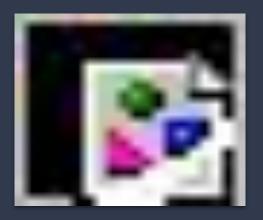
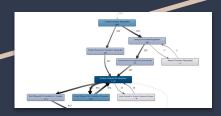
## Chess Mining

Micha Birklbauer, BSc. Dorian Karaban, BSc.



### Overview & Goals





Although chess games do not necessarily have timestamps they are neatly ordered and can be expressed as sequence of moves.

In the following we suggest modelling chess games using process mining tools. We consider the following attributes:

- Case ID: The match number
- Activity: The move e.g. "e4"
- Resource: White or Black
- Timestamp: The current turn iteration

The goal is to compare openings - which we define as the first 10 turns - of different users and look for patterns in the generated process model as well as conformance between players.

### The Data



We are using matches from two different players namely Dorian and Robert Fischer - as well as some popular openings scrapped from various websites like chess.com in standard pgn notation.

#### Example PGN:

```
[Event "Match"]
[Round "5"]
[White "Fischer Robert J (USA)"]
[Black "Spassky Boris V (FRA)"]
[Result "0-1"]
[WhiteElo "2785"]
[BlackElo "2560"]
```

1.e4 e5 2.Nf3 Nc6 3.Bb5 a6 4.Ba4 Nf6 5.0-0 Be7 6.Re1 b5 7.Bb3 d6 8.c3 0-0 9.h3 Nb8 10.d4 Nbd7 11.Nbd2 Bb7 12.Bc2 Re8 13.Nf1 Bf8 14.Ng3 g6 15.Bg5 h6 16.Bd2 exd4 17.cxd4 c5 18.d5 Nb6 19.Ba5 Nfd7 20.b3 Bg7 21.Rc1 Qf6 22.Rb1 b4 23.Ne2 Qe7 24.a3 bxa3 25.Bc3 f5 26.Bxg7 Qxg7 27.Nf4 fxe4 28.Nh4 g5 29.Ne6 Qf6 30.Qg4 Nxd5 31.Nxg5 hxg5 32.Qxd7 Nb4 33.Qxb7 Nxc2 34.Rxe4 a2 35.Rf1 Nb4 36.Rg4 a1Q 37.Rxa1 Qxa1+ 38.Kh2 Qg7 39.Qf3 Qe5+ 40.g3 Rf8 41.Qg2 Qf6 42.f4 Ra7 43.Rxg5+ Rg7 44.Rh5 Qe6 45.g4 Rxf4 0-1

### Preprocessing

# From PGN to Eventlog

#### Python:

- package "chess.pgn" offers a convenient interface to read pgn files
- we manually convert every match into a series of moves and save them as json
- finally we convert the json to csv where we assign to every move the match number, colour and turn iteration

#### R:

- filtering rows for:
  - player
  - colour
  - turn iteration < 20 (10 turns/player)</li>

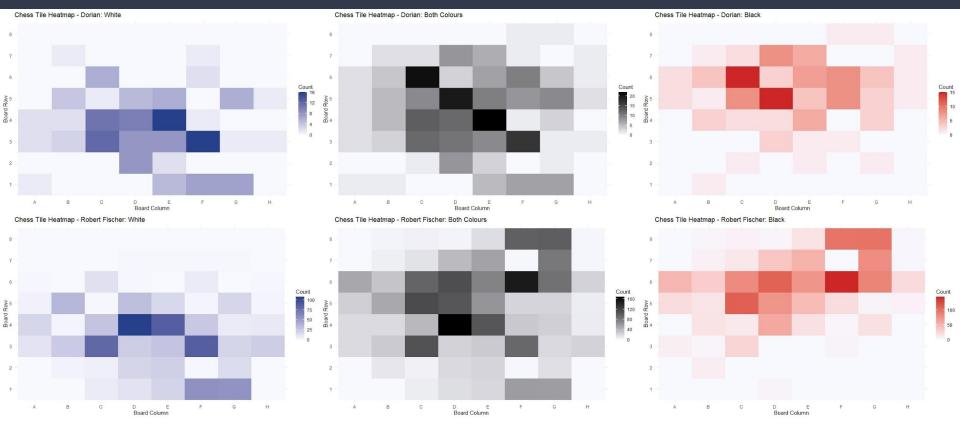
#### Disco:

