Producing creative chess through chess engine selfplay

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CREATIVITY IN CHESS: THE CONCEPT OF "OPENINGS"

"The game of chess has exact rules but inexact principles for playing it. Many of these principles were discovered over centuries through insight and experience and are documented in chess literature." – Bushinsky

SO WHAT IS CREATIVITY IN CHESS?

- According to Bushinsky, a computer scientist and creator of Junior engine:
  - No different from other domains.
  - De Bono's lateral thinking [De Bono, 1973]:
    - Nonconformism
    - Provocation (in the positive sense)
    - Flexibility
    - Casting doubt
    - Thinking out of the box
    - Transfer

SO WHAT IS CREATIVITY IN CHESS?

- According to Amatzia Avni, a psychologist and a chess master:
  - Analyzed roots of creativity in human play [Amatzia, 1998].
  - Intelligent process composed of four distinct steps:
    1. Gathering: collecting the raw materials during position evaluation.
    2. Synthesis: opinion forming and plan shaping.
    3. Enlightenment: a sudden observation of an idea.
    4. Realization: translating the idea into practical lines of play.
  - Even defines particular creative elements in the game of chess:
    - Nonstandard positioning or functions of chess pieces.
    - The removal of one's own piece.
    - The breaching of theoretical principles.
    - ...

CREATIVE CHESS MOVES: BASED ON KNOWLEDGE

Definition

A chess move is creative if it has never been played in a tournament.

Definition

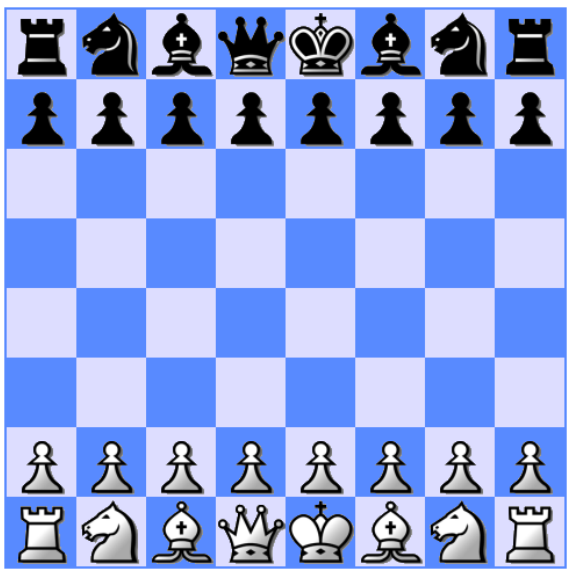
A chess move is creative if it has been played in a tournament but its win rate is very low.

CREATIVE CHESS MOVES: BASED ON THEORY

Definition

A chess move that captures a piece is creative if the captured piece is not the most valuable piece that could have been captured.

