diyarbakır. An identity card was created for the plan and facade data of the buildings and transferred to the table. Then, the door and window typologies of the exterior facade elements of each examined building were crossed within themselves with the GA method. As a result of the crossover, alternative joinery typologies with a total of 31 windows and 53 different door typologies with compatibility values were produced. Thus, the sustainability of the data of traditional joinery typologies for use in contemporary houses has been ensured. In conclusion, optimal alternative typologies were presented in regard to every chopping typology assessed with the genetic algorithm method. It is thought that this study should be a method that can be used in the production of exterior joinery typologies of contemporary houses to be built in many different cities of our country, especially in the historical texture. Thus, by using the GA method for the production of exterior joinery typologies of contemporary houses to be built in the region, different designers will be able to obtain various designs compatible with the traditional architectural texture while preserving their originality.

Keywords:
Generative systems, genetic algorithms, shape grammar, traditional texture

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INTRODUCTION

Generative designing systems reflect the automation-related features of computers. This study aims to examine the relationships between generative designs and offer a generative designing method where different systems are collectively used. With the development of technology, different digital methods have been used to perform architectural shaping. Shape grammar and genetic algorithms (GA), two generative approaches, were used in the present study.

GA is a fitness method based on the natural selection principles. John Holland set the basic principles of GA [Emel & Taşkın ,2002]. GA are based on the continuation of fitter ones' lives considering the natural evolution. Data are coded as genes in GA. Optimal solutions can be achieved through the methods of crossing and mutation performed on these coded genes. Many relevant studies have been performed after setting the main principles regarding GA. This method has been improved thus far and used in many fields covering manufacturing, plant layout, scheduling problems, construction technologies, optimization, vehicle routing, job planning, architecture and soon.

In the prepared study, alternative door and window typologies with genetic fitness value were produced by using genetic algorithm method and shape grammar method. For this purpose, Suriçi region of Diyarbakır was selected as the study setting as it intensely hosted traditional houses of Diyarbakır. The chopping clearances have not reached the present day as the traditional buildings in the area were significantly damaged and even collapsed. Therefore, the study was limited with six Diyarbakır traditional houses with U plan type considering the chopping types of restitution and restoration projects regarding the buildings studied. Contemporary alternative door and window typologies will be produced in line with the data of traditional authentic chopping styles for the buildings to be constructed in the region.

Many buildings with an architectural design have facade elements that have no association with sustainability-related concerns, which is a great issue for architectural housing within the traditional texture. Furthermore, the fact that such issue regarding the traditional texture has not been examined through a scientific method such as GA was regarded as the problem of the study.

Accordingly, using the genetic algorithm method, the purpose was to prepare new door and window typologies with genetic fitness for the architectural designing process of the buildings to be constructed in Suriçi Region, Diyarbakır, Turkey. The contribution of GAs that are also used as an optimization tool to designing will also be discussed. This method offers an opportunity to everybody so that they can pass down their traits to the following generations.

Making correct decisions in the first stages of architectural designing is critical for the alternative door and window typology examples regarding the buildings to be constructed in the region.

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MATERIAL AND METOD

GA and shape grammar were used as the methods in the study. Initially, the concepts of generative systems, shape grammars and GA were explained. Then, traditional Diyarbakır houses in Suriçi region, and their facades were assessed.

Rule sets were defined through shape grammar whereas fitness functions were set through the genetic algorithm. Utilizing the genetic algorithm method, a field study was performed for the proposal of new door and window typologies with the fitness value.

The field study was assessed through the plans and facade analyses regarding six Diyarbakır traditional houses with U plan type in Suriçi region of Diyarbakır. The traditional Diyarbakır houses with U plan type were coded in the field study. Moreover, facade chopping types in plans were internally grouped. This grouping activity included door and window chopping types.

The sizes of top windows, the architectural elements on facades, were measured and a module was set to form the rule set of shapes constituting the facades. In the process of determining the module, many facades of Diyarbakır traditional houses were examined. It was observed that the facades have joinery openings that can grow and shrink with the combination of small modules. It was determined that the smallest opening in the facades of Diyarbakır traditional houses belongs to the skylight. The size of the module was selected as 40 x 45 cm due to the fact that a skylight module measuring 40 x 45 cm is generally used in these facades. An 8x8 grid plane was formed in two dimensions as the pre-set module was reproduced and combined.

This plane was determined considering the height of a floor in traditional Diyarbakır houses. Heights of floors in these houses varied between and 3.20 meters. Since the number of modules meeting this floor height is 8 pieces, an 8x8 gridal plane has been preferred.

There are certain parameters to be set before proceeding with processing algorithms. The parameters were determined by reference to the external view of the joinery openings of Diyarbakır traditional houses. There were six parameters affecting the facade design, and they are as follows:

- transparent surface (0),
- openable transparent surface (1),
- non-transparent wall surface (2),
- non-transparent openable wooden surface (3),
- non-transparent openable wooden surface (3a),
- non-transparent fixed wooden surface (4).

Genotypes and phenotypes of chopping typologies were formed in line with the parameters determined above. Fitness value of every chopping typology was defined, crossed and mutated. The new typologies obtained at the end of crossing should be within these fitness values. However, there is no such obligation for the mutated typologies. Certain coding procedures were performed for the fitness value. These are as follows;

x: Number of modules reflecting the parameters in the genotype of chopping typology

y: Number of modules in the genotype of chopping typology

z: Fitness value typology

z: x / y

Building-specific details were conveyed by using the identity cards formed for every building in the last step. The authentic chopping typologies that were examined later were conveyed through the sections present in the building. Therefore, the chopping typologies examined in the study were clearly reflected. Finally, optimal alternative typologies were presented in regard to every chopping typology assessed with the genetic algorithm method.

Generative System Approach

The concept of "generative" is defined as the capacity of revealing anything or showing the source of creativity [Fischer & Herr, 2001]. Furthermore, the concept of generative designing is explained as the method where the designer is interested in the process rather than the output, and generative designing system can be considered as the system supporting the users in the operations. The generativity level of the system is determined based on whether the designer can generate creative products or improve their perception toward designing [Fischer & Herr, 2001].

With the developing technology, the importance of creative designing methodologies becomes clearer. Generative designing overcomes and avoids the monotonous structure of products offered through computers. Two main generative designing systems constitute the conceptual background of the study. Traits of these generative systems will be explained and compared within the study.

Shape Grammar

Introduced by Chomsky in 1970s, the concept of grammar was studied by George Stiny and James Gibs in a manner to define the rule-based structure of grammar formalism describing the generation systems with an algorithmic structure. With the algorithm, the solution of an already-present problem is formulated [Aksoy, 2001]. The main purpose here is not to minimize designing to the formula level, but to generate new alternatives with the pre-set rules. With these rules, the architectural language can be re-interpreted and different outputs can be achieved.

Designers can generate various compositions utilizing the shapes, rules and procedures within the shape sets. Different outputs can be achieved with certain actions to be performed on shapes. New shapes can be found with Boolean operations such as the total, difference or intersection of shapes, Euclid conversions or parametric changes (Figure 1).

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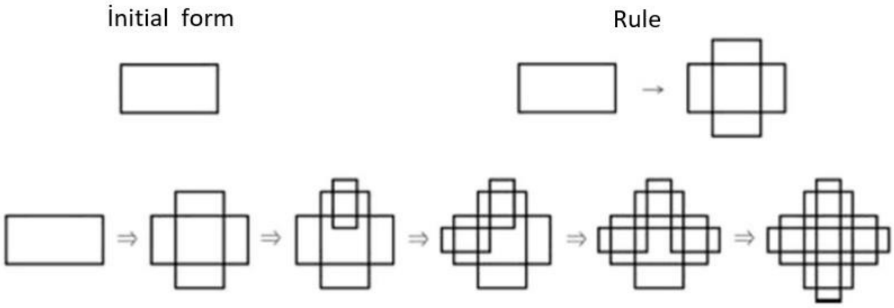

Figure 1. Adaptation of the rule to the initial shape [Knight & Stiny, 2001,s.363]

Shape grammars are accepted in different artistic disciplines, particularly architecture, and used to represent and understand different designing languages and styles and to create original designs. The purpose of designs created with the shape grammar includes;

- creating totally authentic designing languages,
- modeling the transformation in already-present designing languages,
- analyzing designing languages,
- forming another designing language using already-present designing languages
- creating new designing language using existing design languages [Karakoyun, 2010].

Fractal

The concept of fractal, which was introduced in 1975 by Beneoit B. Mandelbrot, a Polish mathematician, examines the shapes that repeat themselves but shrink for a limitless period of time, the parts that constitute an object, or the entire component object.

Although the fractal approach is used in different disciplines such as mathematics, geometry, chemistry or physics, fractal setups have been used in different manners within the discipline of architecture. It is safe to state that a building has similar details in its different sections ranging from its mass to the smallest indoor element. The shapes that are present within fractals may provide new alternatives resembling the initial shapes. The same result emerges no matter how many times the relevant procedure is repeated.

