Particle Swarm Optimization in Health Care Domain

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Abstract

Particle swarm optimization is a deterministic optimization technique inspired by certain animals' collective behaviour like bird congregation. It is a global heuristic method of optimization, initially constructed by Kennedy and Eberhart in 1995 and now one of the optimization methods that is most widely used in health care domain.The numerous kinds of PSO[1] were suggested by the researchers to refine and enhance the efficiency of PSO. By optimizing initialization of the swarm, some researchers attempt to enhance it whereas some of them add new criteria such as constriction coefficient and weight of inertia. Many researchers developed various different techniques of weight of inertia to optimize the efficiency of this technique whereas some focused on the best universal and local particles by implementing the modified procedures. Inspired by the immediate needs of healthcare centres, an effective plan is developed using PSO and multigents to manage the hospital environment. Various parameters of publications like publications by year, by affiliation, by countries are described here in this paper with the help of some comparative tables and graphs.

Keywords: Swarm intelligence, PSO Overview, Patient Scheduling, Multi-objectiveoptimization, PSO Variants.

INTRODUCTION

The algorithm for PSO is a swarm-based optimization processgiven by Kennedy & Eberhartin 1995. The PSO[2], [3] algorithm mimics the social behavior of mammals, birds and fish. They adhere to a mutual strategy of seeking meal and due to the learning experiences of their own and other participants, each participant of the swarms continuesimproving the search model. The key model of PSO[4], [5]technique is explicitly connected to two studies:

Evolutionary Technique - Utilize a swarm paradigmthat enables the optimized objective function to scan large areas simultaneously in the solution space.

Artificial life - Explores life in artificial environments and characteristics.

To examine the behaviour of social animals with the theory of artificial life, there are five fundamental rules:

1. **Proximity**- It must be able to perform basic measurements of space and time.

2. **Quality**- It must be capable to feel and answer to required changes in quality in the atmosphere.
3. **Diverse** - It must not restrict its pattern of getting the resources to a restricted range.
4. **Stability**- It must not change its mode of action with any change in the atmosphere.
5. **Adjustability** – It must change its pattern of action if change is worthwhile.

Patient scheduling is the process of scheduling and sequencing the patients for various multiple resources in health-care domain. The multiple constraints and multiple goals to be achieved in minimal time makes this problem highly complicated. Computational complexity is maximum in using accurate technique in solving optimization problem. The process of PSO[6]–[8] has been widely used for scheduling the patient in hospitals and health care centres. It is used to the continuous optimization problems, where particles' position p_i, the velocity v_i, acceleration parameters c_1&c_2, and weight of inertia ω, are all continuous parameters. Main focus is in determining a best schedule using the meta-heuristic technique PSO[9]–[12] and managing the hospital environment using multi-agents. Several researches have conducted research in this area of patient health care and the following gives a relative publication documents by year, affiliation, countries and subject area.

Documents by Year: The publications in the area of Particle Swarm Optimization (PSO) has been fluctuated yearly by and the records by year of the same is represented in the table given below:

Table 1: Publications of PSO Yearly for Recent 10 Years

Sr. No.	Year	Count of Published Articles
1	2021	56
2	2020	853
3	2019	1071
4	2018	913
5	2017	781
6	2016	771
7	2015	729
8	2014	733
9	2013	783
10	2012	777

