# LOCAL AREA NETWORK DESIGNED BY GENETIC ALGORITHM 

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#### Abstract

In this article are shown the possibilities of genetic algorithm (evolution methods in general) for the design process of low-current distribution system. For existing object was designed deployment of elements needed for LAN web, which is optimal from economic view. This demo example shows basic principles of evolution methods and in nutshell the influence of theirs parameters on final solution.


Keywords: Evolution methods, genetic algorithm, local area network

The task is very simple, to designed the deployment of LAN elements for given object (building). According to reach the maximum correspondence with reality, we picked up real object (Fig. 1a - left), for which we will seek solution. For block of flats and similar buildings (administrative object etc.) is common the fact, that the wirings of DS or other systems are placed in wiring shafts (WS) (Fig. 1a - right, WS). From this knowledge follows the fact, that the flats distances are various from WS (Fig. 1a - right, A, B, C, D).


Fig. Ia Real object (left), flats positions (right)

As we assume aforementioned precondition, we have four various flat distances from wiring shaft, (see Fig. 1a - right) i.e. A ( 8 m from WS), B ( 12 m from WS), C ( 2 m from WS) a D ( 6 m from WS).

Note: We created universal algorithm, so on the floor can be (n) flats, with arbitrary distances from WS and the object can have ( $m$ ) floors (for our case $m=8$ ).

### 2.1 Process of GA creating

## Structure of string

As we mentioned before, the length string is equal the number of plug flats. The genes can distend only integer values from the interval $\langle 1$, count of floors $\rangle$, ground floor is considered as first floor. The gene of string represents the plug of flat i.e. the floor number of switch.

## Size of population

The size of population depends on amount of flats which we want to plug (PF). The size is always two times bigger than PF.

## Mutation

Proposed GA uses two types of mutations. The first is the mutation on random value from given interval (with ratio 0.25 ) and the second is additive mutation (with the same rate). (The rate - amount of mutations in one generations in normalized to interval <0, $1>$ bigger number means often mutation occurrence)

## Crossing

In the algorithm was used on point crossing and crossed strings are selected randomly.

## Fitness

Fitness function is created from two parts, which are

- price of switches
- price of wiring

In the first step is assigned the switches requirements for each floor, it means that the algorithm goes through whole string and count the amount of plugged flats on each floor.

Note: If we want to plug e.g. 3 flats into switch which is placed on X-th floor, we need minimal 5 and not 3 ports switch due to the fact, that switches have to be interconnected.

In the second step is counted the price of required switches (which are founded in the first step).

In the third (last) step is counted the price of wiring, which is needed for interconnection between switch and flat.

## Results

If we launched GA with mentioned set of parameters and we obtained following results.
Note: Vector "connections" represents switch position (floor number) i.e. the floor into which will be carry the wiring from flat assigns in " $E V$ "
$1^{\text {st }}$ condition of termination: after reaching prescribed amount of generations (60 000) : program output
*** Flats connections and switches deployment ***

connections $=$|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $E V=$ | 2 | 2 | 2 | 4 | 4 | 4 | 6 | 6 | 6 | 6 | 6 | 6 |  |
|  | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 7 | 8 |
| 9 |  |  |  |  |  |  |  |  |  |  |  |  |  |

The first row of EV represents the floor of flat which want to be connected the second row of $E V$ represents the flat distance from wiring shaft.

On the 2 floor is 8 ports switch
On the 4 floor is 5 ports switch On the 6 floor is 8 ports switch

The price of wiring is 1089SKK
The price of switches is 1569 SKK
The total price is 2658 SK


Fig. $2 a$ The progress of fitness after reaching prescribed amount of generations (left), if the value of fitness is stable for prescribed amount of generations (right)
$2^{\text {nd }}$ condition of termination: if the value of fitness is stable for prescribed amount of generations (25000) : program output
*** Flats connections and switches deployment ***

connections |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| $E V=$ | 2 | 2 | 2 | 4 | 4 | 4 | 6 | 6 | 6 | 6 | 6 | 6 |  |  |
|  | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 7 | 8 | 9 |
| 8 | 10 | 2 | 8 | 6 | 2 | 6 | 8 | 10 | 2 | 8 | 2 | 10 | 6 |  |

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From Fig. 2a, and also from program outputs is obvious, that we obtained same results by both ways (it need not be same in general). From figures is also evident that for each new run of GA we have another progress of fitness. It is caused by the alone evolution, because the mutations and crossing are randomly events, therefore GA can find the best solution even in the first generation.

## Conclusion

The main point of this paper was to show the possibilities of evolution method in general in some new areas. Proposed genetic algorithm solves the task of optimal elements deployment of local area network. The criterion of solution suitability was focused on the final price of the solution. The price consists from price of wiring and switches. The biggest asset of this approach is saving money and lucidity of solution. The algorithm was proposed as universal, so with a few simple modification can be used for any low-current distribution subsystem and in general for any large objects, but it is important to keep in mind that with the volume of parameters increases also time needed for calculation, which is the biggest weakness of evolution methods in comparison with classic approaches.

