Eurasian Journal of Health Technology Assessment

# A Model for Check-Up Processes In Health Care Systems Using Genetic Algorithms

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**Abstract-** This paper examines the appropriate route determination in check-up process for minimizing the time wasted through the process. In this recent research, health information systems are explained and a framework is presented. The clinics to be visited are assumed to be predetermined. A genetic algorithm based Quadratic Assignment Problem structure is proposed as a new approach for time minimization through the process.

**Keywords-** Genetic algorithm; health information system; optimization; quadratic assignment problem.

## 1. Introduction

Health care business activity is facing serious challenges to providing care in a quickly uncertain environment (Aiken, et. al., 2002), and is opinionated by different of internal and external forces. Forces may include changes in settlement, a shortage or excess of changes in the political landscape, the economy, and others (Edens, 2005). In fact, the sensitive cost pressure the health care industry has practised radical organizational change (Walston and Bogue, 1999). Managers must be adaptable of the environment in which they function in order to anticipate and recognize the requirements for change (Edens, 2005).

Hammer and Champy (1994), the founders and leading proponents of reengineering, defined the process as the fundamental rethinking and radical redesign of process to achieve improvements in essential, existing measures of performance, like cost, quality, service, and speed. Reengineering is the design of a completely new process, whereas variations on reengineering can deliver enhancement or improvement in an existing process or a response to an external stressor.

Patients and governments are concerned about the quality of health care in all countries. In some countries, half of doctors feel that their ability to provide quality care has worsened over time. Patients and the public indicate overpoweringly that health systems have to be changed fundamentally. Demand in health care is growing rapidly due to growing patient expectations and population ageing. Improving the performance of health care systems is essential for optimizing health spending and correcting deficiencies in care quality (DELSA Newsletter, 2007).

Information of health management supports decision-maker for different levels of system, from policies. The usage of the data for management is critical for analysis (Health Reformplus Project, 2005).

Many studies demonstrate that patient perceptions of quality determine the use of services and willingness to pay. Although cost is very important, in this study, it is not considered in implementation because the priority of this research is the quality of service not to waste time for patients. Quality improvement processes has many instruments like standard treatment guidelines, (Health Reformplus Project, 2005), check-up processes. If there is a little change in these processes, there will be an improvement for health care system.

In this research, Genetic Algorithm (GA) will be implemented to health care systems. GA gives various alternatives with the optimum or better solution to the decision-making. In all cases, it is sure that the solution is not always exact optimum. As a model proposed with parameters and conditions, the decisions can be offered to suit objectives with respect to resources, although there are more difficulties. Through this opinion, GA is chosen as the most suitable method implementation. Therefore, GA is chosen as an optimization and search technique.

For this study, GA approach will be developed in health care systems for check-up tests. The objective function structure of Quadratic Assignment Problem (QAP) can be used for health care systems. The QAP statement and structure will be explained in detail in the next section. QAP uses the multiplication of two matrices (flow matrix represents the flow units between departments and distance matrix which represents the distance units between locations). It is seen that this structure can be adapted for check-up system.

In the next section, HIS, which will be in the implementation, will be explained in detail. In this study, like the multiplication in QAP, density matrix (consists of distance matrix for each department in check-up process) and flow matrix (the patients' ground time in each department in check-up process) will be used for the multiplication to minimize waste times in check-up process. GA is used as an optimization technique for check-up processes to determine the available route because GA is the most appropriate method for decision makers as seen in previous studies on different kind of problems. The GA procedure, implementation details and why this algorithm is chosen will be explained in detail in the next sections.

## 2. Objectives

The main objective is determining a new approach and compare the previous studies about health care systems for check-up process using GA and health care performance indicators until now and to select the best route for patients in check-up process for not wasting time with new developed genetic algorithm approximation in this study.

The objective function structure of QAP can be used for check-up process. QAP uses the multiplication of two matrices (flow matrix represents the flow units between departments and distance matrix which represents the distance units between locations). It is seen that this structure can be adapted for check-up process. In this study, like this multiplication, density matrix (consists of density matrix for each department in check-up process) and flow matrix (the patients' ground time in each department in check-up process) will be used for the multiplication to minimize waste times in check-up process. GA will be used for choosing the best route for check-up system for each patient. Like QAP's objective function, the fitness function will be prepared for each route for minimizing ground time between departments in check-up process. New developed GA procedure will be used for minimizing ground time for each patient to save time in this process.