This study presented an approach that could guide the efforts of designing by generating new alternatives that could ensure the sustainability of architectural language through the fractal dimension of this language. It is believed that the occupancy-clearance ratio detected on the facades of traditional buildings through the fractal method is at a certain level, and that this level is important for the sustainability of architectural language. Accordingly, a holistic study of the algorithms based on the generative systems was presented as a proposal for the production of new chopping typologies with sizes similar to this ratio.

Genetic Algorithm

GAs serve as a method of searching and optimizing that uti lizes genetics as the source of inspiration and acts with natural selection principles. GAs are some of the sub-concepts of evolutionary architectural approach. Based on Darwin's principle that the best survives, it mimics the biological processes in nature. The ideas that those that can adapt to their environment can maintain their lineage or that superior people can be raised and parented by parents with superior characteristics resulted in the belief that the crossing method which is used in various manners would provide a better solution to the complicated problems [Vural, 2005]. This belief has been intensively used in the solutions of complicated problems such as form creation and function analyses. GAs scientifically provide a solution to most of the relevant problems and they help improve designers' creativity and explore richer designing fields. Fractal systems yield the same shapes with the initial system, and different shapes from the same family are generated through different reproduction procedures within this formation method. Accordingly, different alternatives resembling the initial shape can be generated with the collective use of generative systems such as shape grammar, fractals and GA.

The first publication related to this concept was presented by Bagley in 1967 [Goldberg,1989]. However, the first studies in this scope were performed in 1975 by John Holland, a psychology and computer science expert at Michigan University [Holland,1975]. Processing steps of GAs are respectively as follows;

- performing selection,
- formation of the first population,
- performing crossing,
- performing mutation,
- calculating the fitness function,
- formation of the new generation and completion of the cycle.

Coding the solutions: The initial condition for developing GA is to formulate and define every person through codes.

Formation of the first population: a solution group with all possibilities is presented. Calculation of the fitness value: Fitness value should be set to reach the desired result for the solution. The population is assessed based on the fitness value. Therefore, all people in the relevant generation are approximated to the fitness function value. People who do not fit this value in the solution group are eliminated. Furthermore, higher fitness value in the solution group increases the potential of reproduction, living and transferring to the following generations [Yeniay, 2001].

Selection: People with the fitness value are selected and gathered in the matching pool [Fığlalı & Engin 2002].

Crossing: The procedure of crossing can be defined as the creation of a change in people's gene combinations from a certain point and

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creation of new people (Figure 2).

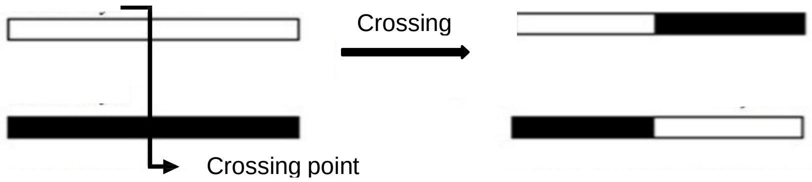

Figure 2. Crossing between two types [Jo & Gero ,1998, s.152]

Mutation: This is the procedure performed to increase genetic variation and/or to prote ct the current variety [Braysy,2001]. With this procedure, new chromosomes are obtained from the already-present ones. If the current gene variety does not have all required data, then the desired solutions can be found through mutation.

Formation of the new generation and completion of the cycle: After repeating the cycle in the desired rate, the populations of the people meeting the fitness value are formed and the cycle is completed.

GAs utilize the terminology used for natural evolution. Two different concepts are used to perform the definitions regarding people: genotype and phenotype (Figure 3).

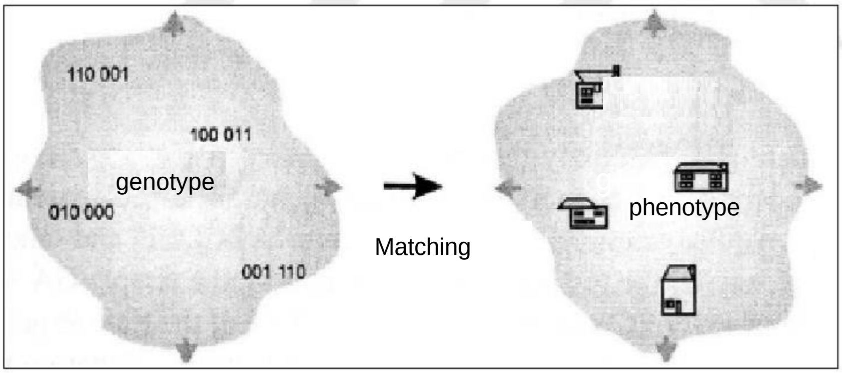

Figure 3. Matching between genotypes and phenotypes [Bentley,1999, s.9]

Genotype: Genes of a person determine that person's genetic traits, meaning his/her genotype [Güngör,2010]. Genetic changes occur through the genotype. Phenotype, on the other hand, is the manifestation of genotype. Coding certain traits such as hair color or eye color as genes is a form of genotype in genetics, but manifestation of these traits as blue eye or yellow hair is called phenotype [Çalışır,2015]. The procedures performed while forming new generations during the operation of GA are called genetic operators. Thanks to these operators, the solution range is expanded and more suitable solutions are found [Akpınar,2009]. These are parameter coding, fitness value calculation, formation of the initial population, selection, crossing, mutation and stopping operators. Numbers or letters can be used for coding but people generally perform coding using the indexes with 0 and 1 [Vural, 2005]. Coding methods, on the other hand, differ according to the problem that needs to be solved. In the present study, genotype encodings were expressed with numbers.

Diyarbakır and Its Facade Traits

The city of Diyarbakır is one of the important cities that reflects the cultural heritage values left by the important civilizations that reigned in this era, such as its monumental buildings, traditional residences, and castle (Figure 4-5); the city also reflects these assets in the current time. Walls, inns, baths, fountains, mosques, churches, mosques, pavilions and traditional houses, all of which are present in the traditional texture of Diyarbakır, hold a significant place in the architectural formation of the city.

Figure 4. Aerial photograph from 1939 [Url-1]
Figure 5. View from Suriçi ,1909 [Url-2]

Traditional houses, one of the most important building groups of Suriçi, face their atria in an inward manner, rather than an outward form, based on the factors of benefiting or deviating from the sun seasonally.

It is clear that

- seasonal factors,
- socio-cultural factors,
- topographic factors,
- materials,
- economic structure,
- and walls have an effect on the architectural shapes of houses.

The plan schema of traditional Diyarbakır houses consisted of atrium in the middle and other spatial units surrounding the atria. The aforenoted houses had I, L, U plans with internal atria based on the masses around the atria (Figure 6).

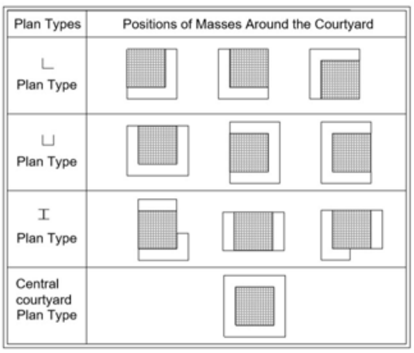

Figure 6. Traditional Diyarbakır houses, location of seasonal masses (Gökçe Salık ,2022)

The lives led within spaces as well as the characteristics of these spaces can be understood from the external facade of traditional Diyarbakır houses. Facades were shaped by their directions and differed from one another. This difference could be seen in the size, number and

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shape of the clearance of facades.

Reflecting the idea of privacy, Diyarbakır houses had an introverted lifestyle, and clearances increased in the internal facades facing the atria. There was also intense ornamentation. The external facade architecture facing the street did not have much clearance, and the two storey buildings had small clearances on the facades. The architectural elements shaping the facades of Diyarbakır houses are ordered as follows (Figure 7):

- Windows
- Doors
- Iwan
- Cantilevers
- Atria
- Roof-eaves
- Ornaments-materials.

Figure 7. Traditional Diyarbakır houses, (Gökçe Salık ,2022)

In traditional Diyarbakir houses, the window and door opening is one of the most important architectural elements affecting the facade. While the number of windows increases according to the size of the spaces, there are increases and decreases in size according to the direction it is located. Windows are divided into three categories as central windows, top windows and basement windows. In traditional Diyarbakir houses, the doors are divided into 3 categories as a location; these are; they are a door to the courtyard, the doors to the basement, and the doors to the rooms. there are differences in door sizes, depending on its location (Table 1).

Table 1. Central window types of traditional Diyarbakır houses (Gökçe Salık ,2022)


Central window types of traditional Diyarbakır houses

Top windows of traditional Diyarbakır houses

Door types of traditional Diyarbakır houses

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FINDINGS

The presence of spaces oriented towards three different facades in U-plan type Diyarbakır traditional houses can contribute to the formation of different facades. For this purpose, this study provided general information about the traditional Diyarbakır houses with U plan typology in Suriçi region of Diyarbakır. Moreover, analyses were performed for the door and window typologies present within the facades of these houses. In the last stage, shape grammar and genetic algorithm method were used for the generation of new typology.