- example: Queen's gambit declined opening

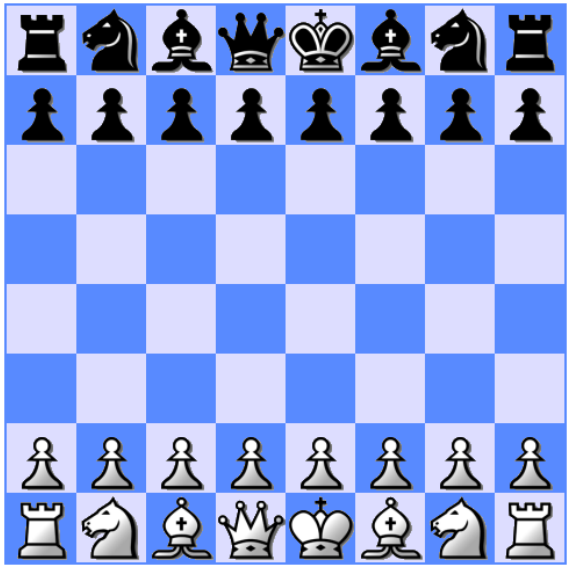


CREATIVITY IN CHESS: BASED ON THEORY

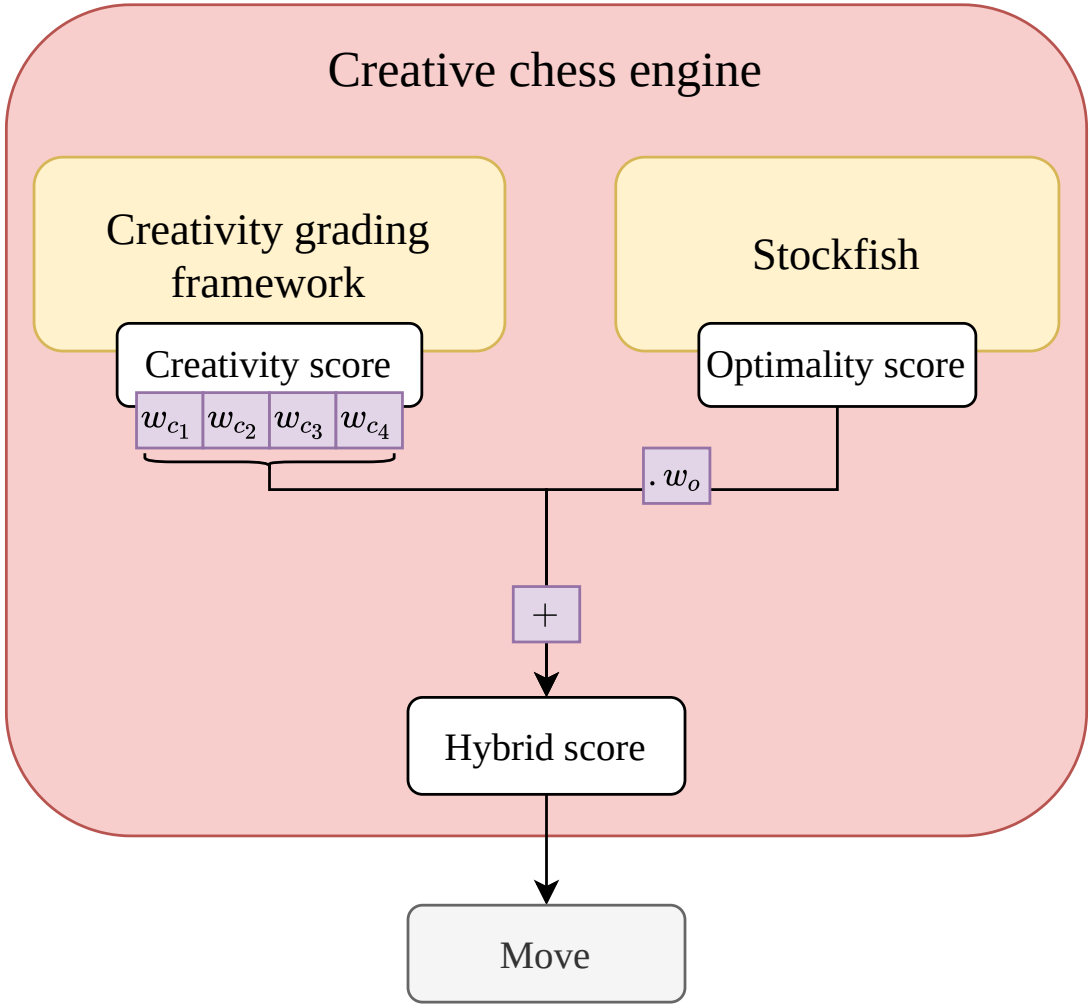
Definition

A chess move is creative if it is a sacrifice. A sacrifice is a move that when played, allows the opponent to capture an undefended piece.

- example: Vienna gambit opening



THE CREATIVE CHESS ENGINE



HOW TO IMPLEMENT THIS

- Knowledge-based definitions: the chess cloud database[1]
  - Simple http API.
  - Free to use.
  - Send position FEN, get known moves and their win rates.
- Theory-based definitions: python-chess[2]
  - Easy-to-use python library for chess reasoning.
  - Loading a UCI engine.
  - Read and write FEN and PGN.
- The inner chess engine: Stockfish[3]
  - Best engine in the world.
  - GNU General Public License version 3.

