

MOBILE DATA INTEROPERABILITY ALGORITHM USING CHESS GAMIFICATION

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Abstract— Mobile data usage, reusability, accessibility, storage leads to challenges in innovative mobile computing. Mobile data interoperability is one of the challenges. Achieving secure data interoperability is a challenging problem. Having, two mobiles at distributed location where no one to operate mobile at the other end, the problem becomes further challenging. Mobile data interoperability will help in achieving secure data availability in a distributed environment.

With recent advances in technology, mobile computing is a challenging task in achieving data interoperability without the use of a third person. This research proposes an algorithmic solution for data interoperability in android smartphones; also the proposed algorithm will be verified with multiplayer chess game. This research makes use of gamification to open door for mobile data interoperability. This research has numerous industrial and social applications. Accessing own private data from one mobile to another has secretly been one of the challenging areas of data interoperability.

Keywords— Android, Chess, Gamification, Interoperability, Mobile Computing, Naïve Bayes Classifier, Probability Theory.

INTRODUCTION

In mobile computing, data is one of the prime aspects, as most of the applications are data centric, and requires data highly available. Mobile data interoperability without the use of third person is one of the challenges, considered in this paper. Interoperability can be described as an ability to communicate data efficiently under the ubiquitous environment consistently resulting in better accuracy [6][8]. Gamification is one of the recent approaches used for problem solving. It makes use of game theory, learning, mechanics and data mining to motivate and engage groups of people to solve problems in a distributed environment [3]. In certain cases, data is shared between the applications of the same mobile phone. In most of the cases, data is exchanged between mobile phones. This may take three steps as establish the connection between mobile phones, select data to send and send the data. Developing the algorithm for the system having communication channel, data, but without the use of sender (mobile owner), is a challenging task. This type of scenario has several issues under consideration such as availability of sender, privacy of data. This problem can be resolved algorithmically by sharing data between applications in different mobiles and maintaining the privacy of data.

The multiplayer chess game for mobile phone is a similar candidate that deals with data interoperability. It is interesting to verify the data interoperability in a typical case of multiplayer chess game in a distributed environment. Multiplayer chess game is a classical data interoperability problem. In this problem, moves played are shared between two processes called, the player and opponent. The player plays move on his device and saves data in the shared game file. On the other hand, opponent process game data based on players move and makes his move based on knowledge gained by processing game data. This cycle repeats till the end of the game. The problem is to handling the data sharing between player and opponents such that allow game data to be available to the player and opponents secretly for the processing of moves.

LITERATURE SURVEY

Sarang Joshi et al. proposed system for selection of first favorable move using chess game database analysis based on winning end state [1].

Shital Bhabad et al. proposed system for selection of favorable move in a multicore environment based on player's behaviour. They aim to increase the processing power of mobile applications [2].

Authors of [4] proposed system for tracing the characteristics of mobile game that may or may not contribute to construction of playfulness culture using gamification and ludification. They explained role of gamification and ludification in knowledge generation during game play.

Keerati Jitrawong et al. convinced us how the gamified information system is more efficient in delivering information than traditional DBMS based information system. They considered video games for demonstration of the system [5].

Scott A. Renner proposed system for achieving semantic data interoperability in different architecture and in different platforms [7].

Trevor Perrier et al. tested speed and performance of NoSQL database in mobile phone. They concluded that NoSQL database doesn't scale well in mobile phone. According to them, using NoSQL in a mobile phone has installation overhead as android doesn't come with NoSQL connection API [8]

ROLE OF DATA INTEROPERABILITY

Interoperability can be described as an ability to communicate data efficiently under the ubiquitous environment consistently resulting in better accuracy [6][9]. This research has demonstrated using multiplayer chess game. Data interoperability plays very important role in multiplayer chess game. Multiplayer chess game is a distributed application with basic requirements of moves to be shared between the players. At the instance, when players shares moves and process that moves the concept of data interoperability comes into the picture. Players are playing on their own mobile phones. In order to move ahead with the game it is necessary achieve data interoperability to share the moves and process that shared move.

PROPOSED SYSTEM

The proposed system has designed a multiplayer chess game for demonstration. In the context of multiplayer chess game, data interoperability is defined as ability to communicate data that means able to share moves efficiently and make use of that data that is based on shared move process chess database and suggest next favorable moves. The system architecture is shown in following figure. Architecture diagram represents the flow of the chess game. The player starts the chess application, and player either hosts new game or joins the already hosted game. Player with white chessmen starts the game and select and play favorable move suggested by one of the approach explained below in detail or known weakness of opponent or by selecting a random move. Based on player1's move opponents plays moves based on either moves suggested or known weakness of opponent or by selecting a random move. Finally, game result in either win, draw, suspend or loose state.