QAP structure using GA for check-up system in this research as a new solution technique is not used and implemented before in the literature. According to the solution technique analysis, this study can guide other researches that will be generated and this can be a basic framework for new researches. If this approach is implemented in real life in hospitals, patients will know his/her route to choose and which department is suitable to go for not wasting time, so health care system can be improved.

## 3. Health Information Systems

Data related to the health services performance is essential for the resource management on health sector. Information about the quantity, on the resources needed to provide services can be created through usual information systems of health management (HIS) (World Health Organization, 2000).

There is a wide agreement that a strong HIS is an integrated part of the health system, which includes a condition of actions. HIS' main intention is to protect, support or recover health (Murray and Frenk, 2000).

Health information quality is highly changeable with different definitions and measurements (World Health Organization, 2000).

Check-up process is an important part of health care system. In this process, the information usage to notify decision-making is also weak. Information in check-up process (densities of departments, patients' ground time in each department, etc.) can be collected and then the process can be strengthened with determining the available route for each patient not to waste time between departments.

There is no consent around any specific formulation about HIS' definition (Kleinau, 2000). The health information system is "an integrated effort to collect, process, report" (World Health Organization, 2000).

It is obvious that the information about health is more about collecting of data. Data have no value by itself – after application and analysis it will be meaningful as seen in Figure 1. This goal of HIS can be adapted to check-up process to get the system more specific.

Performance of a system measurement is deal with not only on the basis of the data quality defined, (Routine Health Information Systems, 2003) but also it is about operations and analysis.

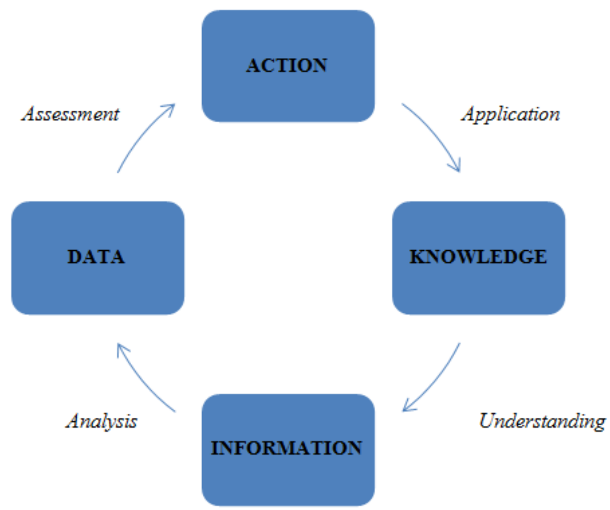


**Fig.1. Goal of HIS (World Health Organization, 2000).**

Health-related data can be gathered analyzed, and used for decision-making in check-up process to improve HIS.

In health sector, there are different types of information are created, such as coverage and care quality (World Health Organization, 2000).

## 4. Literature Review

Health care processes are complex, hard to understand and accordingly difficult to model effectively in the system development life cycles analysis in decision-making (SDLC) (Kushniruk, 2002). Table 1 shows the literature about HIS.

The traditional SDLC is included by the phases (Kushniruk, 2002) like; planning, analysis, design, implementation, maintenance (support).

**Table 1. Survey for HIS**

| Authors | Model/Measurements |
|---|---|
| Kushniruk, 2002 | Dependent measures are the length of stay, cost-effectiveness, care quality and etc. |
| Hoffer, et. al., 1999 | Life cycle models using the complex systems evaluation and development |
| McConnell, 1996 | Rapid application development (RAD) and various approaches |
| Kushniruk and Patel, 1998 | Continual with design methodologies integrated with the design and development process |
| Friedman and Wyatt, 1997 | Subjectivist approaches |