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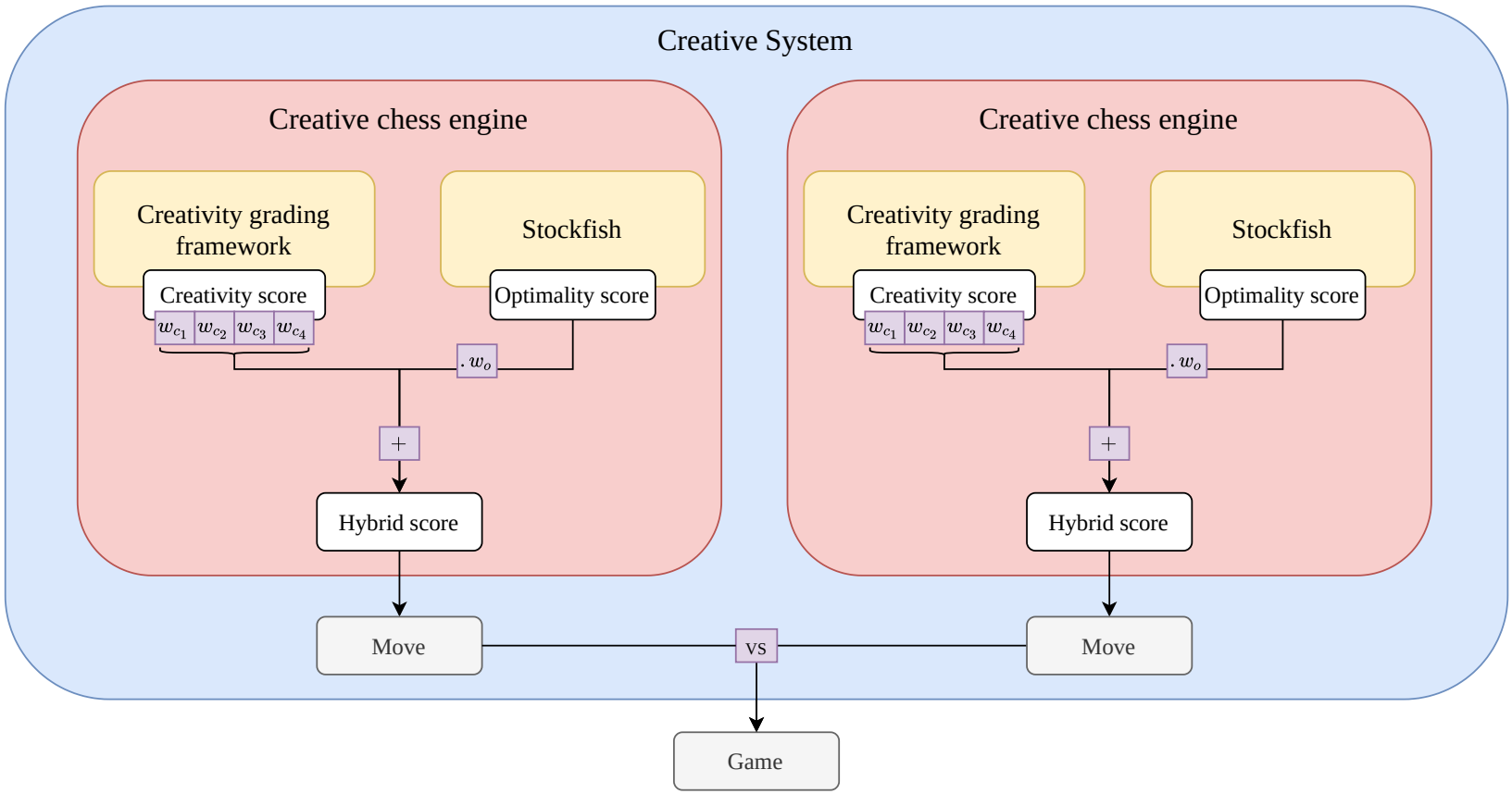
[1] `https://www.chessdb.cn/queryc_en/`

[2] `https://python-chess.readthedocs.io/en/latest/`

[3] `https://stockfishchess.org/`

THE CREATIVE CHESS SYSTEM



THE CREATIVE SYSTEMS FRAMEWORK

- [Boden, 1992], [Wiggins, 2006a], [Wiggins, 2006b]
- Exploratory creativity:

$$< U, L, [\![.]\!], \ll . \gg, R, T, E > \tag{1}$$

- Transformational creativity:

$$< L^*, L_L, [\![.]\!], \ll . \gg, R_L, T_L, E_L > \tag{2}$$

THE CREATIVE SYSTEMS FRAMEWORK: FILLED IN

EXPLORATORY CREATIVITY

$$< U, L, [\![.]\!], \ll . \gg, R, T, E >$$

In which:

- U is the universe of all possible partial and complete chess games played at any moment by any two players.
- L is a language specific to this creative system that allows for writing rules for:
  - Restricting the chess concepts in U to complete and legal chess games that were played by two of the creative chess-engines.
  - Defining the values of the creative chess-engine's weights.
  - Defining which outputted games are to be accepted and which are to be rejected.

THE CREATIVE SYSTEMS FRAMEWORK: FILLED IN

EXPLORATORY CREATIVITY

$$< U, L, [\![.]\!], \ll . \gg, R, T, E >$$

- $[\![.]\!]$ is a testing interpreter for R.
- $\ll . \gg$ is an enumerating interpreter for R, T and E.
- R is a set of rules, written in L, defining the conceptual space C in U of *complete* and *legal* games that were played by two of the creative chess-engines.
- T is a set of rules, written in L, defining the values of the creative chess-engine's weights.
- E is a set of rules, written in L, defining which *complete* and *legal* games outputed by the creative system, that are to be accepted and which are to be rejected.