Formation of Generative Facade Elements in Traditional Diyarbakır Houses

Plan types and facade clearances of every traditional house in this study were analyzed initially. Certain significant needs that would guide the designers and architects in implementing the rules for new door and window typologies were determined through GA and shape rules. Six chopping typologies of traditional Diyarbakır houses with U plan, the restitution and restoration projects of which were accessed, were analyzed in this study. In the table below, window Chopping typologies of U-plan type Diyarbakir traditional houses are shown (Figure 8).

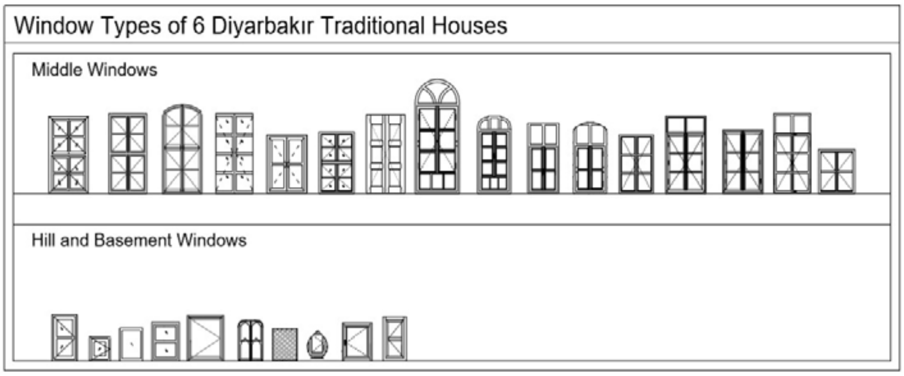

Figure 8. Windows Chopping types of traditional Diyarbakır houses with U plan (Gökçe Salık, 2022)

In the table below, doors Chopping typologies of U-plan type Diyarbakir traditional houses are shown (Figure 9).

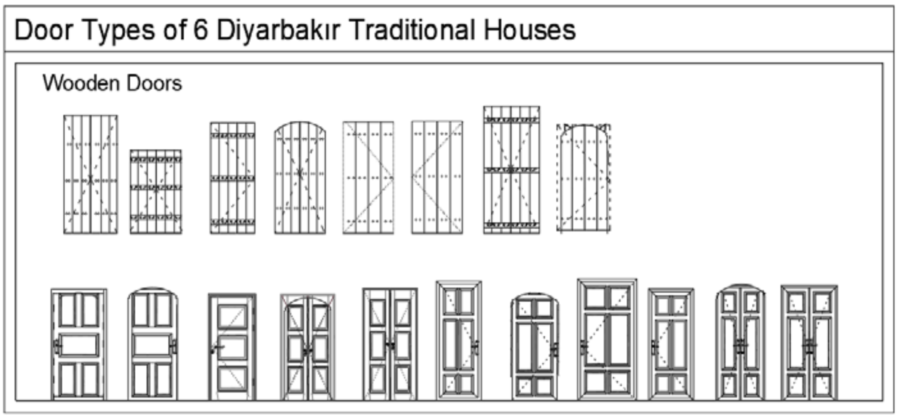

Figure 9. Doors Chopping types of traditional Diyarbakır houses with U plan (Gökçe Salık, 2022)

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Typological studies were carried out through the specified joinery openings, and the door and window openings located on the facade were revealed with concrete data. The examined facade openings are abstracted with the determined top window module (40 x 45 cm). In determining the created grammatical language, the dictionary elements included in the following way were used (Figure 10).

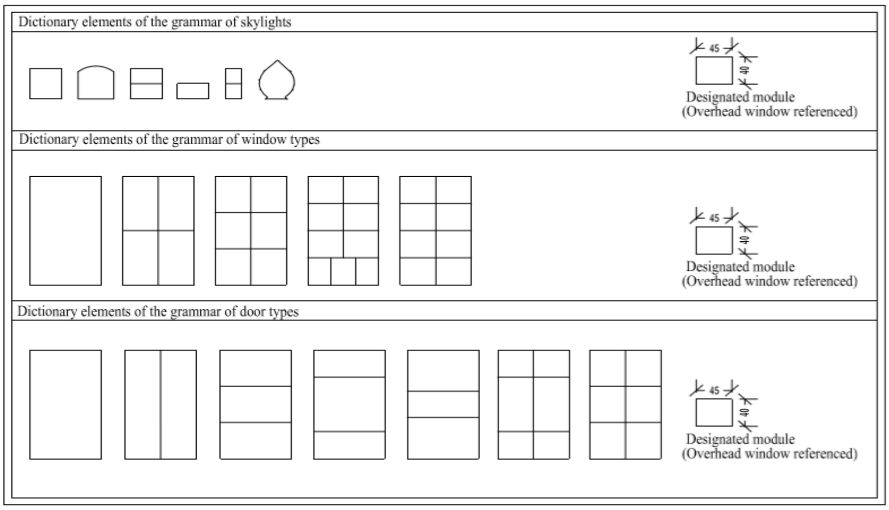

Figure 10. Lexical elements of grammar (Gökçe Salık ,2022)

A grid system was prepared as a base to be used in two dimensions to perform facade analysis and generation for the traditional houses. The sizes of top windows, the architectural elements on facades, were measured and a module was set to form the rule set of shapes constituting the facades. The size of the module is 40 x 45 cm. This with the module, 8x8 grid was formed to create the shape repertory. This grid was determined considering the height of a floor in traditional Diyarbakır houses. The important point here is whether the shape code generated through shape grammar is accepted as genotype.

The change experienced in the parameters defined in the stage of processing the genetic algorithm affects the solution-related duration as well as the cluster hosting the solution and people's choices.

Accordingly, there were six parameters affecting the facade design, and they are
as follows:

- transparent surface (0),
- openable transparent surface (1),
- non-transparent wall surface (2),
- non-transparent openable wooden surface (3),
- non-transparent openable wooden surface (3a),
- non-transparent fixed wooden surface (4).

The fitness values were determined in line with the following criteria;

• In every crossed window within every house type; x transparent surface (0) and at least z unit square of these non-transparent surfaces being an openable transparent surface (1), y non- transparent surface (2),

- For doors belonging to each type of housing; x non-transparent opening wooden surfaces (3), and at least y unit squares of these non-transparent opening wooden surfaces must be a non-transparent opening wooden surface (3a), or z unit squares must be a non-transparent fixed wooden surface (4).

Every chopping typology of these houses is crossed and mutated in a binary form. The new typologies obtained at the end of crossing should be within these fitness values. However, there is no such obligation for the mutated typologies. The fitness value range is reflected as follows.

x: Number of modules reflecting the parameters in the genotype of chopping typology

y: Number of modules in the genotype of chopping typology

z: Fitness value

z: x / y

As windows with a width of 90 cm were generally used on the chopping typologies of traditional Diyarbakır houses, the width size was set as 90 cm for the moderate-size windows produced through alternative window production. Regarding the doors, as doors with a width of 90 cm and height of

200 cm were frequently used within the indoor areas of traditional Diyarbakır houses, a standard size of 90-200 cm was preferred as the indoor door size.

Facade Analysis of U-Type Traditional Diyarbakır Houses with Genetic Algorithm

The geometrical ratios of the facades on traditional buildings that had a specific architectural language were examined, and an approach that was based on the generative system which could guide the generation of new designs was proposed. The authentic architectural language of the traditional building facades within the historical texture was defined through shape grammar and fractal geometry. the light of the data presented above, genetic algorithm method was utilized to generate facade typology for new buildings to be constructed within the historical area, and different door and window facade chopping typologies with values similar to those obtained through fractals were formed. Furthermore, shape grammar, fractal and genetic algorithm methods were collectively used to present proposals in line with the algorithm operation principle.

Building data of six Diyarbakır traditional houses with U type were conveyed, and facade analysis was performed using the genetic algorithm method. An identity card showing the data of every house was formed and tabulated. The algorithm flow chart of the activity is presented below (Figure 11).

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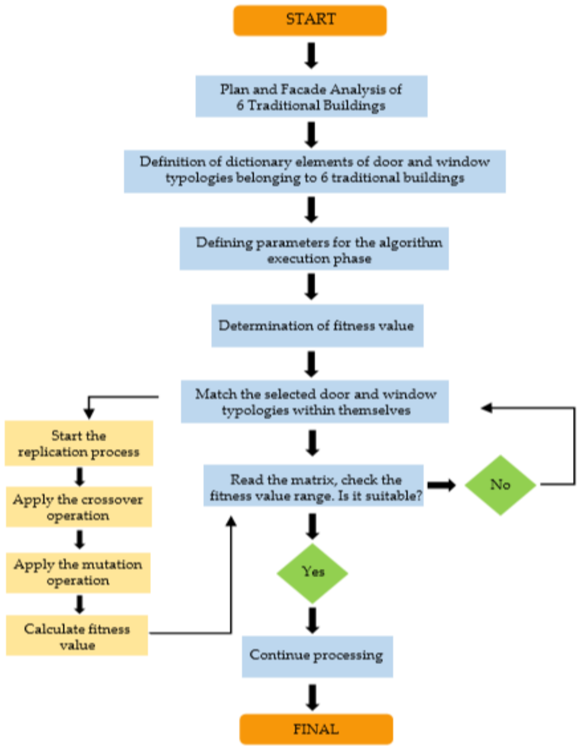