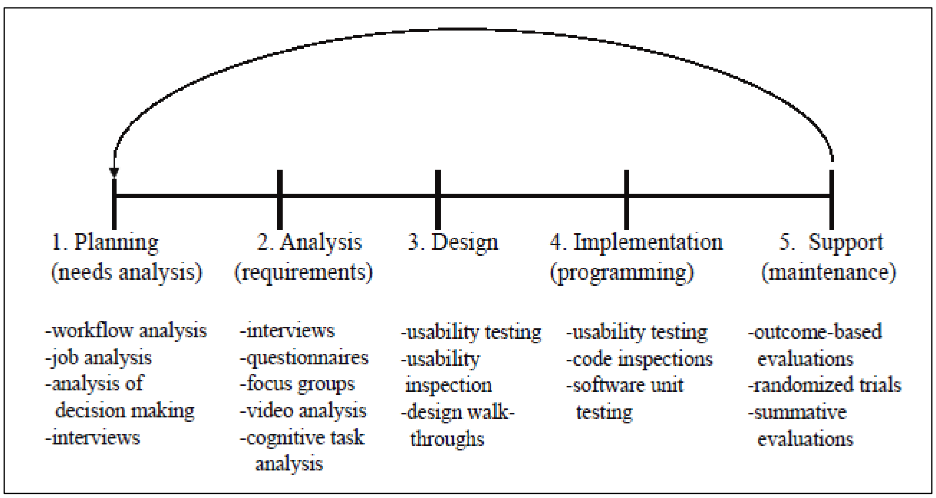


**Fig. 2. The systems development life cycle (SDLC) related with evaluation methodologies (Kushniruk, 2002)**

Evaluation in health informatics is like a project planning to design and implementation. Figure 2 relates a number of approaches that have been used in the evaluation of HIS.

## 5. Quadratic Assignment Problem Statement

The Quadratic Assignment Problem (QAP) is a special kind of assignment problem used for layout and location studies (Duman and Or, 2007). QAP is one of the fundamental combinatorial optimization problems in the branch of optimization of the facilities location problems (Erol, 2010).

QAP is one of the most complicated problems in the NP-hard class (Loiola, et. al., 2007). In this kind of problem like facility location problem, finding the better/best location of facilities is very important (Francis and White, 1976). QAP method can be used as a method for solving the assignment problem. In this kind of problems, the distances between locations, the demand flows among the facilities are generally known (Saremi and Abedin, 2008).

In previous research's techniques, there are different methods for QAP modeled problems (Gilmore, 1962), to achieve a global optimum for QAP (Lawler, 1963). QAP models a number of real world applications (Loiola, et. al., 2007). Exact solution methods proposed for instances of size larger than 15 generally become unsuccessful up to size 36 (Erdoğan, 2006).

Consider the set {1,2,…,n} and two $n \ x \ n$ matrices $A=(a_{ij})$, $B=(b_{ij})$. The QAP with coefficient matrices $A$ and $B$, shortly denoted by QAP($A$,$B$), can be stated as follows

$$\min_{\Pi \in S_n} \sum_{i=1}^{n} \sum_{j=1}^{n} a_{\Pi(i)\Pi(j)} b_{ij}$$

where $S_n$ is the set of permutations of {1,2,…,n}. That is, QAP ($A$,$B$) is the problem of finding a permutation $\Pi \in S_n$ which minimizes the double sum in the above formulation. Obviously, the value of this sum depends on the matrices $A$ and $B$ and the permutation $\Pi$. To formalize these dependencies that is denoted:

$$Z(A,B,\Pi)=\sum_{i=1}^{n}\sum_{j=1}^{n}a_{\Pi(i)\Pi(j)}b_{ij}$$

The function $Z(A,B,\Pi)$ is called *the objective function* QAP(*A*,*B*) and a permutation $\Pi_0$ which minimizes it over $S_n$ is called an *optimal solution* to QAP(*A*,*B*). The corresponding value of the objective function $Z(A,B,\Pi_0)$, is called *the optimal value* of the objective function QAP(*A*,*B*).

If any of the coefficient matrices (*A*, *B)* is symmetric, the function is termed *symmetric QAP*. Otherwise, the function is said to be *asymmetric* (Çela, 1998).

This objective function structure of QAP can be used for check-up systems. QAP uses the multiplication of two matrices (flow matrix represents the flow units between departments and distance matrix which represents the distance units between locations). This multiplication can be adapted for check-up processes.