THE CREATIVE SYSTEMS FRAMEWORK: FILLED IN

EXPLORATORY CREATIVITY

The rules in E:

- Accept when: for each weight w_{c_i} and w_o:

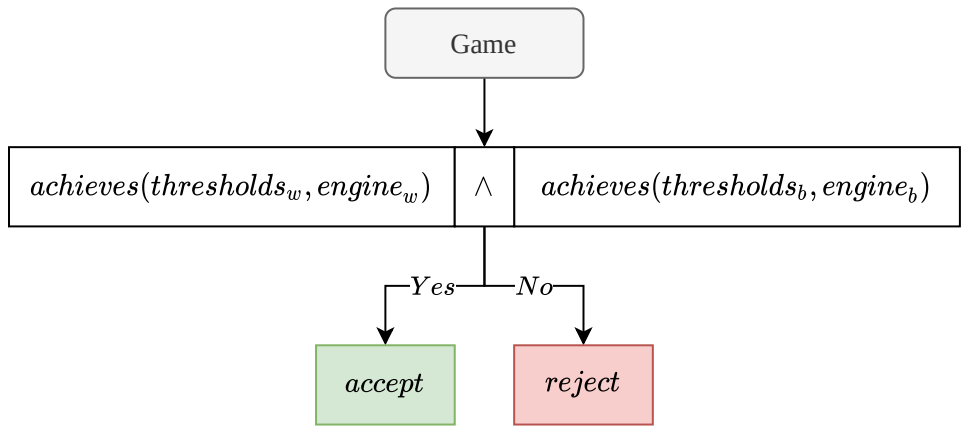
$$\frac{\#moves\_played_i}{\#total\_moves} = p_i > threshold_i \tag{3}$$

- For both engines.

Can be done internally & externally!

THE CREATIVE SYSTEMS FRAMEWORK: FILLED IN

EXPLORATORY CREATIVITY



THE CREATIVE SYSTEMS FRAMEWORK: FILLED IN

TRANSFORMATIONAL CREATIVITY

$$< L^*, L_L, [\![.]\!], \ll . \gg, R_L, T_L, E_L >$$

In which:

- $L*$ is the powerset of the language L.
- L_L is a meta-language to describe L and L^*.
- $[\![.]\!]$ is a testing interpreter for R_L.
- $\ll . \gg$ is an enumerating interpreter for R_L, T_L and E_L.
- R_L is a set of rules defining a conceptual space of syntactically well-formed rules.
- T_L is a set of rules defining the search strategy.
- E is a set of rules for evaluating the found transformation.