reading of csv and generating xes logfile

### Methods & Results

- Disco
  - directly-follows graphs
- pm4py (python)
  - alpha miner, heuristic miner, inductive miner, petrinets, token-based replay, alignments
- bupaR (R)
  - inductive miner, petrinets, alignments
- ggplot2 (R)
  - heatmaps

### Comparing Tile Usage between Players



### Discovery - Search the "Italian Game"



#### Datasource:

Games selected by Chess Opening ECO Code

- Grandmaster games: 2129
- Elo: 1950-2851 [2482]
- Code: C50-59 Giuoco Piano (Italian Game)

#### Goal:

Discover expected activities,
 e.g. <e4, e5, Nf3, Nc6, Bc4, ...>

#### Selection:

Exceptional Games are defined as Noise

Cases: 2129Variants: 204

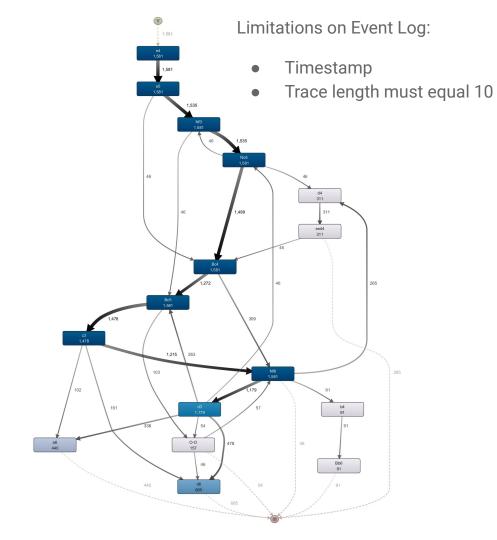


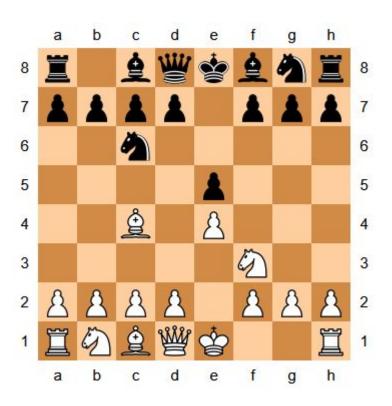
#### **Final Process Map Data:**

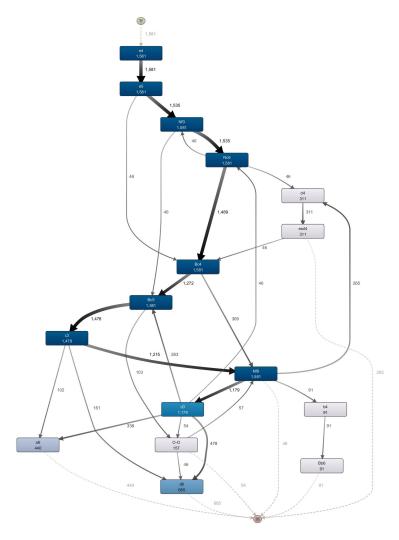
• Cases: 1581

Variants: 11

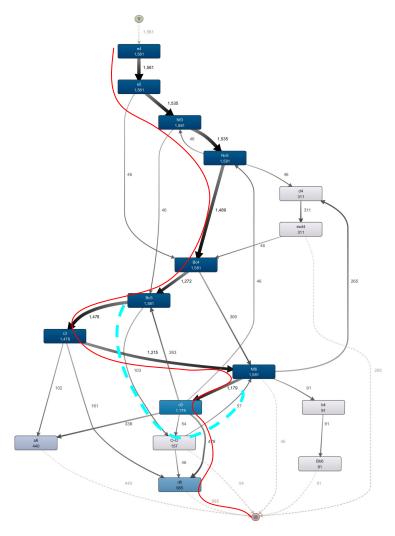




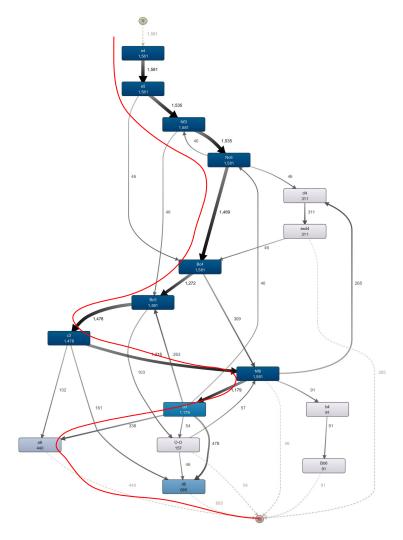




v1 (26.63%): <e4, e5, Nf3, Nc6, Bc4, Bc5, c3, Nf6, d3, d6>