## 6. Complexity Of Quadratic Assignment Problems

From the computational point, the QAP is one of the most difficult problems to solve. There are several aspects regarding the complexity of the QAP. Although computational complexity characterizes worst case instances, it also plays an important role in developing new algorithms (Pardalos, et. al., 1994).

QAP is NP-complete, which implies that finding a polynomial time algorithm to solve it unlikely (Ji, et. al., 2006).

## 7. Genetic Algorithms

Genetic Algorithms (GAs) receive their name from an instinctive explanation based on Darwin's theory (Burkard and Çela, 1996).

Genetic algorithm is a powerful and robust solution (Ahuja, et. al., 2000), includes a randomized search methodology (Radhakrishnan, et. al., 2009) for developing methods for large scale optimization problems. Algorithm is started with chromosomes set called population (Obitko, 2010). In Figure 3, a genetic algorithmic skeleton is given. GAs imitate evolution process on an optimization problem (Ahuja, et. al., 2000).

**begin**

create initial population

**for every generation, repeat**

randomly select the individuals into the mating pool;

apply genetic operators to generate offspring;

apply post-crossover heuristic on offspring;

**if not in generation size generations**

compare every offspring with its similar parent and remove the worse one;

**else**

compare every offspring with the worst member in current population and remove the worse one

**until some condition is met**

**end;**

**Fig. 3. The genetic algorithms scheme based on the new replacement strategy (Ji, et.al., 2006)**

There are some inherent difficulties for the solution of decision-making problems. For overcoming the difficulties, recently GAs are used as optimization technique (Mondal and Maiti, 2002).

### *7.1. Genetic Algorithm Application And Computational Study*

#### *7.1.1. Initial Requirements*

In this study, Java programming language is used. The program is developed on Eclipse Kepler 4.3 by using Java Development Kit 1.6. Since Java is one of the leading programming languages and it is the programming language, it is chosen as the development language. Not to mention that it would take more time to run the program on a lower capacitated PC.

### *Input Files*

The problem data format is;

*n*
*A*
*B*

where *n* is the instance size, and *A* and *B* are matrices, either density matrix (consists of density matrix for each department in check-up process) or ground time matrix (the patients' ground time in each department in check-up process). This corresponds to a QAP of the form;

$$\min_{p} \sum_{i} \sum_{j} a_{ij} b_{p(i),p(j)} \qquad (1)$$

where *p* is a permutation.

There are many tests in check-up processes. Table 2 shows the twenty tests chosen for implementation.

For input files (APPENDIX 1), data is collected and taken from a hospital in Turkey. For example, Department 1 indicates urinalysis process, etc.

*7.1.2. Genetic Algorithm Application*

According to the size of problem (n), the main method does assignment n departments to n locations randomly. There is n! possible assignments for each problem instances, but it is impossible to get all these assignments for large size problems. To run the program to get result for all problem instances, population size determined as n*10 assignments randomly. These n*10 assignments are sent to the PopulationList and for each run this list returns to null value. Each of two parents is choosing by a random number from the sequence of assignments by roulette wheel selection technique.

**Table 2. Tests for application**

| Departmant No | Test Name |
|---|---|
| 1 | Urinalysis |
| 2 | Blood Work (Hemogram) |
| 3 | Blood sugar, cholesterol, triglyceride, HDL, LDL |
| 4 | Liver function tests (AST, ALT) |
| 5 | Kidney function tests (Ure, creatinine) |
| 6 | Uric acid |
| 7 | Abdominal ultrasonography |
| 8 | Chest radiography |
| 9 | Goitre test (TSH) |
| 10 | Mammogram |
| 11 | Gynecological diseases and childbirth |
| 12 | Serological tests (HBsAg, Anti HIV, Anti HCV<br>Rose Bengal-Brucella Tarama Testi) |
| 13 | Rrheumatismal tests (Sedimentation, CRP, RF) |
| 14 | Smear Testi Pap Smear and Pelvic Exam |
| 15 | EKG |
| 16 | EKG with effort |
| 17 | Physiotherapy |
| 18 | Eye examination |
| 19 | Measurement of Bone Mass |
| 20 | Prostate Specific Antigen (PSA) |

According to the size of problem (n), the main method does assignment n departments to n locations randomly. There is n! possible assignments for each problem instances, but it is impossible to get all these assignments for large size problems. To run the program to get result for all problem instances, population size determined as n*10 assignments randomly. These n*10 assignments are sent to the Population List and for each run this list returns to null value. Each of two parents is choosing by a random number from the

sequence of assignments by roulette wheel selection technique.