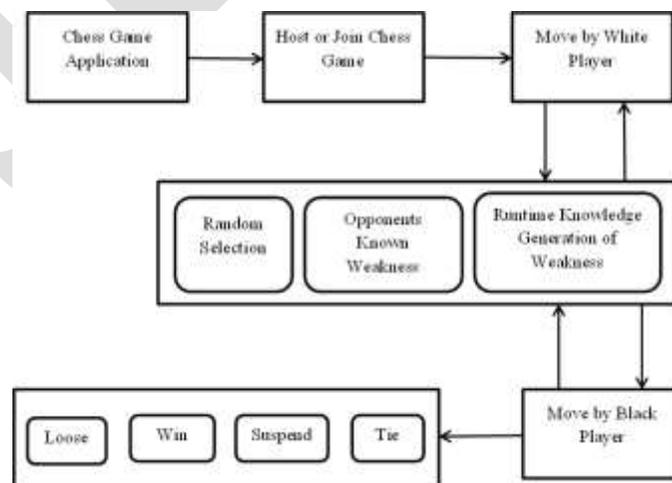


Fig. 1 system architecture

We have proposed a system for interoperability in android smart phone. The connection between the mobiles are established using 3-way handshake mechanism. Once the connection is successfully installed, mobile users are authenticated to share the valid data. Data is shared between mobile user upon successful authentication process. The shared data is validated and the this data is used for further processing after validation test is passed. If the validation test is failed, message is send to other player for valid data sharing. This process is explained using block diagram as follows:

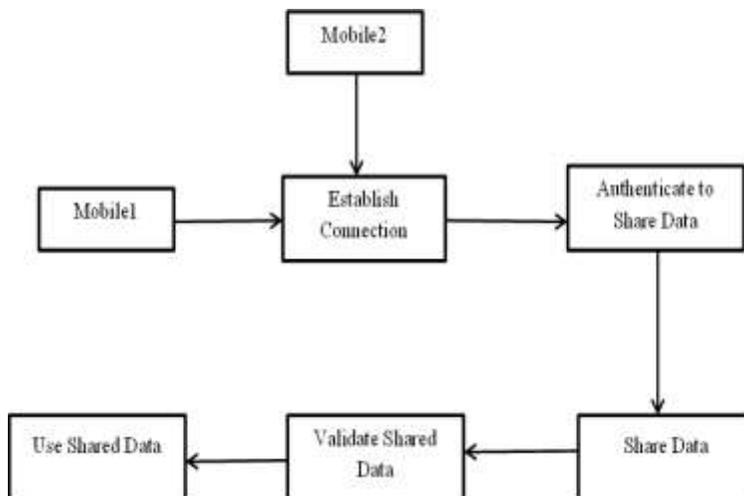


Fig. 2 Interoperability block diagram

Handshake process for connection establishment is in detail discussed in figure 3. Mobile1 send sequence number x to mobile 2. On receiving the sequence number from mobile1, mobile2 send acknowledgement $x+1$ and its sequence number y . Mobile1 sends the acknowledgement $y+1$ to mobile2 after receiving acknowledgment and sequence number and the secure connection is established.

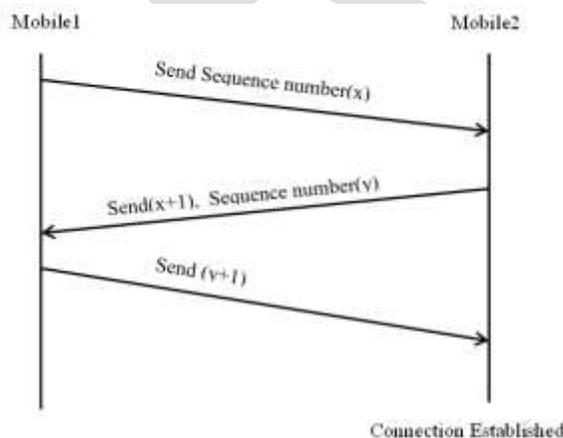


Fig. 3 Handshake process

Two important tasks in data interoperability, one is to share data and other is to make use of shared data.

