using particle SWARM optimazation to solve the transporation problem iN iRAQI blood national bank with practice

استعمال خوارزمية سرب الطيور لحل مشكلة النقل في المركز الوطني لنقل الدم مع تطبيق عملي

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Abstract
In this paper, will discuss solving the problem of blood group transfusion in National bank of Iraq by using a multi-models consisting of a transfusion model, Particle Swarm Optimization algorithm and analytic hierarchy process, the model will applied to find the best transfusion from the donors to the persons whom need it ,and will take into consideration the compatibility among blood groups in case there isn't availability of specific blood group and in this case we depend on the opinion of specialists by surveying their opinions to get an a clear indication, in same time we put in consideration the for expiry amount and to keep available stock for all blood groups especially O+ to by launched to all persons during emergency cases .

المستخلص
سيتم في هذا البحث حل مشكلة نقل فصائل الدم من خلال انموذج متعدد متكون من نموذج نقل وبأستعمال خوارزمية سرب الطيور وعملية التحليل الهرمي حيث سيتم تطبيق النموذج لايجاد افضل نقل ممكن لفصائل الدم من المتبرعين الى المحتاجين للدم مع الاخذ بالنظر الاعتبار مدى التوافق بين فصائل الدم في حال عدم توفر نفس الفصيلة حيث تم اعتماد رأي الخبراء المختصين بذلك من خلال ملأ استمارة استبانة وتم ايجاد معدل لأرائهم ،و كذلك تم اعطاء الاولوية في تجهيز كميات الدم الاقل صلاحية مع الاخذ بنظر الاعتبار توفير كميات كافية من جميع فصائل الدم و بالاخص فصيلة O+ نظرا للحاجة الماسة لها عند الحالات الطارئة .

Keywords
Particle Swarm Optimization, Transpiration problem

1. Introduction

This paper reports the improvement performance for transportation of blood to meet patient's requirements for blood transfusion request by Analytic Hierarchy Process (AHP) and using also particle swarm optimization (PSO) In Iraqi blood transfusion bank. There is a need for effective and efficient management of available amount of this important material in blood banking systems, Moreover, there is a risk issue must take in consideration such is the wrong

transfusing of blood types to the patients, unnecessary importation of blood units from the donors, and wastage of blood amounts due to non-usage necessitate, therefore the development of mathematical models and techniques for effective handling of blood distribution among available blood types is really important in order to achieve all demands, minimize wastages and importation from external sources.

All those considerations led gives rise to the blood transportation problem in order to manage the mentioned considerations, the results obtained show the efficiency of the proposed algorithm for BTP with no blood units wasted and very low importation just necessary cases from outside the blood bank, therefore the results can serve as a benchmark and basis for decision support tools for real-life deployment.

2. Mathematical Models

1. Transportation Model

Min $z = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij*} x_{ij}$ ……. (1)[7]

(Subject to):

The constraint of demand amount as it should be less than or equal to the stock amount in the source:

$$\sum_{i=1}^{n} x_{ij} \leq ai \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The constraint of demand amount as it should achieve at least of demand:

$$\sum_{j=1}^{m} x_{ij} \geq bj \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$x_{ij} \geq 0$ و J=1,2,...,m ……...(4)

Where is i=1,2,… ,n

It possible to be there is a balance in transportation model as the offered amount is equal the demand amount , and this will consider supposed constrain ,as may me the offered amount been less than the demand amount as shown in below :

$$\sum_{j=1}^{m} b_j = \sum_{i=1}^{n} a_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

In this supposed case the model will be as a standard form and we can call this model is standard transportation and all constraints will be as an equations as shown in below:

Min $z = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij*} x_{ij}$

Subject to :

$$\sum_{i=1}^{n} x_{ij} = ai \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$\sum_{j=1}^{m} x_{ij} = di \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$X_{ij} \geq 0$ [7]

Matrix of compatibility of blood group

In below table it shown the compatibility of blood group among each other, as there is some of them able to be a donor and some of rest of them able to be receiver or donor and receiver, and it reflect a crystal clear approach:

Blood Group Compatibility Of									
	Blood Group	Donor Blood Group							
		A+	A−	B+	B-	AB+	AB-	O+	O-
Received Blood Group	A+	YES	NO	NO	NO	NO	NO	YES	YES
	A−	NO	YES	NO	NO	NO	NO	NO	YES
	B+	NO	NO	YES	YES	NO	NO	YES	YES
	B-	NO	NO	NO	YES	NO	NO	NO	YES
	AB+	YES	YES	YES	YES	YES	YES	YES	YES
	AB-	NO	YES	NO	YES	NO	YES	NO	YES
	O+	NO	NO	NO	NO	NO	NO	YES	YES
	O-	NO	NO	NO	NO	NO	NO	NO	YES

Table 1 [3]

2-Analysis Hierarchy Process

There is another technique analysis Hierarchy Process (AHP) has been used to set the priority of in transfusion of blood especially when provide an alternative blood group, it was calculated by survey that handled with five specialist of blood group compatibility and achieved below results:

Expert1 Survey Of								
	A+	A-	B+	B-	AB+	AB-	O+	O-
A+	90.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0
A-	0.0	80.8	0.0	0.0	6.2	13.0	0.0	0.0
B+	0.0	0.0	90.0	0.0	10.0	0.0	0.0	0.0
B-	0.0	0.0	8.0	67.4	2.8	21.9	0.0	0.0
AB+	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
AB-	0.0	0.0	0.0	0.0	11.1	88.9	0.0	0.0
O+	8.3	0.0	8.3	0.0	8.3	0.0	75.0	0.0
O-	10.3	5.1	6.2	6.1	6.1	6.1	6.2	53.8

Table 2

Expert2 Survey Of								
	A+	A-	B+	B-	AB+	AB-	O+	O-
A+	90.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0
A-	0.0	81.8	0.0	0.0	9.1	9.1	0.0	0.0
B+	0.0	0.0	90.0	0.0	10.0	0.0	0.0	0.0
B-	0.0	0.0	7.6	68.3	2.7	21.5	0.0	0.0
AB+	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
AB-	0.0	0.0	0.0	0.0	10.0	90.0	0.0	0.0
O+	8.3	0.0	8.3	0.0	8.3	0.0	75.0	0.0
O-	5.5	9.3	5.4	5.9	6.6	5.9	7.8	53.6

Table 3

Expert3 Survey Of								
	A+	A-	B+	B-	AB+	AB-	O+	O-
A+	90.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0
A-	0.0	81.8	0.0	0.0	9.1	9.1	0.0	0.0
B+	0.0	0.0	90.0	0.0	10.0	0.0	0.0	0.0
B-	0.0	0.0	24.4	27.0	21.1	27.6	0.0	0.0
AB+	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
AB-	0.0	0.0	0.0	0.0	50.0	50.0	0.0	0.0
O+	8.7	0.0	8.7	0.0	9.3	0.0	73.4	0.0
O-	6.9	6.9	6.8	6.9	6.8	6.8	6.8	51.9

Table 4

Expert4 Survey Of								
	A+	A-	B+	B-	AB+	AB-	O+	O-
A+	90.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0
A-	0.0	81.8	0.0	0.0	9.1	9.1	0.0	0.0

B+	0.0	0.0	90.0	0.0	10.0	0.0	0.0	0.0
B-	0.0	0.0	8.5	74.3	8.8	8.5	0.0	0.0
AB+	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
AB-	0.0	0.0	0.0	0.0	10.0	90.0	0.0	0.0
O+	8.3	0.0	8.3	0.0	8.3	0.0	75.0	0.0
O-	6.2	6.2	6.2	6.2	6.2	6.2	6.2	56.2

Table 5

Expert5 Survey Of								
	A+	A-	B+	B-	AB+	AB-	O+	O-
A+	90.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0
A-	0.0	81.8	0.0	0.0	9.1	9.1	0.0	0.0
B+	0.0	0.0	90.0	0.0	10.0	0.0	0.0	0.0
B-	0.0	0.0	10.5	57.5	10.5	21.5	0.0	0.0
AB+	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
AB-	0.0	0.0	0.0	0.0	10.0	90.0	0.0	0.0
O+	8.3	0.0	8.3	0.0	8.3	0.0	75.0	0.0
O-	6.3	5.8	6.3	6.3	6.3	6.3	7.1	55.6

Table 6

Mean of Matrix of hierarchy

We found the mean of surveys by calculate the average to all factors five matrixes and that will be applicable to use on behalf of C cost in transportation model, and all those percentage consider the percentage of ability to use same blood group or alternative group:

Mean of Surveys								
	A+	A-	B+	B-	AB+	AB-	O+	O-
A+	90	0	0	0	10	0	0	0
A-	0	81.6	0	0	8.52	9.88	0	0
B+	0	0	90	0	10	0	0	0
B-	0	0	11.8	58.9	9.18	20.2	0	0

AB+	0	0	0	0	100	0	0	0
AB-	0	0	0	0	18.22	81.78	0	0
O+	8.38	0	8.38	0	8.5	0	74.68	0
O-	7.04	6.66	6.18	6.28	6.4	6.26	6.82	54.22

Table 7

3-Partial Swarm Optimization

According to the huge data, it calculated by one of efficiency algorithm to find the calculation of transportation with thirty work days by using Matlab program interface:

Main

```
Clc
clear
C=[90.0     0.0     0.0     0.0     10.0    0.0     0.0     0.0
0.0     81.8    0.0     0.0     9.1     9.1     0.0     0.0
0.0     0.0     90.0    0.0     10.0    0.0     0.0     0.0
0.0     0.0     7.6     68.3    2.7     21.5    0.0     0.0
0.0     0.0     0.0     0.0     100.0   0.0     0.0     0.0
0.0     0.0     0.0     0.0     10.0    90.0    0.0     0.0
8.3     0.0     8.3     0.0     8.3     0.0     75.0    0.0
5.5     9.3     5.4     5.9     6.6     5.9     7.8     53.6]';
C(C==0)=-1000000;
D=[54 11    78  7   21  2   81  7
66  8   57  8   31  1   75  9
64  30  65  21  42  5   61  26
43  15  62  13  26  8   68  6
66  18  92  10  23  5   61  13
47  11  64  25  24  4   56  27
94  17  49  11  10  4   58  22
57  15  42  6   18  1   55  15
67  7   88  10  26  3   103 15
61  19  135 19  30  2   101 22
64  22  89  20  26  5   81  30
53  16  48  14  20  4   70  29
52  15  25  29  26  0   21  73
28  8   44  15  14  1   55  20
43  11  82  14  26  2   44  11
31  11  64  6   17  2   65  8
54  18  52  22  31  6   47  20
47  12  41  17  21  1   59  16
49  18  42  21  32  4   65  20
30  12  20  18  19  2   53  14
48  9   51  13  25  3   60  14
```

33	3	65	4	13	2	67	9
51	3	79	15	31	11	102	11
74	22	72	14	33	8	84	29
62	22	76	14	26	3	73	23
56	15	85	15	15	6	100	24
52	20	45	15	34	4	75	22
81	13	41	10	23	6	42	20
48	10	51	7	10	4	56	9
69	10	58	4	11	1	89	10];
IN=[33	4	48	5	8	1	45	6
48	3	45	2	16	2	73	11
174	22	206	22	56	7	213	22
128	16	139	21	35	3	157	18
137	11	116	14	30	1	158	21
104	9	114	20	32	1	123	22
199	29	108	24	59	5	228	28
39	8	44	2	7	1	40	9
36	9	41	10	14	2	81	6
240	24	212	28	68	5	272	31
160	6	151	24	47	1	159	18
175	18	148	11	58	5	172	23
148	14	157	12	39	3	204	12
154	18	171	26	38	5	215	15
36	5	30	4	5	1	62	7
48	6	38	7	18	2	74	7
150	16	167	14	43	3	198	13
155	13	167	21	74	5	200	23
136	13	189	23	49	2	184	28
172	12	184	13	56	10	225	14
37	3	39	50	14	0	50	2
44	1	35	10	9	1	44	4
53	10	48	4	11	3	62	8
115	24	199	21	63	6	262	30
136	23	160	13	48	0	175	19
148	6	146	20	38	6	151	21
108	15	133	12	41	5	139	14
183	20	181	24	66	20	257	31
35	2	46	7	8	0	50	2
47	7	64	3	15	3	48	13];

Results Analysis

In below tables we can find the results as those consider a part of total results per day:

1. The transfusion for first day : we covered almost of requests and postpone some of them according to availability of stock :

Day_1										
	A+	A-	B+	B-	AB+	AB-	O+	O-	الطلب	الطلب المؤجل
A+	33	0	0	0	0	0	0	0	54	21
A-	0	4	0	0	0	0	0	0	11	7
B+	0	0	48	0	0	0	0	0	78	30
B-	0	0	0	5	0	0	0	0	7	2
AB+	0	0	0	0	8	0	0	0	21	13
AB-	0	0	0	0	0	1	0	0	2	1
O+	0	0	0	0	0	0	45	0	81	36
O-	0	0	0	0	0	0	0	6	7	1
الخزين	33	4	48	5	8	1	45	6	0	0
باقي الخزين	0	0	0	0	0	0	0	0	0	0