Figure 11. Algorithm schema (Gökçe Salık ,2022)

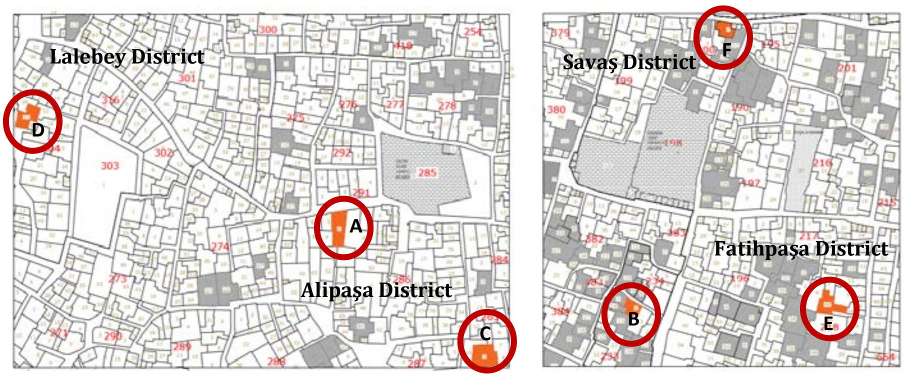
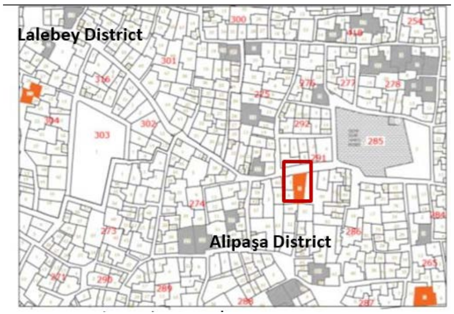


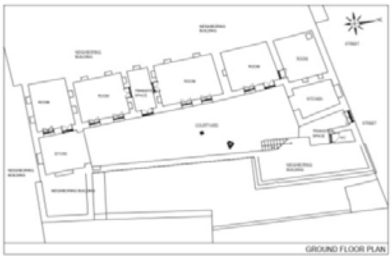
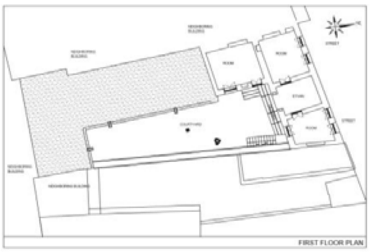
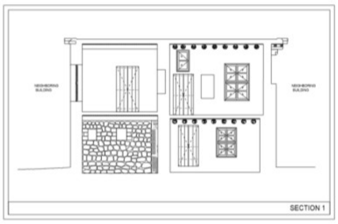
Figure 12. The houses examined in Diyarbakır Suriçi Region (Gökçe Salık ,2022)

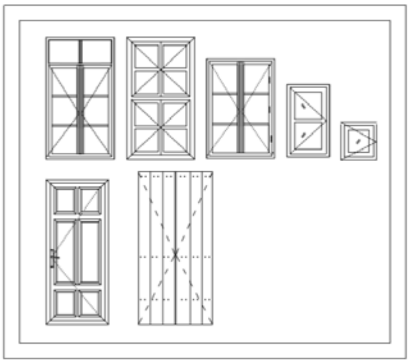
As population was selected out of an already-present design, the facade element typologies were considered as the optimum value and fitness range was set later. Door and window typologies of every building generated through GA are present below.

Identity information of the building A are as follows (Table 2).

Table 2. Identity information of the building A

<table>
<tr><td rowspan="2">BUILDING INFORMATION</td><td colspan="2">ADDRESS: BLOCK OF BUILDINGS/PARCEL 286-6</td></tr>
<tr><td colspan="2">

Location on the map</td></tr>
<tr><td>IMAGES</td><td colspan="2"> 
Images</td></tr>
<tr><td>PLANS</td><td colspan="2">
Ground floor plan

First floor plan</td></tr>
<tr><td>SECTIONS</td><td>
Section 1

Section 2</td><td>
Examined frame types</td></tr>
</table>

Five window and two door typologies were examined. These typologies were transferred to the grid base and coded based on the pre-set parameters. Windows and doors among the pre-selected chopping

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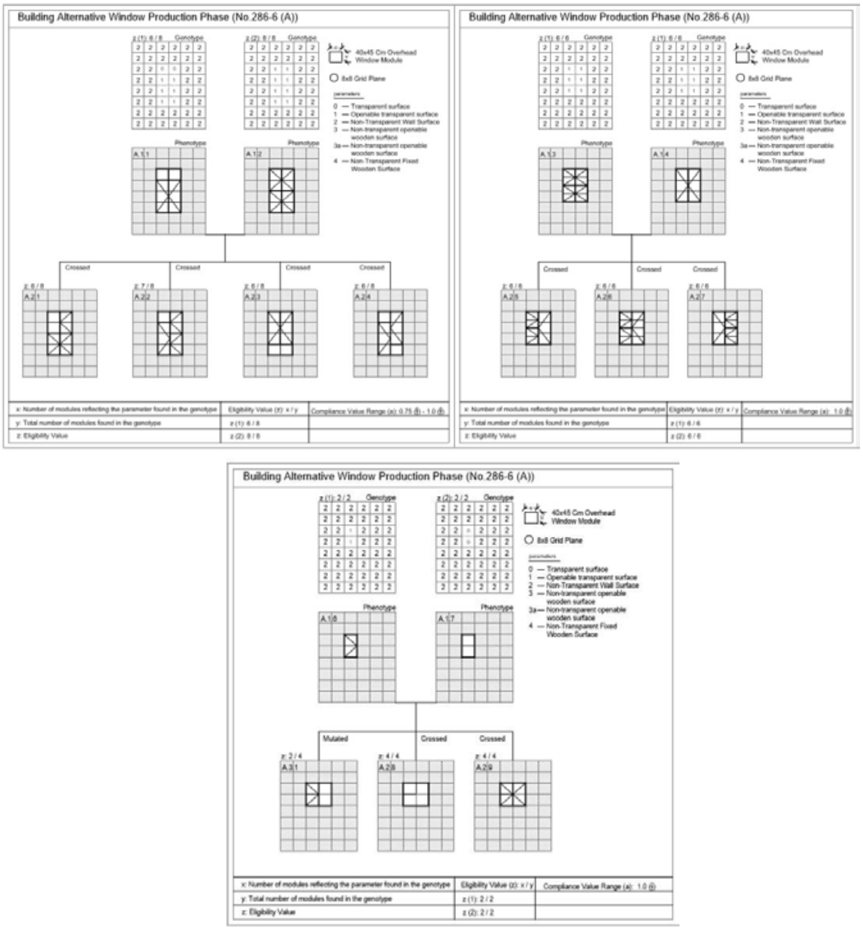
typologies were randomly selected, crossed and mutated. As a result of crossing, new typologies with fitness value were obtained. In conclusion, 10 new window typologies and 4 new wooden door typologies were obtained with the crossover with GA.

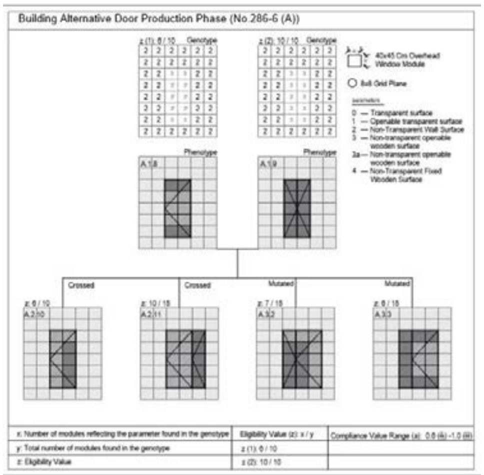
10 new window typologies produced by the genetic algorithm method are shown in the figure below (Table 3).

Table 3. Window typologies generated through GA method (Gökçe Salık ,2022)



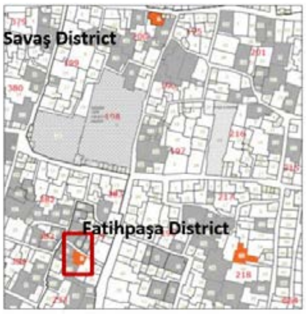
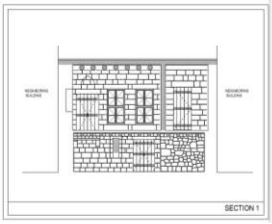
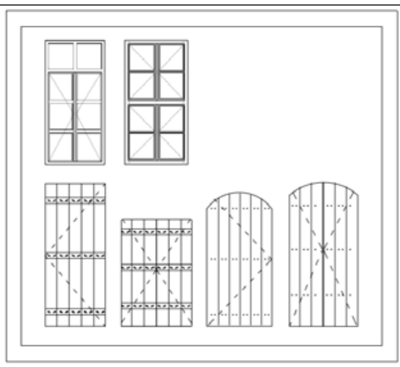
4 new wooden door typologies produced by the genetic algorithm method are shown in the figure below (Table 4).

Table 4. Wooden door typologies generated through GA method (Gökçe Salık ,2022)



Identity information of the building B are as follows (Table 5).

