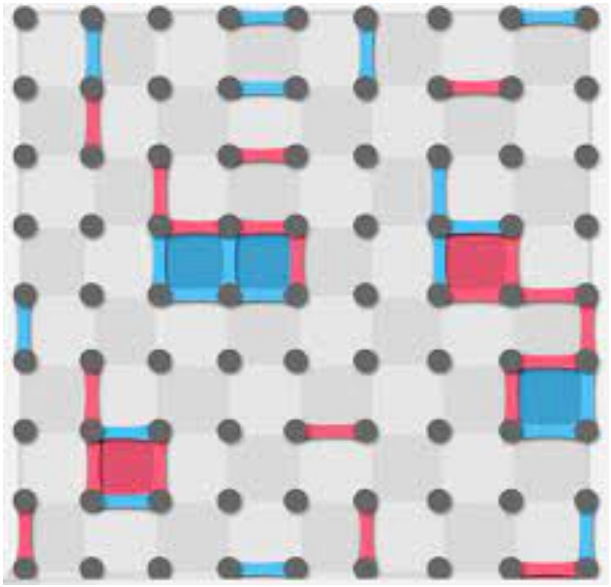
Data Systems

Assignment - 1 (Part-1)

Dots and Boxes



Team Information

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Assumptions

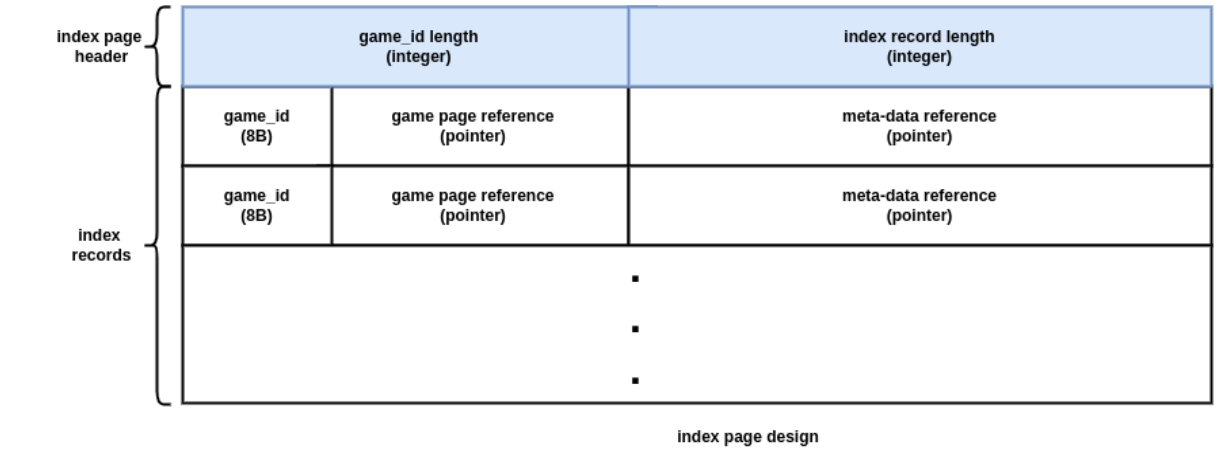
1. General assumptions
    1.1. The game function checks if a box has been created and provide another opportunity to the player that completed the box.
    1.2. The game moves in a cyclic rotational manner.
    1.3. The software provides the order of players.
    1.4. The move made by the player is provided to the database in the form of tuples containing the information (index of the point from where the line started, the direction the line went towards (U,D,R,L))
    1.5. There are no illegal moves.
2. Parameter assumptions
    2.1. Minimum number of players:100, maximum:256
    2.2. Size of the game:1000 x 1000
    2.3. Page size: 4KB

