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Printease - A Smart Printing Application: Implementation

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Abstract: *PrintEase - A Smart Printing Application is an android based application which is primarily built for common people so that they can avail printing service at their fingertips. The main purpose behind building this application is to save people's time and provide value added packages to all the users. Value added packages are generated by analyzing the order history and usage of application. By using Data mining concepts users behavior is analyzed. Particle Swarm Optimization (PSO) algorithm is a data mining algorithm that is used for data analysis and generation of packages.*

Keywords: *Data Mining, Particle Swarm Optimization (PSO), Data Analysis, Personal Best, Global Best*

I. Introduction

PrintEase - A Smart printing application is an android based application which uses data mining concepts for analyzing data and generating packages. By analyzing user history and usage of application, Particle Swarm Optimization (PSO) analyzes the parameters and generates the best package available for the group. PSO algorithm provides the best optimal solution for the group. The main purpose of including PSO algorithm in our application is to provide the best packages for users, so that users can use or application more often and save their time.

II. Related Work

A. Particle Swarm Optimization (PSO)

Particle Swarm Optimization (PSO) is an approach to problems whose solutions can be represented as a point in an n-dimensional solution space. A number of *particles* are randomly set into motion through this space. At each iteration, they observe the "fitness" of themselves and their neighbours and "emulate" successful neighbours (those whose current position represents a better solution to the problem than theirs) by moving towards them.[3] Various schemes for grouping particles into competing, semi-independent *flocks* can be used, or all the particles can belong to a single global flock. This extremely simple approach has been surprisingly effective across a variety of problem domains. Particle swarm optimization (PSO) is a population based stochastic optimization technique developed by Dr. Eberhart and Dr. Kennedy in 1995, inspired by social behaviour of bird flocking or fish schooling. [1]

PSO shares many similarities with evolutionary computation techniques such as Genetic Algorithms (GA). The system is initialized with a population of random solutions and searches for optima by updating generations. However, unlike GA, PSO has no evolution operators such as crossover and mutation. In PSO, the potential solutions, called particles, fly through the problem space by following the current optimum particles.[4]

This algorithm takes following values:

1. Global best value
2. Personal Best value
3. Stopping criteria for large scales

1. Global best value: It is also known as gbest value. It increases the rate of aggregation which offers high robustness. Instead of maintaining all the solution of individuals. Gbest offers a facility of maintaining single best solution fitness value. It generally acts like magnet which pulls all the particles towards it.
2. Personal best values: As PSO works efficiently with the group of elements. Instead of taking alone action with the help of swarm the corporate behaviour can be achieved. Let us take the example of flocking birds which are in search of their food. So the target of the whole population is food. Each particle has its own persona best information which guides to reach the target. The personal best is that best position the element has visited which gives the fitness value of swarm.
3. When to stop the large scale optimization of Non- linear data: When the number of iterations may not compatible with large scale. When maximum number of function evaluation is done the CPU time is utilized.

B. Application of PSO:

The first practical application of PSO was in the field of neural network training and was reported together with the algorithm itself (Kennedy and Eberhart 1995). Many more areas of application have been explored ever since, including telecommunications, control, data mining, design, combinatorial optimization, power systems, signal processing, and many others. To date, there are hundreds of publications reporting applications of particle swarm optimization algorithms. Although PSO has been used mainly to solve unconstrained, single-objective optimization problems, PSO algorithms have been developed to solve constrained problems, multi-objective optimization problems, problems with dynamically changing landscapes, and to find multiple solutions.

A number of research directions are currently pursued, including:

- Theoretical aspects
- Matching algorithms (or algorithmic components) to problems
- Application to more and/or different class of problems (e.g., multiobjective)
- Parameter selection
- Comparisons between PSO variants and other algorithms
- New variants

III. Equations

Equation (a)

```
v[] = c0 *v[]
    + c1 * rand() * (pbest[] - present[])
    + c2 * rand() * (gbest[] - present[])
```

Equation (b)

```
present[] = present[] + v[]
For each particle
   Initialize particle
END
```

Pseudo code of PSO:

```
Do
For each particle
Calculate fitness value
 If the fitness value is better than its personal best
  set current value as the new pBest
    End
Choose the particle with the best fitness value of all as gBest
 For each particle
Calculate particle velocity according equation (a)
Update particle position according equation (b)
End
While maximum iterations or minimum error criteria is not attained
```

Particle swarm optimization is a collection of elements which has their own fitness value. In first equation (a) the velocity is calculated using personal best and global best value and the new particle is initialized.
In the above pseudo code the fitness value of each particle is calculated. The Personal Best value is changed if the fitness is better than current value. After calculating the personal best the best fitness value is considered as global best value of whole population and after that the velocity is calculated by equation [5,6]

```
v[] = c0 *v[]
    + c1 * rand() * (pbest[] - present[])   + c2 * rand() * (gbest[] - present[])
```

and update the particle position by

```
present[] = present[] + v[]
```

IV. Example Of PSO

This is a simple example where the algorithm finds three numbers that add up to a target value. A fully connected neighbourhood is used, so all particles can be compared to each other.
This example's simplicity makes it very easy to experiment with. Almost all variables can be modified.