Table 5. Identity information of the building B

	ADDRESS: BLOCK OF BUILDINGS/PARCEL 233-2		
BUILDING INFORMATION	 Location on the map		
IMAGES			
	Images		
PLANS	 Basement floor plan	 Ground floor plan	 First floor plan
SECTIONS	 Section 1  Section 2	 Examined frame types	

Two window and four door typologies were examined. These

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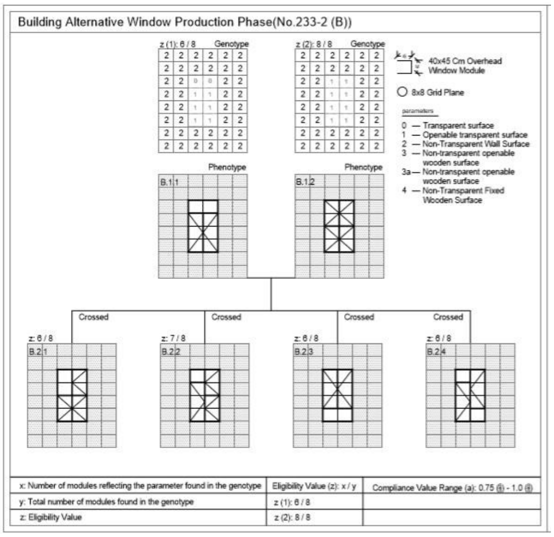
typologies were transferred to the grid base and coded based on the pre-set parameters. Windows and doors among the pre-selected chopping typologies were randomly selected, crossed and mutated. As a result of crossing, new typologies with fitness value were obtained. In conclusion, 4 new window typologies and 8 new wooden door typologies were obtained with the crossover with GA.

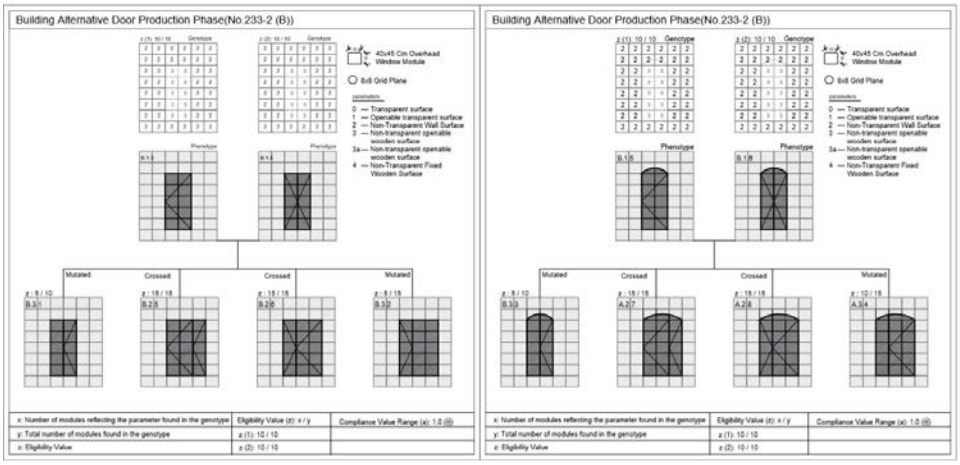
4 new window typologies produced by the genetic algorithm method are shown in the figure below (Table 6).

Table 6. Window typologies generated through GA method (Gökçe Salık ,2022)



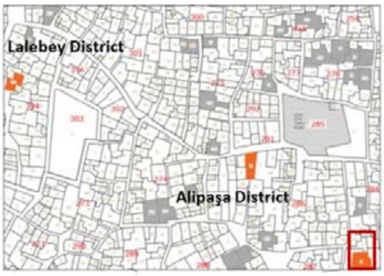
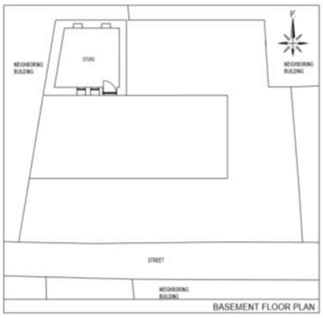
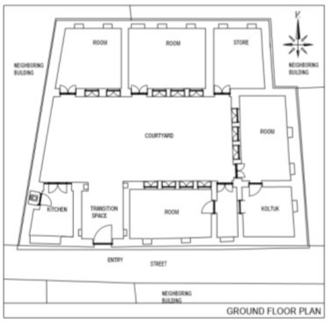
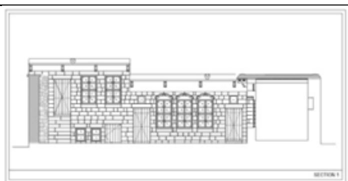
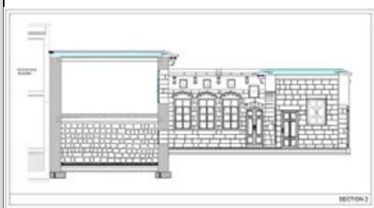
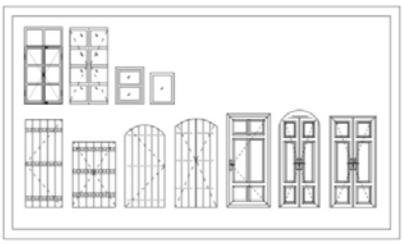
8 new wooden door typologies produced by the genetic algorithm method are shown in the figure below (Table 7).

Table 7. Wooden door typologies generated through GA method (Gökçe Salık ,2022)



Identity information of the building C are as follows (Table 8).

Table 8. Identity information of the building C

	ADDRESS: BLOCK OF BUILDINGS/PARCEL 233-2
BUILDING INFORMATION	 Location on the map
IMAGES	  Images
PLANS	 Basement floor plan  Ground floor plan
SECTION	 Section 1  Section 2  Examined frame types

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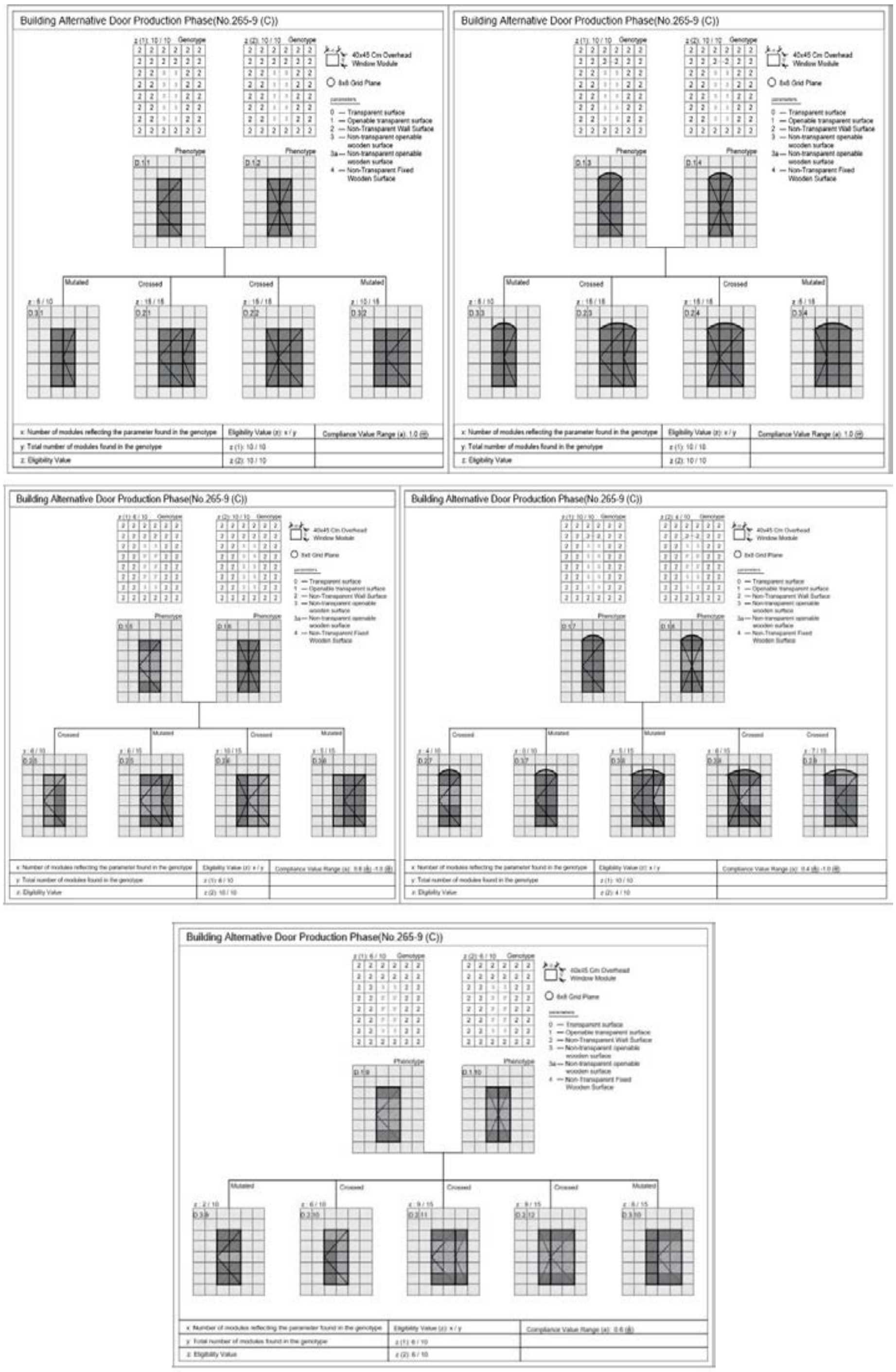
Four window and ten door typologies were examined. These typologies were transferred to the grid base and coded based on the pre-set parameters. Windows and doors among the pre-selected chopping typologies were randomly selected, crossed and mutated. As a result of crossing, new typologies with fitness value were obtained. In conclusion, 9 new window typologies and 22 new wooden door typologies were obtained with the crossover with GA.