Proposed Methodology

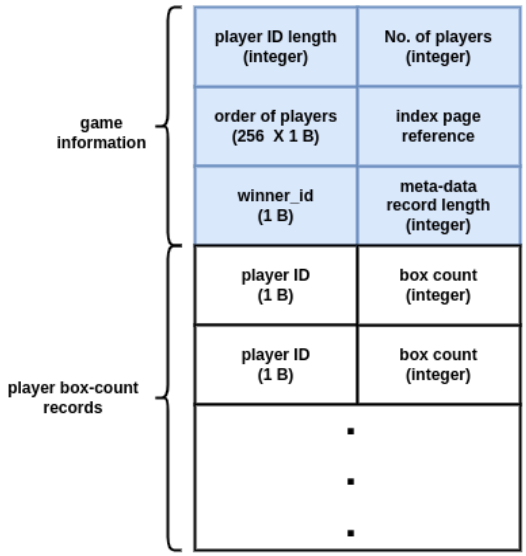
1. The order of the player is stored in the Meta-data page which is accessed through the Index page of the game.
2. Every move made in the game is logged into the database in a sequential manner in the form (starting_dot_index, direction_of_line, box_fill_flag).
3. Every move needs to be logged sequentially in the order it was played in the game.

Page Design

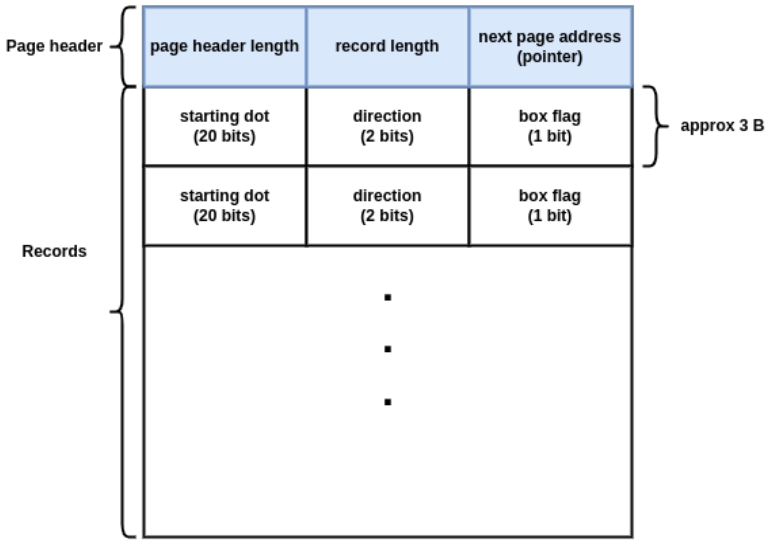
1. The proposal include three categories of pages
    1.1. Index Page
    1.2. Game Page
    1.3. Meta-data page