4. TARGET - the answer the algorithm is looking for.
5. MAX_INPUTS - this number of operands in the expression.
6. MAX_PARTICLES - number of particles employed in the test.

7. V_MAX - maximum velocity change allowed.
8. MAX_EPOCHS - number of iterations for the algorithm.
9. START_RANGE_MIN - smallest random number to start operands at.
10. START_RANGE_MAX - largest random number to start operands at.

Find three operands that add up to 50. Ten particles used. V_MAX = 10.

47 + -3 + 8 = 52
27 + 3 + 10 = 40
41 + 6 + 31 = 78
47 + 40 + -4 = 83
41 + -3 + 30 = 68
6 + 14 + 35 = 55
3 + 11 + 36 = 50
47 + 2 + 9 = 58
40 + -3 + 29 = 66
1 + 8 + 11 = 20
epoch number: 21
Particle 6 has achieved target.
3 + 11 + 36 = 50.

The above example shows the mathematical solving of PSO algorithm. In which best solution to achieve target 50 is made by selecting best option amongst all. [2]

Consider a following situation:

- In our application we are providing the service of package to those users who frequently use our application. To do so the selection of package is done by pso algorithm. As we know that PSO works on group of different elements and gives the best solution amongst it to complete the target.
- Consider a scenario where 10 users are using black white printing services. In this case a group of these 10 users are created. If the target of package is 250.
- Now we will trace each user activity that is the fitness value of each element that is of users in our system.
- Let the average value of each user they spend per week be 40,50,70,60,80,60,55,89,96,85.these are the fitness value of each user.
- The next task is to find the gBest value of this group which is approximately 100 rupees .
- Now the administrator of the system wants to give package of 250 monthly.
- Now this group is perfect to avail this service.
- In this way the PSO is used in our application.

V. Proposed System

There are two PrintEase applications one for Customers and one for Shopkeepers. Customer performs all the functions using customer app and shopkeeper perform all the functions using shopkeeper app. Communication between customer and shopkeeper applications is done using API. Communication such as sending customer documents to shopkeeper for printing, shopkeeper updates estimated time for completing the order which is shown to customers based on pickup/delivery service. PrintEase offers both pickup and delivery services.

PrintEase also offer packages/discount offers to the users. This is an important feature and is not provided by the existing systems. This adds intelligence to our application. This is done by analysing the user behavioural pattern and also pattern of group of users in different areas. PrintEase uses Particle Swarm Optimization data mining algorithm for analysis and package generation.

First the user login/register with the application. After that based on users current location a list is displayed of shops nearby to the user's location (taking minimum distance as default). PrintEase provides both options to the users that is either first to select the shop for printing by viewing shop details and then uploading documents or first uploading documents and then selecting the shop from the list of shops that is generated based on the printing information of documents provided by the user.

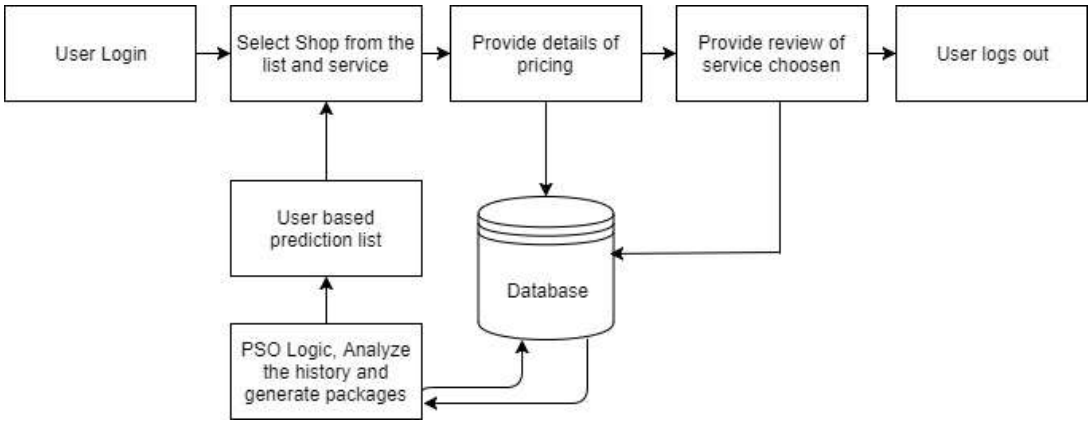

Figure 1 – Proposed System Architecture

VI. Conclusion

PrintEase application provides unique and easy way to users to print their documents. Valued added packages are an advantage to the users who need printing service more frequently. Particle Swarm Optimization (PSO) an algorithm of data mining is implemented that analyses data and generates packages that are best fit to the group of users.

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