Two point crossover technique is used for the application. After choosing two parents, two children (named child1 and child2) are created according to two crossover points that is randomly determined by the program. Crossover points are created by roulette wheel selection technique.

After choosing parents, roulette wheel selection technique is used for crossover. In each generation, every chromosome is paired up with another chromosome randomly (Erol, 2010).

According to the density matrix and ground time matrix values for each problem instances and the assignments of departments and locations, density matrix value is multiplied by ground time matrix value and the sum of this cost pairwises are calculated. Fitness value (total cost) is determined at the end according to the cost pairwises.

*7.1.3. Output File/Results*

After five runs and if there is no improvement, GA application process is ended. The five runs' results are shown in Figure 4. All tests took 9.5578 sec. The best route is illustrated.

| Solution: |
|---|
| 2->7->8->12->1->4->18->15->5->19->10->6->13->11->16->17->9->20->14->3-> |
| Cost= 1390 |
| 2->6->8->13->3->4->19->15->5->18->9->7->12->11->17->16->10->20->14->1-> |
| Cost= 1390 |
| 2->7->8->13->4->3->18->15->5->19->10->6->12->11->17->16->9->20->14->1-> |
| Cost= 1390 |
| 4->6->8->13->1->3->18->15->5->19->9->7->12->11->17->16->10->20->14->2-> |
| Cost= 1390 |
| 1->7->8->12->4->3->18->15->5->19->9->6->13->11->17->16->10->20->14->2-> |
| Cost= 1390 |
| 1->7->8->13->3->2->18->15->5->19->9->6->12->11->16->17->10->20->14->4-> |
| Cost= 1390 |
| **Best Cost:1390**<br>**All tests took 9.5578 sec** |

**Fig. 4. GA application results after five runs.**

## 8. Conclusion And Future Research

According to this research, the patient can be conducted the route in which he/she does not waste time. This approach as a new solution technique is not used and implemented before in the literature, thus this study can guide other researches that will be generated and this can be a basic resource and framework for new researches.

Improving the performance of health care systems is a major and growing concern for management. This system can also increase the performance of check-up process in health care systems and management. As a result, this new approach in this research will be a new contribution to real life. Also this approach can be adapted for not only check-up process but also all process in HIS. Then it can be a way to improve HIS for countries. Also it can be implemented to different countries.

This implementation of check-up system using GA will be explained in detail and the solution techniques for HIS until now will be compared with this approach. This comparison will be a way to improve health care information system. It can be taken different ground time (relatively high, medium, low densities) of patients between departments in check-up process to demonstrate the efficiency of the application of GA to check-up process.

This system can also be adapted to an information support system. Thus, for doctors, experts or guardians can register into the system for specific patients, it will be guideline. They can help to manage and check the user's health route and give the prescription of behavior or advice to the patient not to waste time to go between departments in check-up process.

It will be used for only check-up process to demonstrate the application of GA. This methodology will be extended with some modifications to the complicated health care management processes. As a future work, the input data of this GA approach for check-up processes can be implemented in fuzzy sense.

