# Automated Town Planner

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**Abstract:** Absence of proper planning for infrastructure of a city leads to various complication and compromise in an individual's life and wastage of vital resources such as Energy, Time, Financial Resource, Flora, Fauna and other resources. Presently the solution to the same is proper planning of any city before raising one but there would always be a chance of human error if the task is performed manually. Thus, we propose to design a system which takes into account all the relevant factors including GIS, position of water bodies and other essential natural structures, Population Census, Power supply, Road Networks, Subway Network etc.

**Keywords:** Machine Learning, Smart City, Genetic Algorithm, GIS Systems, Town Planning, Voronoi Diagram, Block System, Aesthetic Arrangement, Sectors, Optimization, Random Search, Delaunay Triangles, 3D Model, Unfolding Maps.

## I. INTRODUCTION

Lack of planning causes inconvenience to every individual in a society. Few of the quandaries that a city can suffer from are anomalous and concentrated distribution of commercial structures. If such structures are kept at an immensely colossal distance from residential areas, the cost of convey and wastage of time is inevitably ineluctable for any employee. Also, if the power plant is at a distance from the industries then the cost of overhead wires to convey the power supply increases and affects the aesthetic view of the city. Such parameters, though intangible, are yet crucial factors to be taken into consideration while planning a city. The ideal solution to it was to plan an ideal city afore designing. However, planning on such an immensely colossal plot requires adept professionals and perplexed calculation (involving various parameters like GIS, soil bearing capacity, wind flow, natural dihydrogen monoxide bodies, terrain altitude, seismic activity etc.) which is extravagant and yet human error is inevitably ineluctable.

## II. LITERATURE REVIEW

B.Kiruparan in his paper suggested a method to select a plot on an existing city by considering parameters such as information received by GIS, Soil Property and distance between key structures required for the comfort and convenience of citizens which would reside in it in future. However, it was clear that comfort was given the least priority and primarily the idea was to plan a single structure at a time whenever one is required instead of planning well in advance. Lifeng Liu[1,2] in his IEEE paper "Voronoi Diagram and GIS-based 3D Path Planning" came up with idea to come up with a path for aircrafts to penetrate enemy defense line with minimal threat by considering cost of the path in term of firepower of enemy at that area. The same logic can be used to plan road systems by considering the parameters such as distance from key structures and the cost of road planning. Krishnanand K. R. in his IEEE paper "GIS Integrated Automation of a Near Real-Time Power-Flow Service for Electrical Grids" introduced a system that aids management of flow of power from power sources. This primly emphasizes on improving sustainability of local regions in aspect of electrical power. This concept can be used to provide choicest location for setting up a power grid, based on raw sources of renewable energy in vicinity based on GIS provided. Michael Isnaemi Djimantoro in his IEEE paper "Smart City Planning System on Settlement Area" put forth the concept of organizing cities by accounting city density and population to area ratio. The corresponding algorithms and logic will be inherited and upgraded to provide superlative solutions on planning a city that will have efficient solution patching the issues that lead to inefficient positioning of residential and commercial structures causing exponential problems on a long run. Jianhua Wu in his paper "A Matching Algorithm Based

on Voronoi Diagram for Multi-Scale Polygonal Residential Areas" highlighted a concept for matching entities on multi-scale data set. This approach can be used to process irregular shapes of areas on which structures have to be planned.

## III PROPOSED SYSTEM

First the system will start by placing key points on lands which are appropriate for utilizing in building structures and mark those lands which are appropriate for agriculture. Using the arrangement of points marked on the land we execute Voronoi algorithm to aesthetically split the land which would also provide a basic structure for road network. Once this is done, there are three ways to achieve the goal.

**1) Brute force with machine learning:**

By this method the system will start placing structures at random. Once done it will then calculate a score which would depend on various factors such as Aesthetic view, distance from residential structures to key structures etc. Once the score is calculated the city and the score will be saved in a database for future references. As, more and more cities are build they'll be compared with those which are in database and the system would learn to build more optimal plans overtime.

**2) Use optimal algorithms:**

This is in a sense opposite to the previous method. While the previous method rely mostly on hit and trial method, this kind of system would use appropriate and optimal algorithms from the start such as Dijkstra's Algorithm or Greedy algorithm or Min Max Algorithm or another hybrid versions off those or others to accurately build one optimal city.

**3) Hybrid of the above two Methods:**

Needless to say both the above algorithms has their own strengths and drawbacks, since the first method would take more time to build, score, compare, evolve and repeat the process until the desirable output is obtained, while the second method, even though works accurately to build one optimal city, it unfortunately won't provide variety of options which might have been more optimal and aesthetic. In other words, it uses a definite method instead of fuzzy. Thus a better solution might be to use the hybrid of both methods to build an optimal plan.