From the Table 1, we observe that the research publications on Particle Swarm Optimization (PSO) is increasing and the highest publications were in the year 2019. Recently, in 2021, there are 56 publications which indicates that the research interest is rising significantly. Figure 1 below provides a comparison of the number of publications in this field of study:
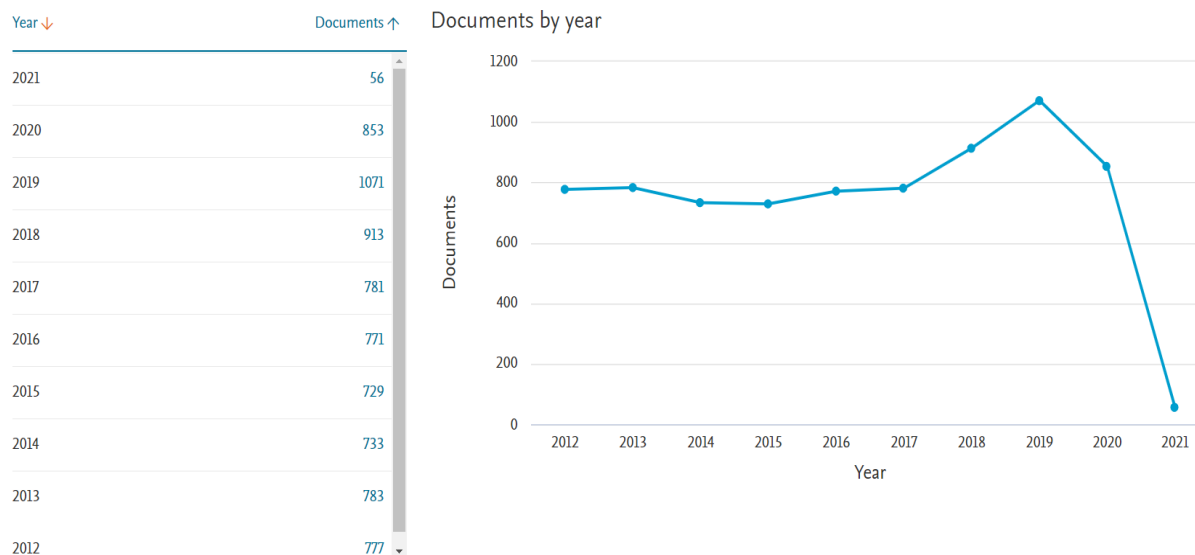
Fig. 1: Comparison of No. of Publications in PSOfor Recent 10 Years

Documents by a Country or Territory: Various countries have published a good number of research papers in the area of PSO. The records of publications by 10 different countries is shown in the following table to compare their publication count:

Table 2: Records of Publications on PSO of10 Countries

Sr. No.	Country	Count of Articles published
1	China	2972
2	India	1654
3	Iran	550
4	Malaysia	243
5	United States	212
6	Taiwan	204
7	Japan	162
8	Algeria	156
9	Indonesia	118
10	United Kingdom	118

Many researchers of different countries are doing research in the field of particle swarm optimization as the research interest is increasing in this area.Above table represents that the two countries China and India have the highest number of publications, i.e. 2972 and 1654 respectively a compared with the other mentioned countries. This comparison of mentioned 10 countries is shown below:
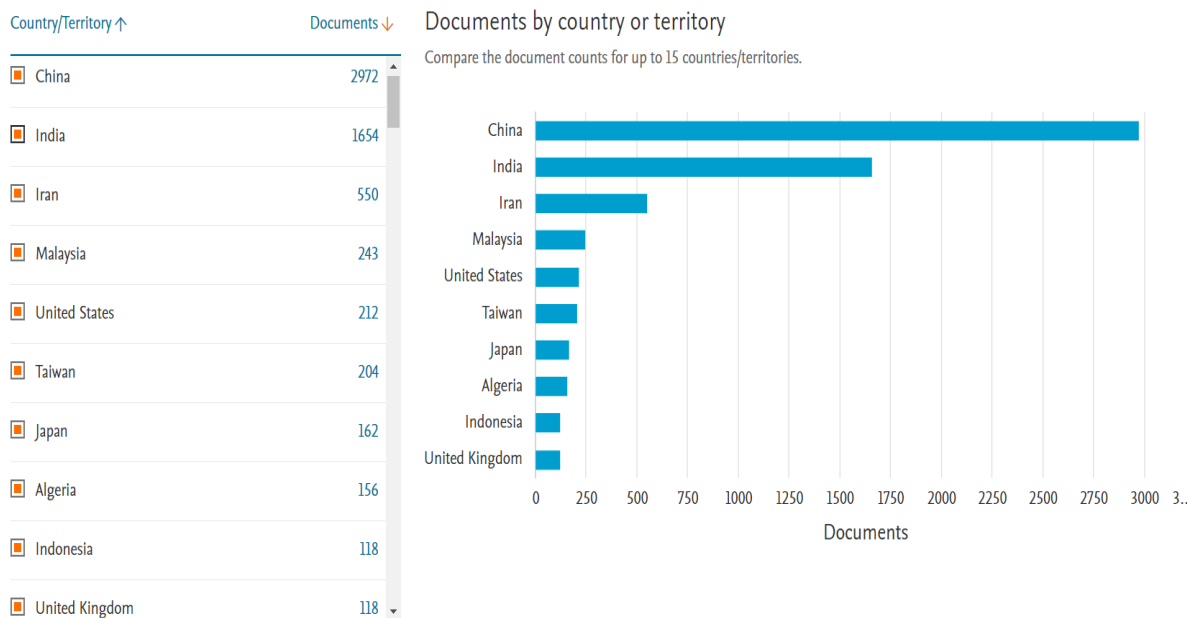
Fig. 2: Comparison of Publications in PSO by 10 Countries