1. Share moves between players: in this research, we used MongoDB to store data of players and games. To share the moves between players, we used single file to write game information per game. A single file is shared between player makes them easy to share respective moves by reading the file. While sharing files, we have taken care of authorization as only authorized players are able to share that file. Each game is associated with unique game_id and access key which is used to join games. When player hosts new game game_id is generated by the system and access key is set by player responsible for hosting new game. This game_id and access key is sent to targeted opponents by SMS. The sample game file is as below:

```

    {
      "_id": "ObjectId('55b08a34e1b1497e0c8bb729')",
      "game_id": 9,
      "player1_uid": "shital",
      "key": "ss1234",
      "state": "1",
      "player2_uid": "sharad",
      "move_string": "g4:e6,f4:h4",
      "moves": {
        "1": {
          "white": {
            "move": "g4"
          },
          "black": {
            "move": "e6"
          }
        },
        "2": {
          "white": {
            "move": "f4"
          },
          "black": {
            "move": "Qh4"
          }
        }
      },
      "result": "0-1"
    }
  }
  }
  
```

2. Make use of shared move to suggest a favorable move: favorable move is a move which assures win state of the game after playing that move. To select next favorable move, we have chosen two approaches: one is simple probability theory based on players' behavior and other is by using the Naïve Bayes classifier.

Mathematical model to describe chess game and a selection of first favorable move is in detail explained in [1] and [2].

a) Probability Theory

From [1] and [2], we know that $M = 20$, where M represents the total no of possible moves for the first game.

Let $F = \{0,1\}$ where F is flag. $F = 1$ represents playing as white and $F = 0$ represents playing as black.

Case 1: When $F = 1$, $n_w = \text{total no of games played by player1}$.

$D_1 = \text{distinct moves played by player1}$ where, $|D_1| \leq |M|$.

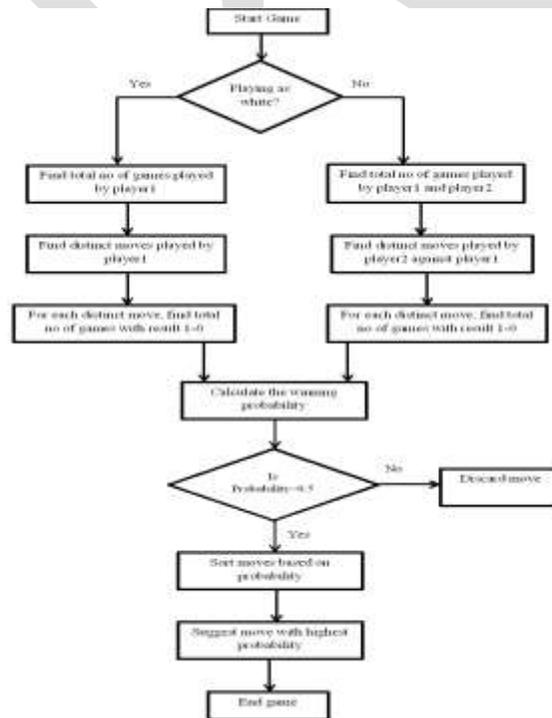


Fig. 4 Favorable move selection using probability theory

$T_w = \{ T_{w1}, T_{w2}, \dots, T_{wn} \}$ represents the set of the game count with result 1-0. $T_{wi} = (x/ x \in D_1)$ represents for each distinct move in D_1 , total no of games with result 1-0.

$P_{ww} = \{ P_{ww1}, P_{ww2}, \dots, P_{wwn} \}$ represents set of winning probabilities of each distinct move x where $x \in D_1$.

$$P_{wwi} = \frac{T_{wwi}}{n_w}$$

We know that $P = 1$; where P represent the probability.

$$P_w = P_{ww} + P_{wl} = 1;$$

$$P_{ww} = 1 - P_{wl};$$

$D_{1d} = \{ D_{1d1}, D_{1d2}, \dots, D_{1dn} \}$ represents set of distinct moves with $P_{ww} > 0.5$

Sort the D_{1d} based on the value of P_{ww} in descending order and suggest a first element of set as favorable move.

Case 2: When $F = 0$, $n_b = \text{total no of games played by player1 and player 2.}$

$D_2 = \text{distinct moves played by player2 against player 1 where, } |D_2| \leq |M|.$

$T_b = \{ T_{b1}, T_{b2}, \dots, T_{bn} \}$ represents the set of the game count with result 0-1. $T_{bi} = (y/ y \in D_2)$ represents for each distinct move in D_2 , total no of games with result 0-1.

$P_{bw} = \{ P_{bw1}, P_{bw2}, \dots, P_{bwn} \}$ represents a set of winning probabilities of each distinct move y where $y \in D_2$

$$P_{bwi} = \frac{T_{bwi}}{n_b}$$

$$P_b = P_{bw} + P_{bl} = 1;$$

$$P_{bw} = 1 - P_{bl};$$

$D_{2d} = \{ D_{2d1}, D_{2d2}, \dots, D_{2dn} \}$ represents set of distinct moves with $P_{bw} > 0.5$

Sort the D_{2d} based on the value of P_{bw} in descending order and suggest a first element of set as favorable move.