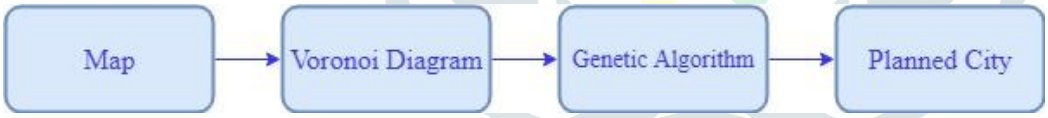


Figure 1) Flow Diagram.

The system uses hybrid of the above two methods.

**1) Map:** The system makes use of Unfolding Library (Open Source) to get Images of location corresponding to the latitude and longitude as shown in Figure 1.1. The same library also handles the panning of maps internally if required. Select an area for city planning as shown in Figure 1.2.


Figure 1.1) Map



Figure 1.2) After Zoom and Pan

**2) Voronoi Diagram:** In modern town planning, Voronoi Diagram is customarily used to engender optimal aesthetic looking spatial arrangements.

Voronoi Diagram can be built using the following algorithm.

1.Place Vertices(Grid arrangement in this case): This is simply because modern planned cities are built by Grid Plan.

2.Delaunay Triangulation: Triangles are made using the above vertices such that circumcircle of any such triangle do not contain any other vertex.

3.Plot centre of each Delaunay Triangle.

4.Connect each such centre to the Circumcentre of the triangle to which the side belongs to.

5.Now every side that composes a closed region will be associated to some Voronoi Cells making sure the closed region doesn't contain any side in it's area.

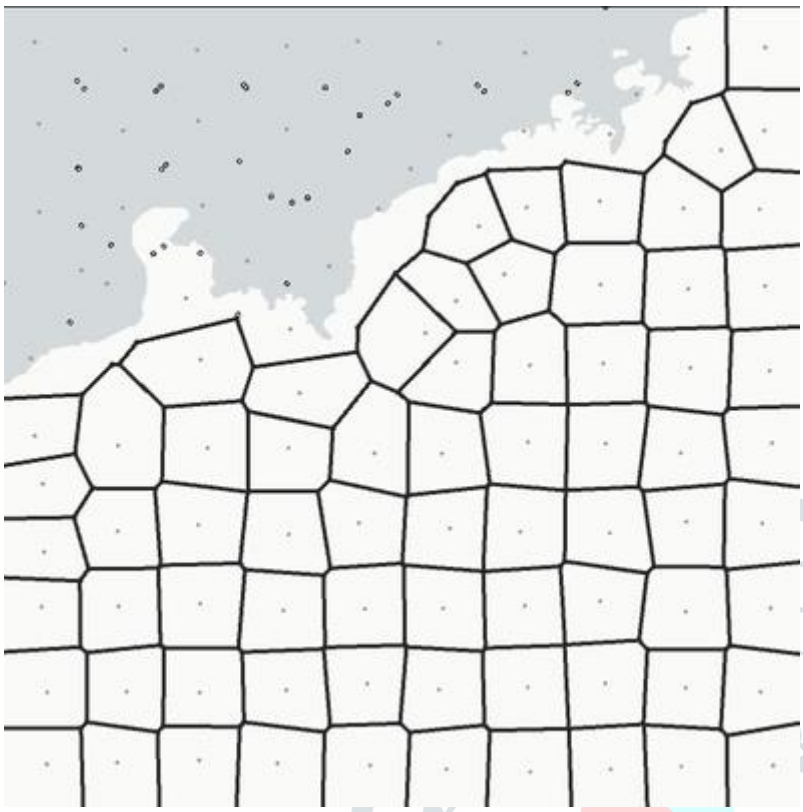

Figure 1.3) Voronoi Diagram

**3) Genetic Algorithm:** Genetic Algorithm is an optimized random search algorithm. The terminologies of Genetic Algorithm and its implementation with respect to this system is as follows:

1.Gene: A unique arrangement of building types over the Voronoi cells.

2.Population: N number of genes grouped and labelled as one generation. The first Generation is engendered at desultory.

3.Fitness Function: A function which takes a gene as an input and provides an arbitrary number which can accurately measure the optimality of a solution (Gene) relatively to the other Genes. In case of this system, the fitness function takes one gene as input and follows certain rules for scoring it. For example for every residential structure built adjacent to an industrial structure reduces the overall score of that gene and for every School/Hospital placed adjacent to one residential structure amends the overall score of the same.