index page design



Meta-data design



Game page design

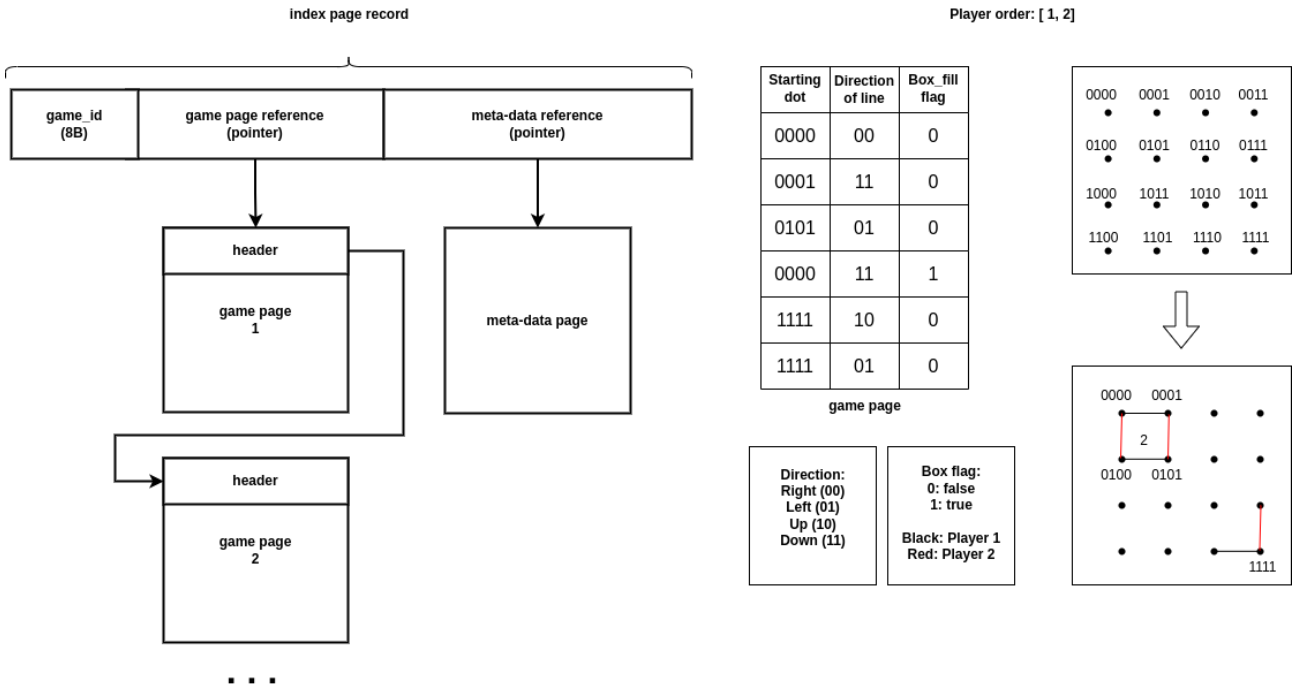
2. All the three types of pages comprise page header and game information.
3. Every point/dot in the game is assigned an index starting from 0 to 10^6 -1.
4. Index page as the name suggests is used for indexing the game pages. It has three fields: Game ID, memory referencing address of the first- Game page of each game and of the Meta-data of each game.
5. Meta-data page has three sections: Header, Player to box-count mapping and winner id information. Every game has one corresponding Meta-data page.
6. It's header has a memory reference to the index page. The mapping section stores player IDs (1Byte for each ID) and the corresponding number of boxes (represented by

20 bits) acquired throughout the game while the winner id (1Byte) information is also present in this page which can be accessed in the header.

7. The Game pages are the pages that include move's information in sequential manner. The first game page as mentioned above is linked to the index page and every game page has memory address of next game page for that particular game.
8. The Game page has the index of the first dot from where the line is drawn, the direction in which the line is drawn and box_fill flag which tells if a box was created in the respective move.
9. Importance of box_fill_flag field in space optimization:
    9.1. Once the order of players is known by the software, it can map the moves with players and if the box_fill_flag field is true, the next move will be assigned to the last player.
    9.2. This way, we are saving almost 2MB of space per game as player id per move would have consumed 1B of space and there are $2*10^6$ Bytes of moves. Eventually for the move information, 8MB could have been used but now 6MB is used.
10. The starting dot index will be 20 bits long (acquired as $\log_2 10^6$ bits), 2 bits of direction (right,left,top,bottom), and 1 bit for box_fill_flag.

Steps for game reconstruction:

1. Access the Index page of the game.
2. Reach Meta-Data page ▶️ Access player order.
3. Access moves' information from Game pages.
4. Get Player to box-count mapping from Meta-data page.
5. Fetch Winner ID from Meta-data page.



Page Design Overview & reconstruction

Features

- Since the data is being stored in a sequential manner, we do not need to store the player ID of the player who made the move as that can be computed in runtime by the game program.
- Each game consumes approximately 6MB of storage space.
- The box_fill_flag makes the mapping of a player with player ID efficient.
- The moves information pages link to the next page.