22 new wooden door typologies produced by the genetic algorithm method are shown in the figure below (Table 9).

Table 9. Wooden door typologies generated through GA method (Gökçe Salık ,2022)



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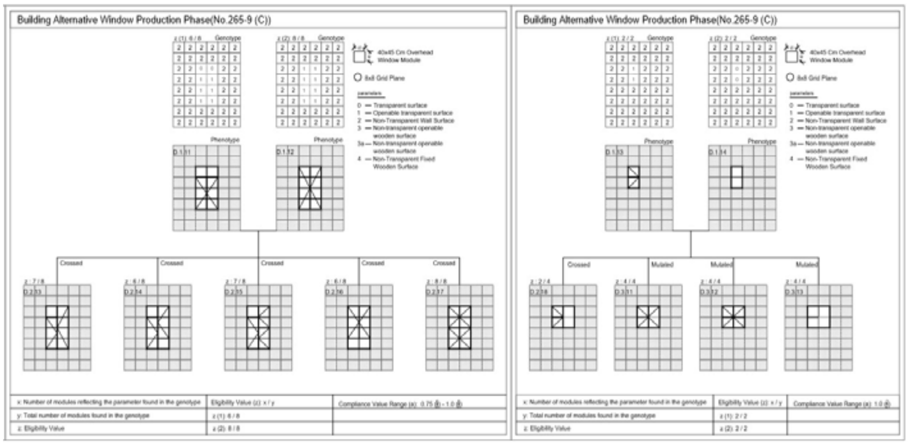
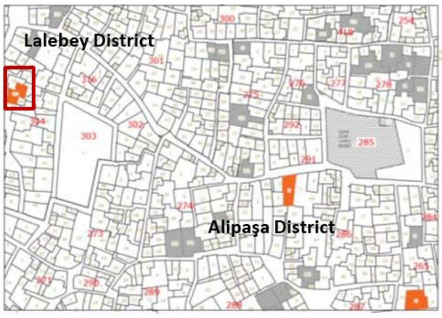
9 new window typologies produced by the genetic algorithm method are shown in the figure below (Table 10).

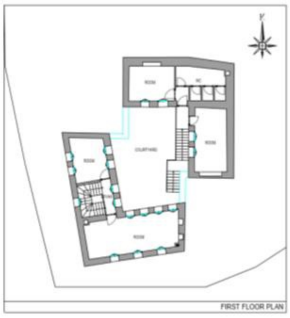
Table 10. Window typologies generated through GAmethod (Gökçe Salık ,2022)



Identity information of the building D are as follows (Table 11).

Table 11. Identity information of the building D

<table>
<tr><td></td><td colspan="2">ADDRESS: BLOCK OF BUILDINGS/PARCEL 304-25</td></tr>
<tr><td>BUILDING INFORMATION</td><td colspan="2">

Location on the map</td></tr>
<tr><td>IMAGES</td><td colspan="2"> 
Images</td></tr>
<tr><td>PLANS</td><td>
Ground floor plan</td><td>
First floor plan</td></tr>
</table>

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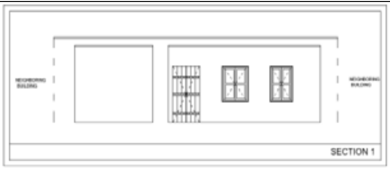
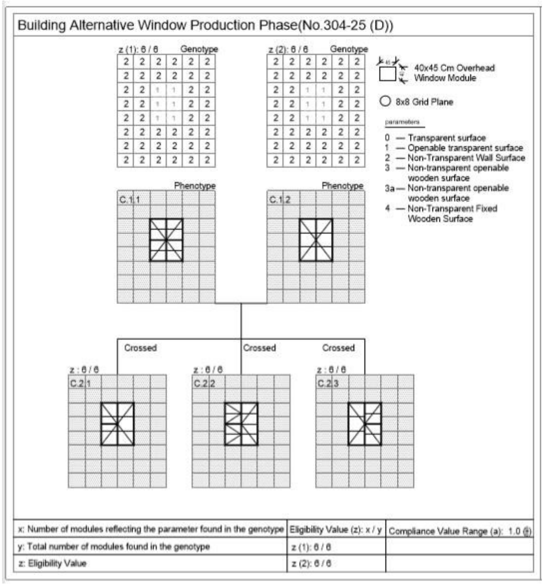
SECTIONS	 Section 1  Section 2	 Examined frame types

Two window and three door typologies were examined. These typologies were transferred to the grid base and coded based on the pre-set parameters. Windows and doors among the pre-selected chopping typologies were randomly selected, crossed and mutated. As a result of crossing, new typologies with fitness value were obtained. In conclusion, 3 new window typologies and 12 new wooden door typologies were obtained with the crossover with GA.

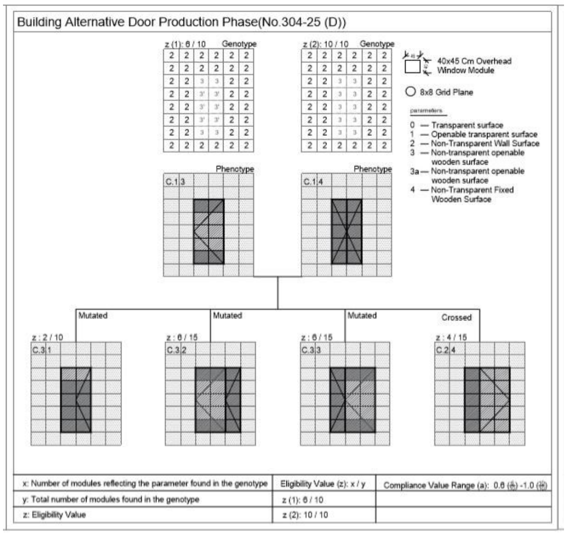
3 new window typologies produced by the genetic algorithm method are shown in the figure below (Table 12).

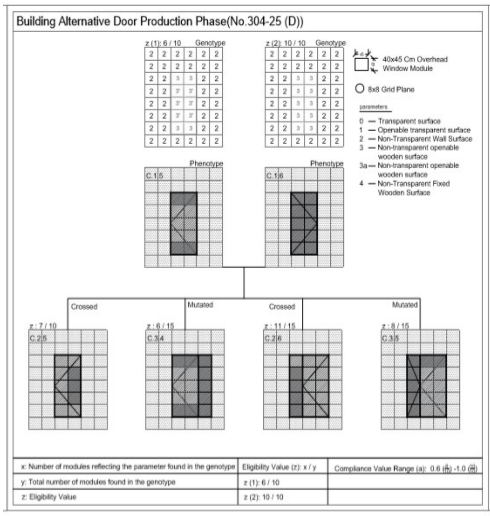
Table 12. Window typologies generated through GAmethod (Gökçe Salık ,2022)

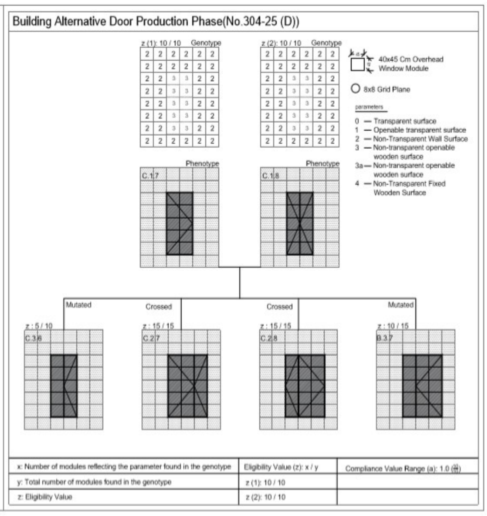


12 new wooden door typologies produced by the genetic algorithm method are shown in the figure below (Table 13).