2. The transfusion for second day: we covered almost of requests and postpone some of them according to availability of stock and we provided an alternative blood group based on compatibility:

Day_2										
	A+	A-	B+	B-	AB+	AB-	O+	O-	الطلب	الطلب المؤجل
A+	48	0	0	0	0	0	0	**1**	87	38
A-	0	3	0	0	0	0	0	0	15	12
B+	0	0	45	0	0	0	0	0	87	42
B-	0	0	0	2	0	0	0	0	10	8
AB+	0	0	0	0	16	0	0	0	44	28
AB-	0	0	0	0	0	2	0	0	2	0
O+	0	0	0	0	0	0	73	0	111	38
O-	0	0	0	0	0	0	0	**10**	10	0
الخزين	48	3	45	2	16	2	73	11	0	0
باقي الخزين	0	0	0	0	0	0	0	0	0	0

3. The transfusion for third day: we covered almost of requests and postpone some of them according to availability of stock and we provided more than an alternative blood groups based on compatibility:

Day_3										
	A+	A-	B+	B-	AB+	AB-	O+	O-	الطلب	الطلب المؤجل
A+	**103**	0	0	0	0	0	0	0	103	0
A-	0	22	0	0	0	0	0	0	42	20
B+	0	0	107	0	0	0	0	0	107	0
B-	0	0	0	22	0	0	0	0	29	7
AB+	**12**	0	0	0	**56**	**2**	0	0	70	0
AB-	0	0	0	0	0	**5**	0	0	5	0
O+	0	0	0	0	0	0	99	0	99	0
O-	0	0	0	0	0	0	0	22	25	3
الخزين	174	22	206	22	56	7	213	22	0	0
باقي الخزين	59	0	99	0	0	0	114	0	0	0

Discussion and conclusion

We can find conclusion through our research some of advantage of solving the issue of transportation through the particle swarm algorithm and hierarchical analysis have contributed for raising the performance effectiveness of the center of blood bank by improving the blood transfusion system and achieve the objectives, and provision of blood for all blood type especially rare type of blood as much as possible and postponing the non-urgent ones to the next day in case there isn't alternative compatible type. And we can recommend to adopting a new scientific methods to manage the blood transfusion process, including prediction and fuzzy programming in the Iraqi National Center for Blood Transfusion, and this will lead to increase the efficiency and performance level of the center and will reduce any probability of the center can't met the requests of patients according to never available amount of the specific or compatible types, and recommend also to keep blood donation campaigns as periodical wise based density of population of people and blood group historical in order to keep and increase all blood types especially o+ group because considers a general donor for all blood group type which we may need in emergency cases ,and recommend to take in consideration the waste of blood according to the expiration as it possible to construct a mathematical model to control on this issue ,and it's worthy to recommend to create an application can be installed to mobile phone and that able to announce and publish periodically which blood group and quantities are required and that will give the donation process more proposed and facilitated to the mobile teams according to depend on the data of responses people whom wish and confirm to donate via this application.

References

1. Ahmed Shawki Jaber " Solving Non Linear Function with Two Variables by Using Particle Swarm Optimization Algorithm".
2. Dian Palupi Rini ,Siti Mariyam Shamsuddin ,Siti Sophiyati Yahaniz "Particle Swarm Optimization: Technique, System and Challenges".
3. Hammed Alshemerti "Operations Research introduction and applications".

4. Kevin Igwe, Micheal Olusanya and Aderemi Adewumi "School of Mathematics, Statistics and Computer Science "On the Performance of GRASP and Dynamic Programming for the Blood Assignment Problem".
5. Komlan Sedzro1, Arif Marouane2, Tov Assogbavi3" Analytical Hierarchy Process and Goal Programming Approach for Asset Allocation".
6. Micheal O. Olusanya, Martins A. Arasomwan, and Aderemi O. Adewumi "Particle Swarm Optimization Algorithm for Optimizing Assignment of Blood in Blood Banking System".
7. Prinolan Govender ; Absalom E. Ezugwu "A Symbiotic Organisms Search Algorithm for Optimal Allocation of Blood Products.