Publicationsby UniversityAffiliation: The comparison of the number of publications in the area of particle swarm optimization in accordance with university affiliation is given in the following table:

Table 3: Publications by University Affiliation

Sr. No.	Affiliation	No. of Publications
1	Ministry of Education China	148
2	Chinese Academy of Sciences	76
3	Islamic Azad University	73
4	Harbin Institute of Technology	70
5	Chongqing University	60
6	Northeastern University, China	55
7	UniversitiTeknologi Malaysia	55
8	Huazhong University of Science and Technology	55
9	Wuhan Universit	54
10	North China Electric Power University	54

Many reputed educational universities and research institutionsof India and Foreign are involved in the research fields like genetic algorithms, optimization methods, artificial neural networks, swarm intelligence, hybrid & approximate algorithms but the study of PSO is one of the most considerable among them. As from Table 3, it is clear that universities are growing the number of publications in the area of PSO.This comparison of document counts among universities with affiliations is shown below:
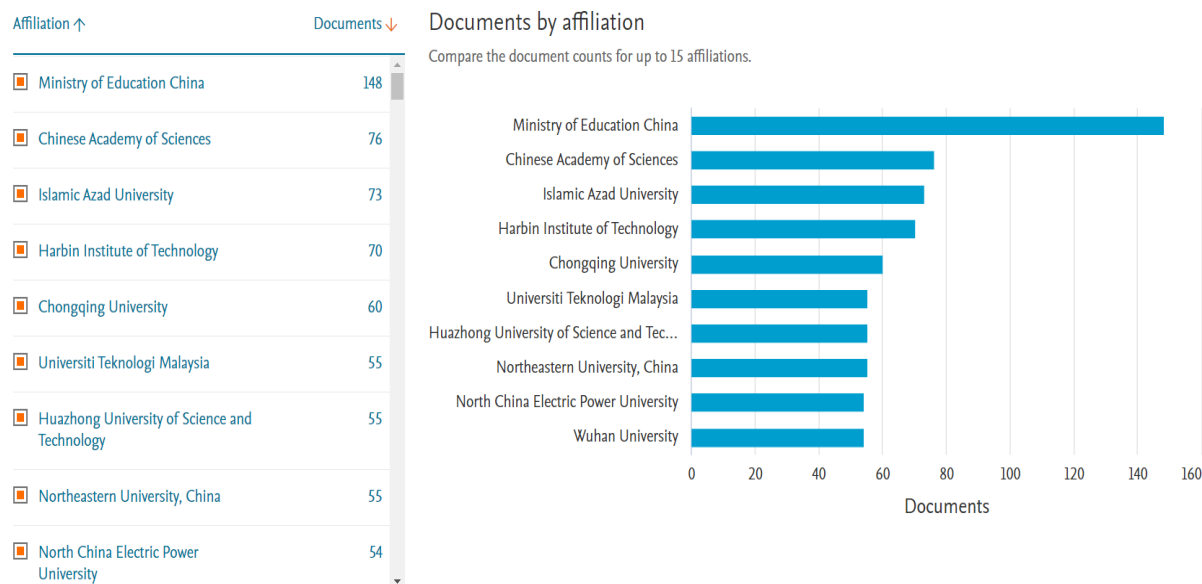
Fig. 3: Comparison of Publications by University Affiliation

The above graph represents the number of publications in the field of PSO by 10 different affiliations.