This approach is used to suggest first favorable move.

b) Naïve Bays Classifier

To find a favorable move using the naïve Bayes classifier, we have followed the steps mentioned below:

Find the current board positions in a database. For each match store game object containing *game_id*, *player1_uid*, *player2_uid*, *identifier*, *prev*, *next* and *moveby* in *allgamedata* object.

Find the *result* of each game in *allgamedata*

Initially *res* = -1, represents the class label

If $((\text{result} = 1-0) \wedge (\text{player1} = \text{moveby})) \text{res} = 1;$

else *res* = 0;

if $((\text{result} = 0-1) \wedge (\text{player2} = \text{moveby})) \text{res} = 1;$

else *res* = 0;

if $(\text{result} = 1-1)$ then *res* = 2;

if game object in *allgamedata* has *res* = -1 then remove game object from *allgamedata*.

For each game data in *allgamedata* get *rows* and *columns* of *prev* and *next* moves where *prev* move is represented as *prev* = (*fromRow*, *fromColumn*) and *next* is represented as *next*=(*toRow*, *toColumn*)

Let *D* be a training set of tuples and their associated class labels. Each tuple is represented by an n- dimensional attribute vector, $X = \{x_1, x_2, \dots, x_n\}$

In our case, $X = \{\text{fromRow}, \text{fromColumn}, \text{toRow}, \text{toColumn}\}$

Suppose that there are m classes C_1, C_2, \dots, C_m that is 0, 1, 2 in our case

Naïve bayes classifier predicts that tuple X belongs to class C_i iff

$$P(C_i|X) > P(C_j|X) \quad \text{for } 1 \leq j \leq m, j \neq i$$

By Bayes theorem

$$P(C_i|X) = \frac{P(X|C_i)P(C_i)}{P(X)}$$

As $P(X)$ is constant for all classes, only $P(X|C_i)P(C_i)$ needs to be maximized.

$$P(X|C_i) = \prod_{k=1}^n P(x_k|C_i)$$

The classifier predicts that the class label of tuple X is the class C_i iff

$$P(X|C_i)P(C_i) > P(X|C_j)P(C_j) \quad \text{for } 1 \leq j \leq m, j \neq i$$

For each distinct tuple from x is classified using above formulas. Tuple with maximum final probability is considered for suggesting favourable move.

EXPERIMENTAL SETUP

The Experimental setup for this proposed system will be building of development and testing environment. Proposed system will be developed in eclipse and tested on real time smartphone with multicore functionality.

The particulars about platform and system used are as follows:

- Base operating system: windows 8/ fedora 21
- Database: MongoDB
- Tools: Eclipse Luna
- Language: Java
- Plugin: android, genymotion

According to this specification system is built up.

RESULTS AND DISCUSSION

To calculate the results, we have considered 10 games played between shital and sharad. Where shital playing using white chessmen and sharad has played using black chessmen.

a) Probability theory

Table 1. move analysis of shital and sharad

Shital's Move	Sharad's Move	Won	Lost
e4	e5	4	0
e4	c6	2	0
g4	e6	1	1
d4	d5	0	2

When playing as shital suggested move is e4 as e4 has maximum winning probability. When playing as sharad suggested move is e6 as e6 has maximum winning probability.

b) Naïve Bayes classifier

Table 2. dataset for naïve Bayes classifier

fromRow	fromColumn	toRow	toColumn	Result
4	4	4	4	1
4	4	4	4	1
4	4	4	4	0
3	3	4	3	0
4	4	4	4	1
3	3	4	3	0
6	6	4	6	0
4	4	4	4	1
4	4	4	4	0

Table. 3 unique tuples

3	3	4	3
6	6	4	6
4	4	4	4

Each unique tuple is classified using the naïve Bayes classifier. Final probabilities for each of this tuple is given in following table

P(0)	P(1)
0.0142	0.140
0.03552	0
0.008	0

When playing as shital P(1) with maximum value is considered, $P(1) > P(0)$ therefore unique tuple with maximum P (1) is considered and moves in corresponding games are suggested as favorable move.

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CONCLUSION

In this research, we have successfully proposed data interoperability solution using gamification of a chess game. Data interoperability is achieved by saving the game data in a single file. We maintained the privacy of data by providing the access key to each game. In this research, shared data are successfully and efficiently used to suggest a favorable move.

In the future, we are planning to achieve data interoperability between smartphone using distinct data files. Solution for the chess favorable move will be extended to more depth.

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