v2 (21.38%): <e4, e5, Nf3, Nc6, Bc4, Bc5, c3, Nf6, d3, a6>
v3 (16.76%): <e4, e5, Nf3, Nc6, Bc4, Bc5, c3, Nf6, d4, exd4>
v4 (7.27%): <e4, e5, Nf3, Nc6, Bc4, Nf6, d3, Bc5, c3, d6>
v5 (6.45%): <e4, e5, Nf3, Nc6, Bc4, Nf6, d3, Bc5, c3, a6>
v6 (5.76%): <e4, e5, Nf3, Nc6, Bc4, Bc5, c3, Nf6, b4, Bb6>
v7 (3.61%): <e4, e5, Nf3, Nc6, Bc4, Bc5, O-O, Nf6, d3, d6>



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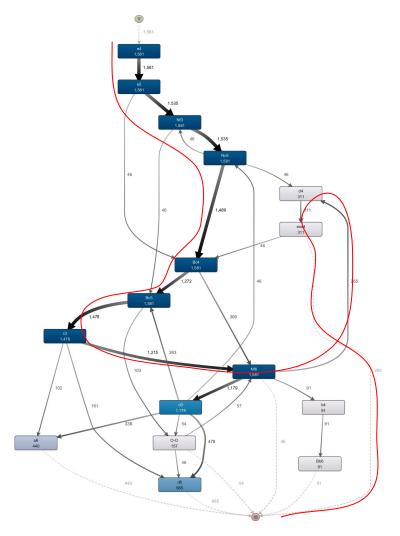
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v1 (26.63%): <e4, e5, Nf3, Nc6, Bc4, Bc5, c3, Nf6, d3, d6>

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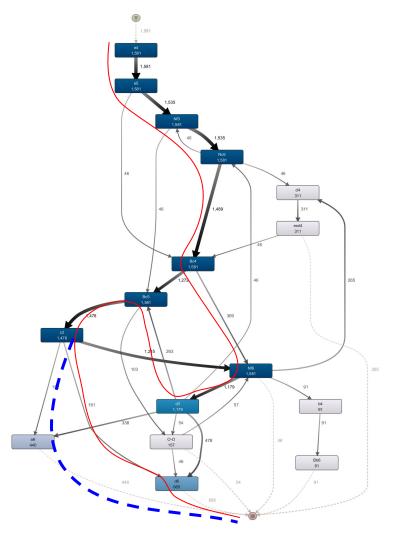
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#### v1 (26.63%)

**C53** Italian Game: Classical Variation, Giuoco Pianissimo



#### v11 (2.91%)

**C53** Italian Game: Classical Variation, Giuoco Pianissimo (Trans. from C23-24)



v2 (16.76%)

**C53** Italian Game: Classical Variation, Center Attack



v10 (2.91%)