Table 13. Wooden door typologies generated through GA method (Gökçe Salık ,2022)







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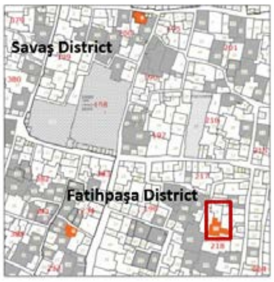
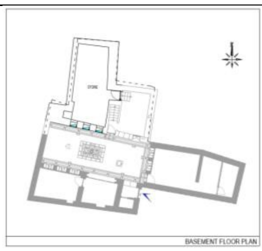
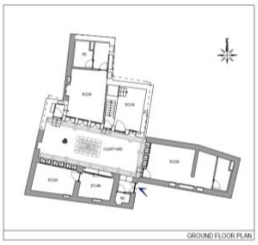
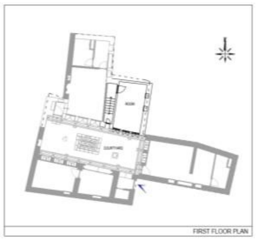
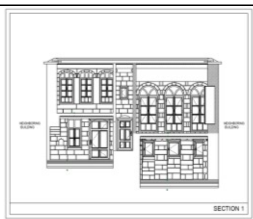
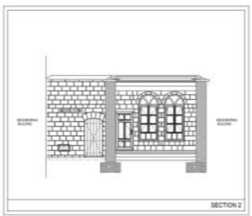
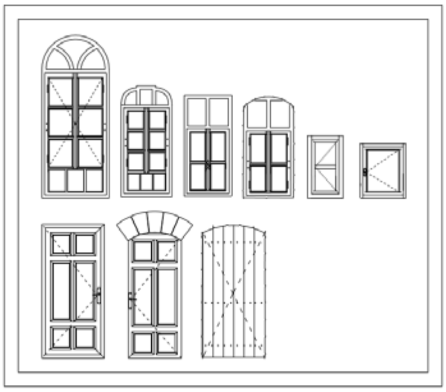
Identity information of the building E are as follows (Table 14).

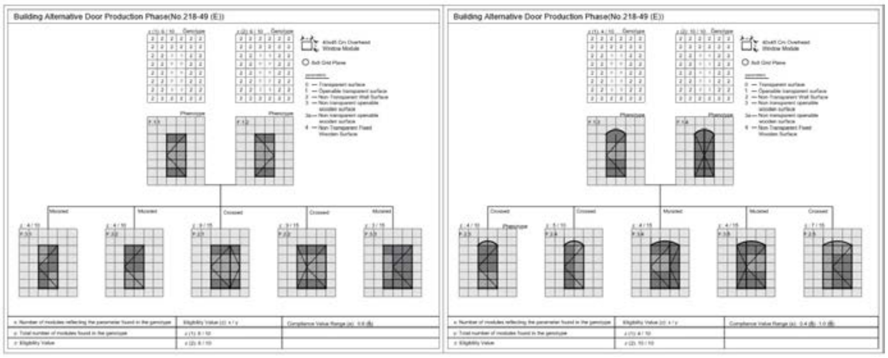
Table 14. Identity information of the building E

BUILDING INFORMATION	**ADDRESS: BLOCK OF BUILDINGS/PARCEL 233-2**		
	 Location on the map		
IMAGES		 Images	
PLANS	 Basement floor plan	 Ground floor plan	 First floor plan
SECTIONS	 Section 1  Section 2	 Examined frame types	

Six window and three door typologies were examined. These typologies were transferred to the grid base and coded based on the pre-set parameters. Windows and doors among the pre-selected chopping typologies were randomly selected, crossed and mutated. As a result of crossing, new typologies with fitness value were obtained. In conclusion, 14 new window typologies and 10 new wooden door typologies were obtained with the crossover with GA.

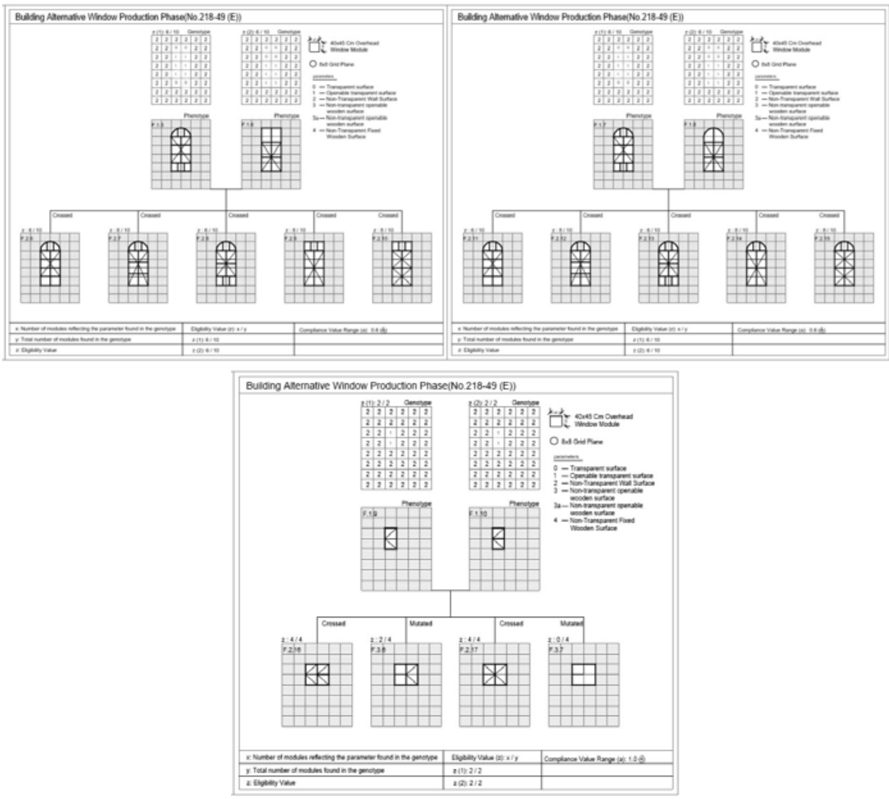
10 new wooden door typologies produced by the genetic algorithm method are shown in the figure below (Table 15).

Table 15. Wooden door typologies generated through GA method (Gökçe Salık ,2022)



14 new window typologies produced by the genetic algorithm method are shown in the figure below (Table 16).

Table 16. Window typologies generated through GA method (**Gökçe** Salık ,2022)



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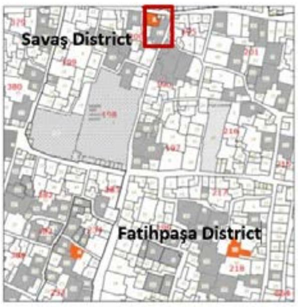
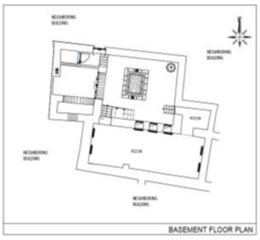
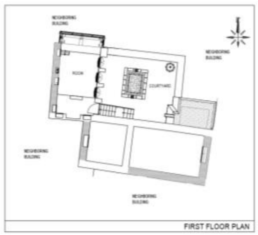
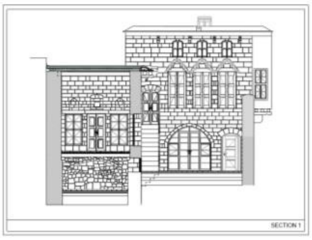
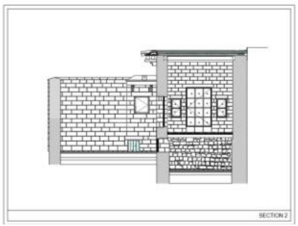
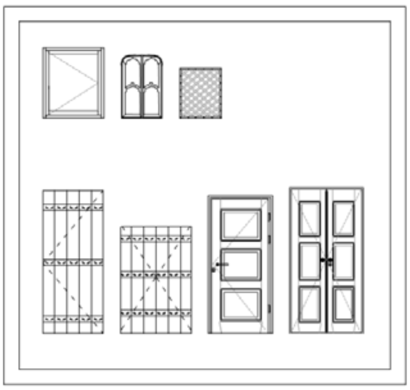
Identity information of the building F are as follows (Table 17).

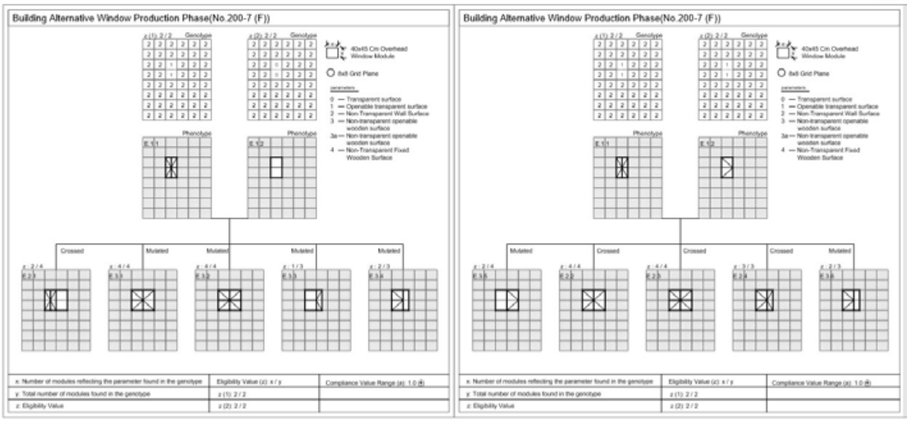
Table 17. Identity information of the building F

	ADDRESS: BLOCK OF BUILDINGS/PARCEL 233-2		
BUILDING INFORMATION	 Location on the map		
IMAGES		 Images	
PLANS	 Basement floor plan	 Ground floor plan	 First floor plan
SECTIONS	 Section 1  Section 2	 Examined frame types	

Three window and four door typologies were examined. These typologies were transferred to the grid base and coded based on the pre-set parameters. Windows and doors among the pre-selected chopping typologies were randomly selected, crossed and mutated. As a result of crossing, new typologies with fitness value were obtained. In conclusion, 10 new window typologies and 12 new wooden door typologies were obtained with the crossover with GA.