4.Selection Process: Two Genes from population N with the highest scores are opted to instigate a progeny. Now the two parent genes and progeny Gene are promoted to Generation N+1 directly. This is to ascertain that the incipient Population composed do not degrade while performing mutation (Explicated Later).

5.Crossover: To foster progeny gene of two genes, a crossover function is utilized. Crossover function accepts two parent genes and generates an offspring gene as output. The incipient gene is composed by including partial gene of both parent genes while maintaining the structure ratio.

6.Mutation: Offspring gene is mutated multiple times to populate the remaining slots available in a population. This is done so by fitfully swapping arbitrary number of structures assigned to Voronoi cells with the other.

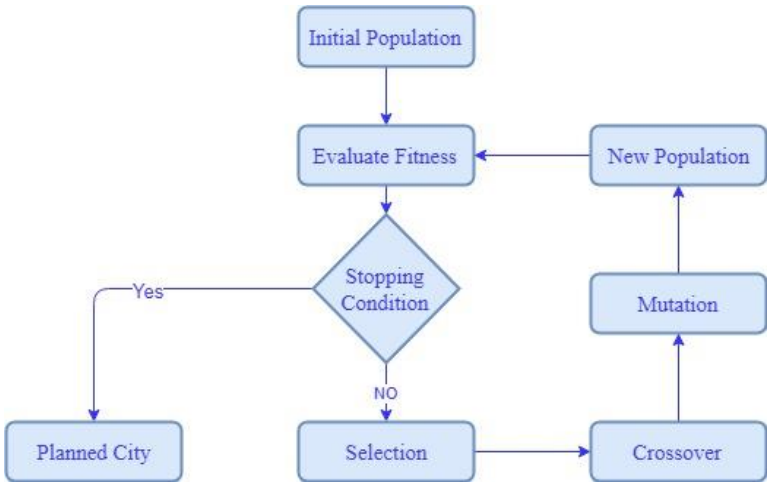


Figure 1.4) Genetic Algorithm Flowchart

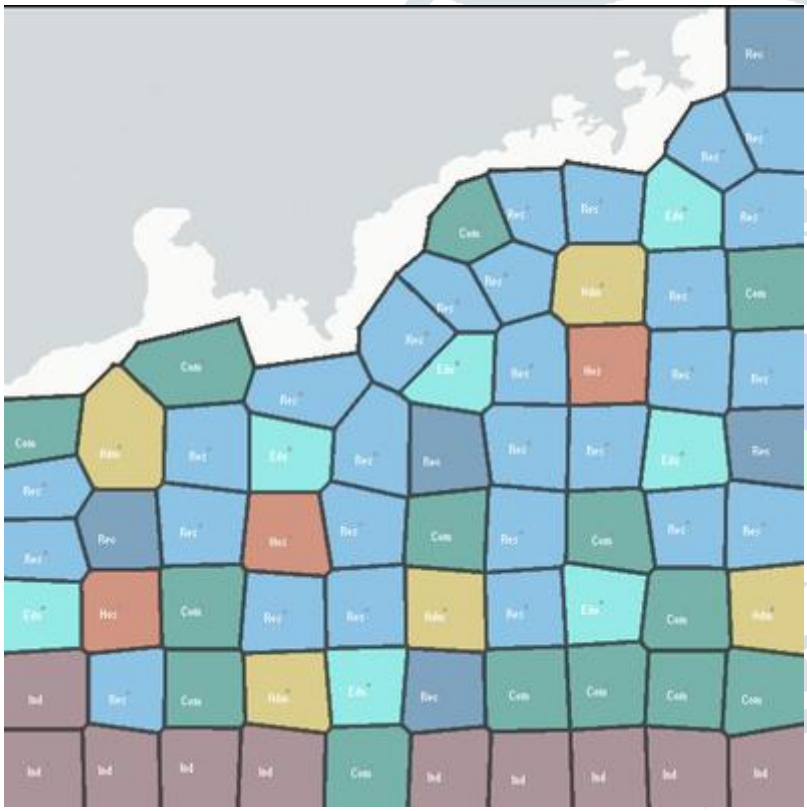

Figure 1.5) Output City Plan

**Legends:**

Industries

Residential

Recreational

Hospital



Educational

Commercial



Administration

## IV. CONCLUSION

Thus the system we develop will automate the tedious task of manual planning while maintaining aesthetic feel as well ensuring optimal and smooth functioning of entire city. The System would also assure an optimal amount of green patches to ensure pleasant environment. It will take the basic shape of terrain as an input and will develop a 2D plan of possible areas to build the structures, which areas should be reserved for which structures (which will be achieved by taking population census and survey into account), optimal road networks ensuring minimal cost at least to the important key structure to provide a sense of convenience to the future population which would reside in there.

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