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## APPENDIX 1

**Table a1. Density matrix (Node:20)**

| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0 | 5 | 6 | 10 | 0 | 0 | 15 | 13 | 3 | 15 | 8 | 5 | 10 | 9 | 14 | 14 | 8 | 18 | 11 | 0 |
| **2** | 5 | 0 | 1 | 5 | 5 | 5 | 10 | 8 | 0 | 10 | 3 | 0 | 5 | 4 | 9 | 9 | 8 | 13 | 6 | 5 |
| **3** | 6 | 1 | 0 | 4 | 6 | 6 | 9 | 7 | 3 | 9 | 2 | 1 | 4 | 3 | 8 | 8 | 2 | 12 | 5 | 6 |
| **4** | 10 | 5 | 4 | 0 | 10 | 10 | 5 | 3 | 7 | 5 | 2 | 5 | 0 | 1 | 4 | 4 | 2 | 8 | 1 | 10 |
| **5** | 0 | 5 | 6 | 10 | 0 | 0 | 15 | 13 | 3 | 15 | 8 | 5 | 10 | 9 | 14 | 14 | 8 | 18 | 11 | 0 |
| **6** | 0 | 5 | 6 | 10 | 0 | 0 | 15 | 13 | 3 | 15 | 8 | 5 | 10 | 9 | 14 | 14 | 8 | 18 | 11 | 0 |
| **7** | 15 | 10 | 9 | 5 | 15 | 15 | 0 | 2 | 12 | 0 | 7 | 10 | 5 | 6 | 1 | 1 | 7 | 3 | 4 | 15 |
| **8** | 13 | 8 | 7 | 3 | 13 | 13 | 2 | 0 | 10 | 2 | 5 | 8 | 3 | 4 | 1 | 1 | 5 | 5 | 2 | 13 |
| **9** | 3 | 0 | 3 | 7 | 3 | 3 | 12 | 10 | 0 | 12 | 5 | 0 | 7 | 6 | 11 | 11 | 5 | 15 | 8 | 3 |
| **10** | 15 | 10 | 9 | 5 | 15 | 15 | 0 | 2 | 12 | 0 | 7 | 10 | 5 | 6 | 1 | 1 | 7 | 3 | 4 | 15 |
| **11** | 8 | 3 | 2 | 2 | 8 | 8 | 7 | 5 | 5 | 7 | 0 | 3 | 2 | 1 | 6 | 6 | 0 | 10 | 3 | 8 |
| **12** | 5 | 0 | 1 | 5 | 5 | 5 | 10 | 8 | 0 | 10 | 3 | 0 | 5 | 4 | 9 | 9 | 3 | 13 | 6 | 5 |
| **13** | 10 | 5 | 4 | 0 | 10 | 10 | 5 | 3 | 7 | 5 | 2 | 5 | 0 | 1 | 4 | 4 | 2 | 8 | 1 | 10 |
| **14** | 9 | 4 | 3 | 1 | 9 | 9 | 6 | 4 | 6 | 6 | 1 | 4 | 1 | 0 | 5 | 5 | 1 | 9 | 2 | 9 |
| **15** | 14 | 9 | 8 | 4 | 14 | 14 | 1 | 1 | 11 | 1 | 6 | 9 | 4 | 5 | 0 | 0 | 6 | 4 | 3 | 14 |
| **16** | 14 | 9 | 8 | 4 | 14 | 14 | 1 | 1 | 11 | 1 | 6 | 9 | 4 | 5 | 0 | 0 | 6 | 4 | 3 | 14 |
| **17** | 8 | 8 | 2 | 2 | 8 | 8 | 7 | 5 | 5 | 7 | 0 | 3 | 2 | 1 | 6 | 6 | 0 | 10 | 3 | 8 |
| **18** | 18 | 13 | 12 | 8 | 18 | 18 | 3 | 5 | 15 | 3 | 10 | 13 | 8 | 9 | 4 | 4 | 10 | 0 | 7 | 18 |
| **19** | 11 | 6 | 5 | 1 | 11 | 11 | 4 | 2 | 8 | 4 | 3 | 6 | 1 | 2 | 3 | 3 | 3 | 7 | 0 | 11 |
| **20** | 0 | 5 | 6 | 10 | 0 | 0 | 15 | 13 | 3 | 15 | 8 | 5 | 10 | 9 | 14 | 14 | 8 | 18 | 11 | 0 |

**Table a2. Ground time matrix (Node:20)**

| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **2** | 100 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **3** | 100 | 100 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **4** | 100 | 100 | 100 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **5** | 100 | 100 | 100 | 100 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **6** | 100 | 100 | 100 | 100 | 100 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **7** | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **8** | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **9** | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **10** | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **11** | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **12** | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **13** | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 30 |
| **14** | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 0 | 100 | 100 | 100 | 100 | 100 | 30 |
| **15** | 40 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 0 | 100 | 100 | 100 | 100 | 30 |
| **16** | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 0 | 100 | 100 | 100 | 30 |
| **17** | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 0 | 100 | 100 | 30 |
| **18** | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 0 | 100 | 30 |
| **19** | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 0 | 30 |
| **20** | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 0 |