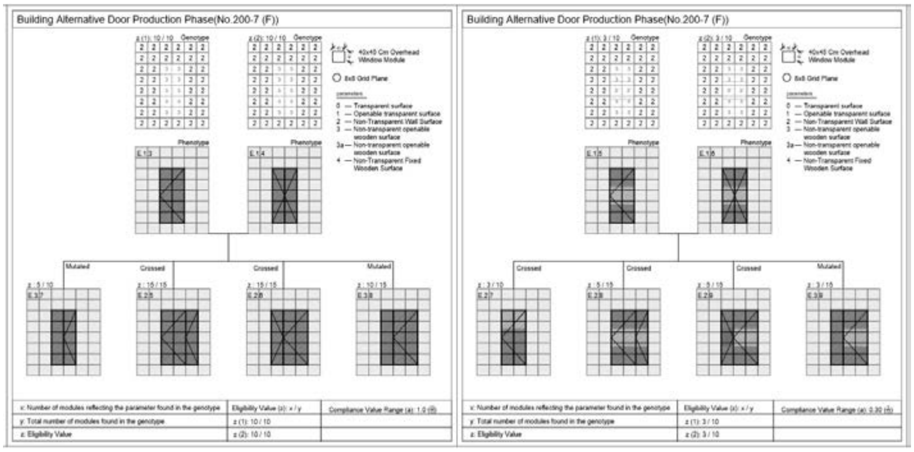
10 new window typologies produced by the genetic algorithm method are shown in the figure below (Table 18).

Table 18. Window typologies generated through GA method (Gökçe Salık ,2022)



12 new wooden door typologies produced by the genetic algorithm method are shown in the figure below (Table 19).

Table 19. Wooden door typologies generated through GA method (Gökçe Salık ,2022)



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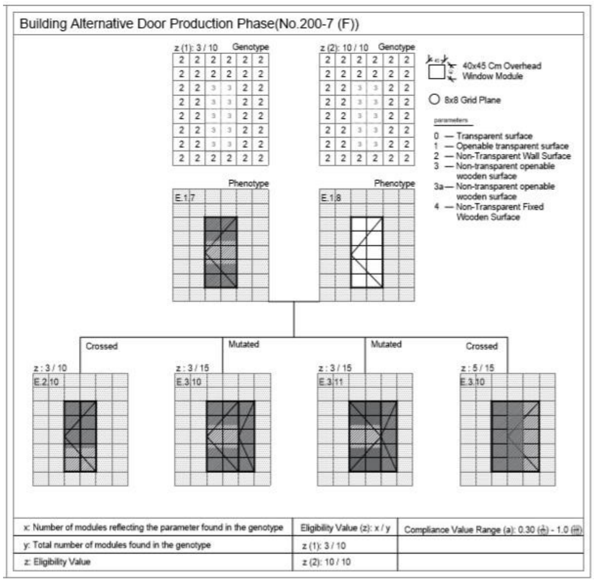


As a result of assessments, 31 window and 53 door types associated with door and window typologies were found. With this study, which was analyzed with the GA method specific to Diyarbakır traditional houses, it was concluded that many joinery typologies compatible with the traditional architectural language can be produced. It is thought that this method can be applied to traditional houses in different climatic regions.

CONCLUSIONS AND RECOMMENDATIONS

Evolutionary information processing method has been popular in designing. It is one of the promising computer-assisted designing methods in the present time. GAs, one of evolutionary designing systems, utilize evolutionary process for the existing problem and reach a solution. Relevant studies that take too long with the traditional methods can be completed in a short time with genetic algorithm. Performing the actions of selecting, crossing and mutating, GAs aim to reach the best solution in every step of any problem. Although they do not promise selecting the best solution at all times, optimal solutions can be achieved for these problems in a short period of time.

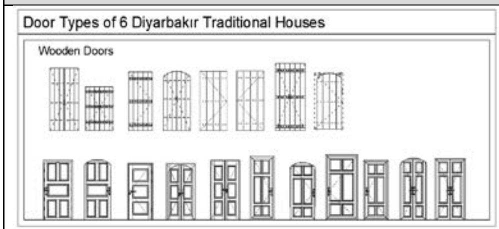
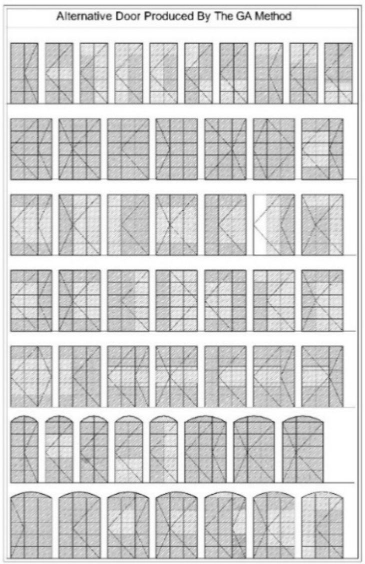
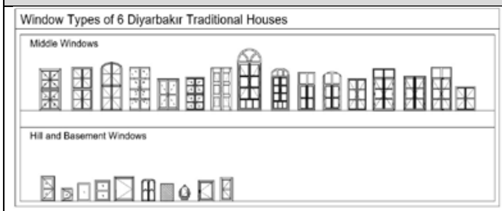
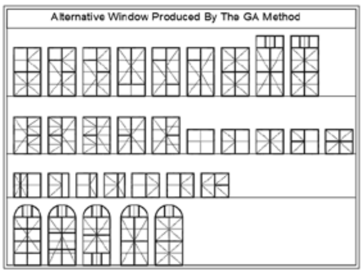
With GA, designers will be able to consider the necessities of architectural designing that they aim to obtain in the end. Through the necessities and limitations brought by the outputs, the range of solutions can be narrowed, and the process will be maintained with the most suitable solutions.

After analyzing the characteristics of generative designing systems, an integrated generative designing system whose genetic algorithms and shape grammar were to be used at different stages was presented in the study. However, a model study was prepared to understand how GA can be used in architectural designs. Assessments were performed through the door and window typologies facing the atria of traditional Diyarbakır houses with U plan. Rules and fitness functions were set for the selected chopping typologies, and different door and window typologies were presented for the buildings.

Within the scope of the study, the door and window typologies of the facade elements of 6 U-plan type traditional houses were examined. There are 26 different door typologies and 19 different window typologies belonging to 6 U-plan type traditional houses examined. As a result of crossover and mutation processes using the GA method, 53 different door and 31 different window typologies with fitness values

were produced. Thus, local data will be transferred to new housing designs by using alternative typologies on the doors and windows of the new U-plan type houses to be designed especially in the traditional residential area. It will also be useful for generating alternative facade typologies. The comparative data of the doors and windows produced as a result of GA and the original door and window typologies of traditional houses are shown in the table below (Table 20).

Table 20. Door and window typologies of 6 U-plan type traditional houses and Alternative door and window produced with the GA method (Gökçe Salık ,2022)

Door and window typologies of 6 U-plan type traditional houses	Door and window typologies produced by GA method
Door typologies of 6 U-plan type traditional houses	Door typologies produced by GA method
	
Window typologies of 6 U-plan type traditional houses	Window typologies produced by GA method
	

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Based on the data found in this study; These are as follows;

- designers are believed to improve further as their perceptions of computer-based generative systems are changed and as they start to consider computers as design generators.
- efforts were made to reveal the contribution of using GAs as an optimization tool to designing.
- this study will help present the results regarding the facade typologies to be designed and planned in future.
- this method will be used for the formation of facade typologies with different architectural shapes in future studies.
- considering the criteria such as fitness function, the method can be used in the buildings with complicated relationship systems.
- ensuring the optimal conditions of evolutionary process, or generation, will help achieve results with higher quality.

Data indicated that GAs should be used frequently and efficiently in architectural designing procedures. Furthermore, it is recommended that this method be used for the formation of facade typologies on the houses in different climate zones. The current use of the present typologies will be revealed in line with the certain criteria, and the traditional architectural language will be sustained.

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URL-2 1909- View from Suriçi https://www.mmo.org.tr/sites/default/files/gonderi_dosya_ekleri/SUR%20RAPORU.pdf

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Resume

Mizgin Gökçe Salık a PhD student at Dicle University, Faculty of Architecture, Department of Architecture. she worked in the private sector on application projects and designs. She is currently working as a lecturer at Department of Architecture and Urbanism in the Ağrı İbrahim Çeçen University. She has publications on architecture.

F. Demet Aykal is currently working as a professor of planning, planning theory and design approaches at Dicle University, Faculty of Architecture.F. Demet Aykal serves as the vice dean of the faculty of architecture in. She has publications in journals in many fields related to architecture and is a referee.

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