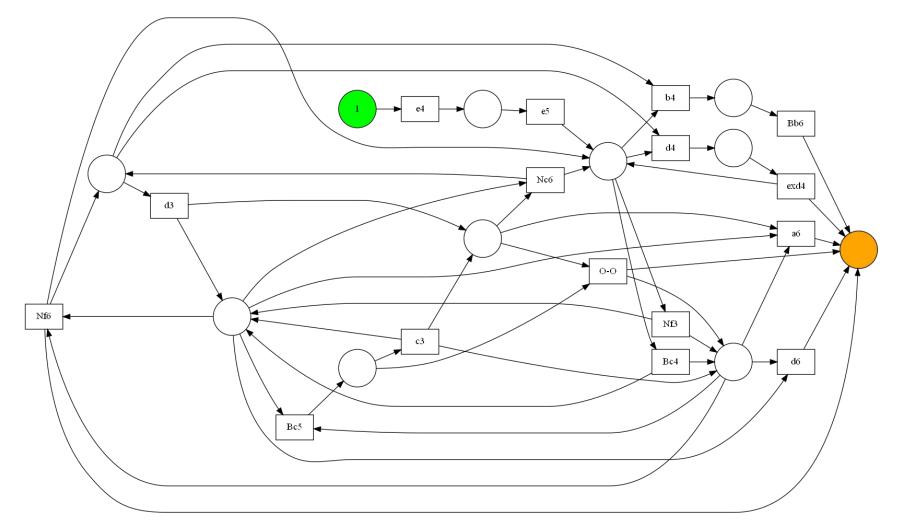
C44 Scotch Game: Haxo Gambit

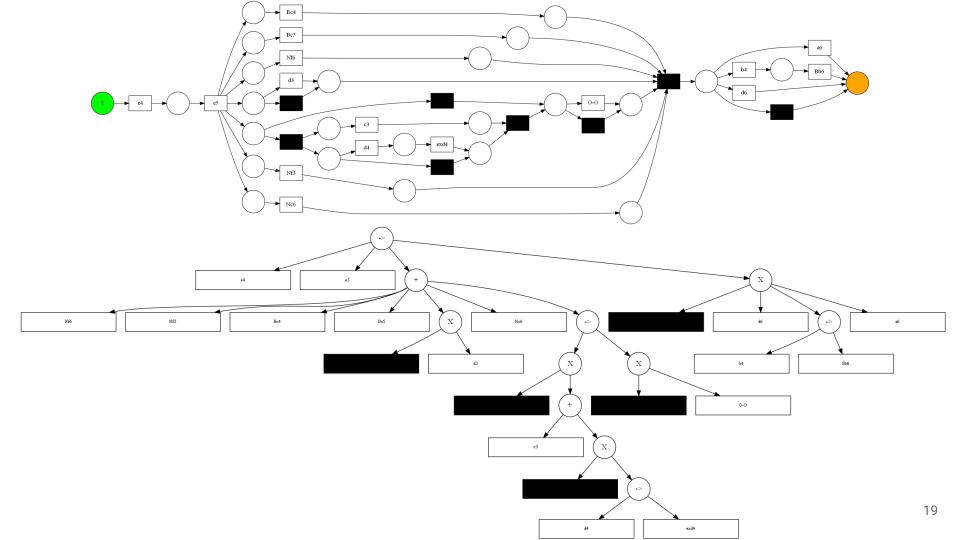


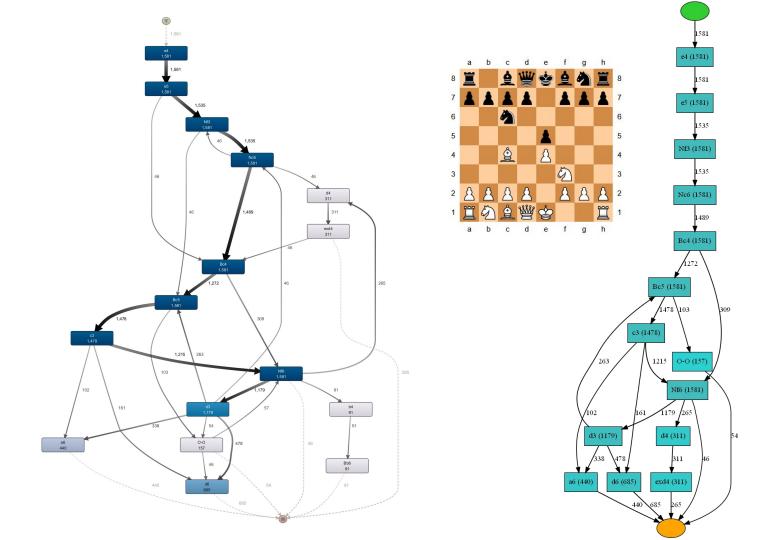
### Discovery Methods

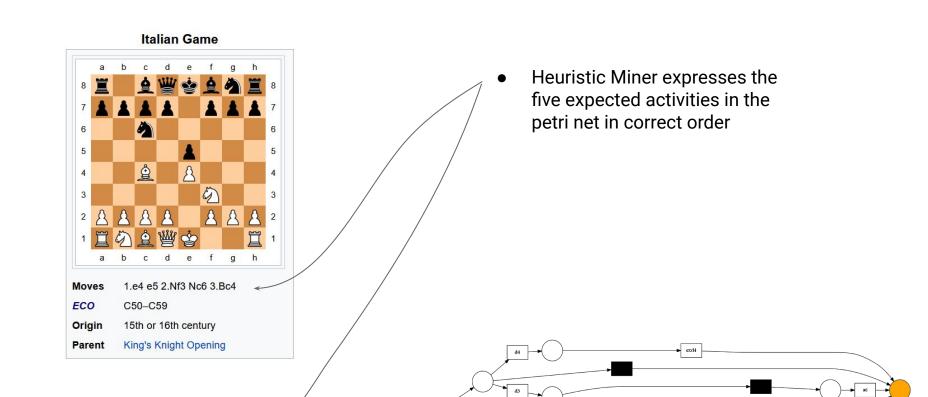


- Alpha Miner
- Inductive Miner
- Heuristic Miner





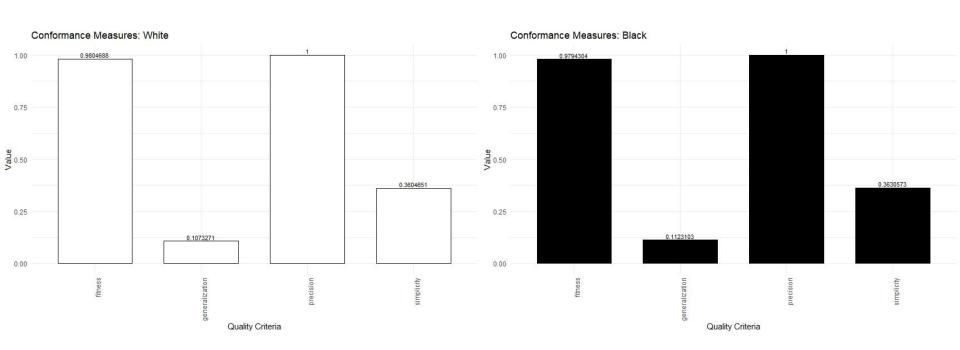




### Conformance - "Play like a Grandmaster"

ALPHA M.	Eventlog (1581)	Small Snapshot (~20)	Italian Games (~90)
Token based replay	0.843	0.629	0.726
Alignement	0.611	0.391	0.477
INDUCTIVE M.			
Token based replay	1.000	0.691	0.784
Alignement	1.000	0.558	0.786
HEURISTICS M.			
Token based replay	0.986	0.680	0.856
Alignement	0.973	0.503	0.773

### Conformance with Robert Fischer



# Thanks for watching (















#### Images:

- https://www.shutterstock.com/video/clip-31363114-not-approved-signed-red-ink-stam p-rubber
- <a href="https://www.promineth.nl/wp-content/uploads/2016/01/Disco1-1024x495.gif">https://www.promineth.nl/wp-content/uploads/2016/01/Disco1-1024x495.gif</a>
- https://de.wikipedia.org/wiki/Bobby\_Fischer