Document by Subject Area: There are a lot of publications in different fields of engineering, computer & materials sciences, mathematics, physics, chemistry, agricultural and biological sciences, chemical engineering, environmental science etc. The subject-wise comparison of publications among the mentioned areas is given in the following comparative table:

Table 4: Subject-wise Comparison of Publications

Sr. No.	Subjects	No. of Publications
1	Engineering	88
2	Computer Science	68
3	Mathematics	42
4	Energy	12
5	Materials Science	11
6	Physics and Astronomy	11
7	Chemistry	7
8	Agricultural and Biological Sciences	6
9	Chemical Engineering	6
10	Environmental Science	6

From the above table, it is clear that there are 88 number of publications in Engineering, 68 in Computer Science, 42 in Mathematics, 12 in Energy, 11 in Materials Science and Physics and Astronomy, 7 in Chemistry, 6 in Chemical Engineering, Environmental Science, Agricultural and Biological Sciences respectively. Therefore, engineering has maximum number of publications as compared with all. This comparison among different subject areas can be shown as in the following figure:
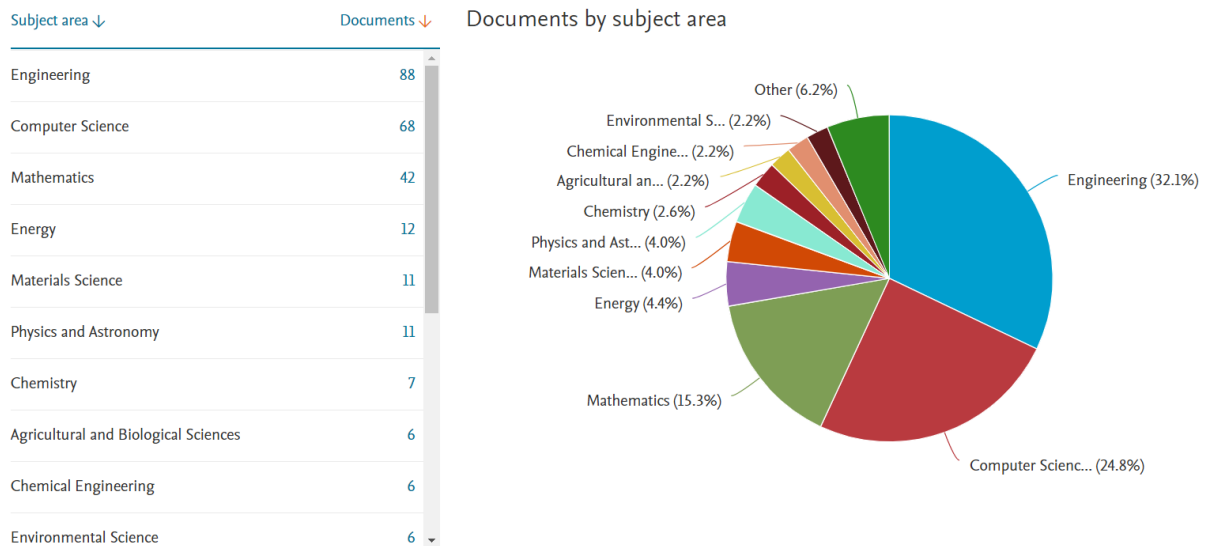

Subject area ↓	Documents ↓
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Environmental Science	6

Documents by subject area

- Other (6.2%)
- Environmental S... (2.2%)
- Chemical Engine... (2.2%)
- Agricultural an... (2.2%)
- Chemistry (2.6%)
- Physics and Ast... (4.0%)
- Materials Scien... (4.0%)
- Energy (4.4%)
- Mathematics (15.3%)
- Computer Scienc... (24.8%)
- Engineering (32.1%)

Fig. 4: Comparison by Different Subject Areas

Form figure 4, it is analysedthat the publications in engineering is high as compared with other areas under considered.

CONCLUSION:

In recent years, the PSO technique has gained large consideration. This technique could be described as it has better reliability and can be used with a small change in various application settings and it has high distributed capability. It converges to the optimal point rapidly and it is very simple to functionalize with other procedures to raise its efficiency. After longtime,the construction, the rate of optimization,quality and the performance of PSO technique have highly enhanced. The PSO [13]–[15]technique has been widely applied in staff scheduling problem, the agent based patient scheduling in various healthcare domains. An optimal scheduling of patients that minimizes patient stay in the hospital enhances patient care, resource utilization and hence reduces anxiety conflicts between employers and family members. The comparison of various publications in the area of particle swarm optimization are discusses in this paper by set up different parameters of publications. It also shows the importance of the subject matter and research on PSO techniques.

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