THE CREATIVE SYSTEMS FRAMEWORK: FILLED IN

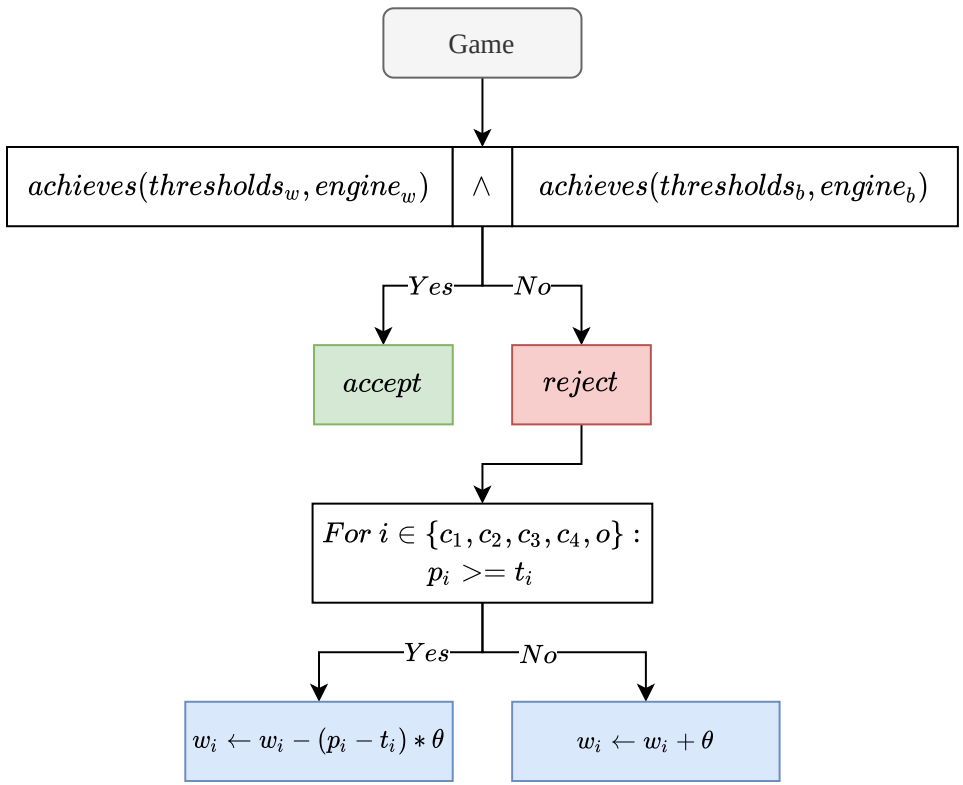
TRANSFORMATIONAL CREATIVITY

- Transforming *R*:
  - Switching from selfplay to otherplay with Stockfish.
  - Switching from selfplay to otherplay with AlphaZero.
  - Switching from selfplay to otherplay with . . .

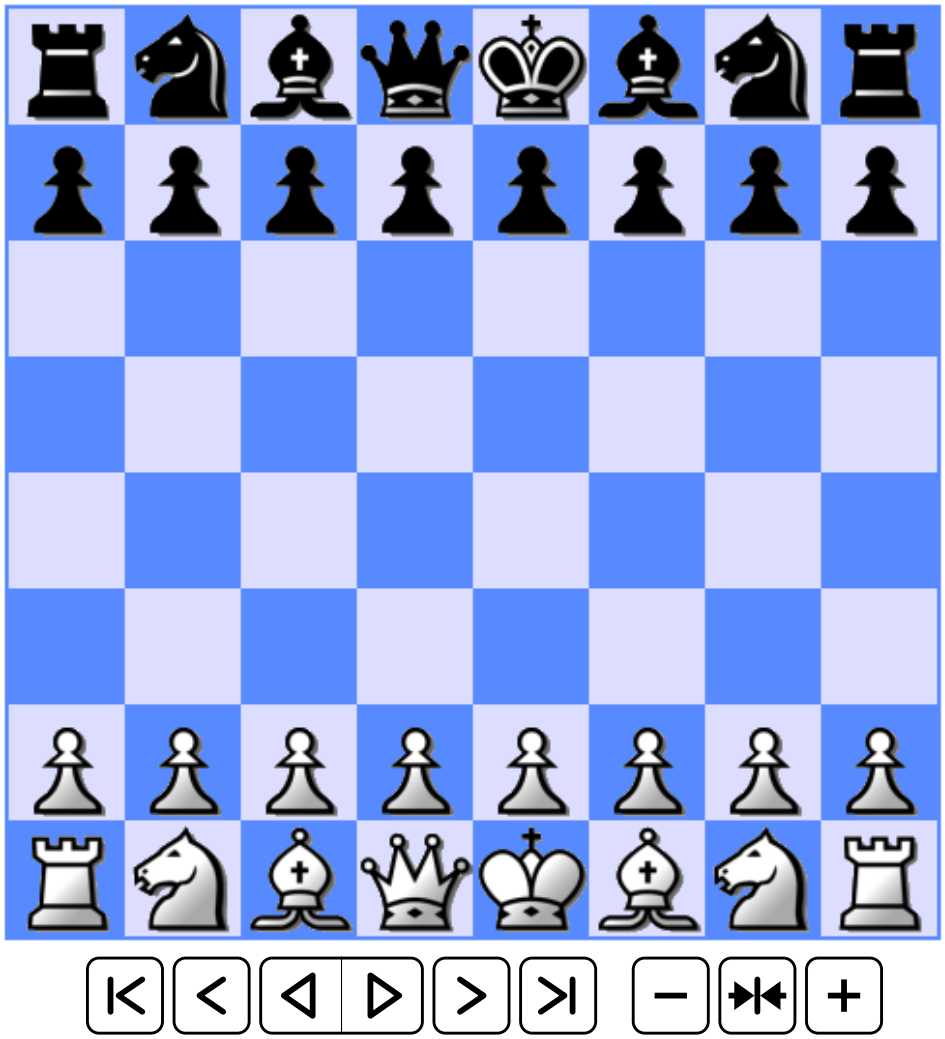
- Transforming *T*:
  - Changing values of the chess-engines' weights.
  - Changing the corresponding definitions of creative moves.

THE CREATIVE SYSTEMS FRAMEWORK: FILLED IN

TRANSFORMATIONAL CREATIVITY



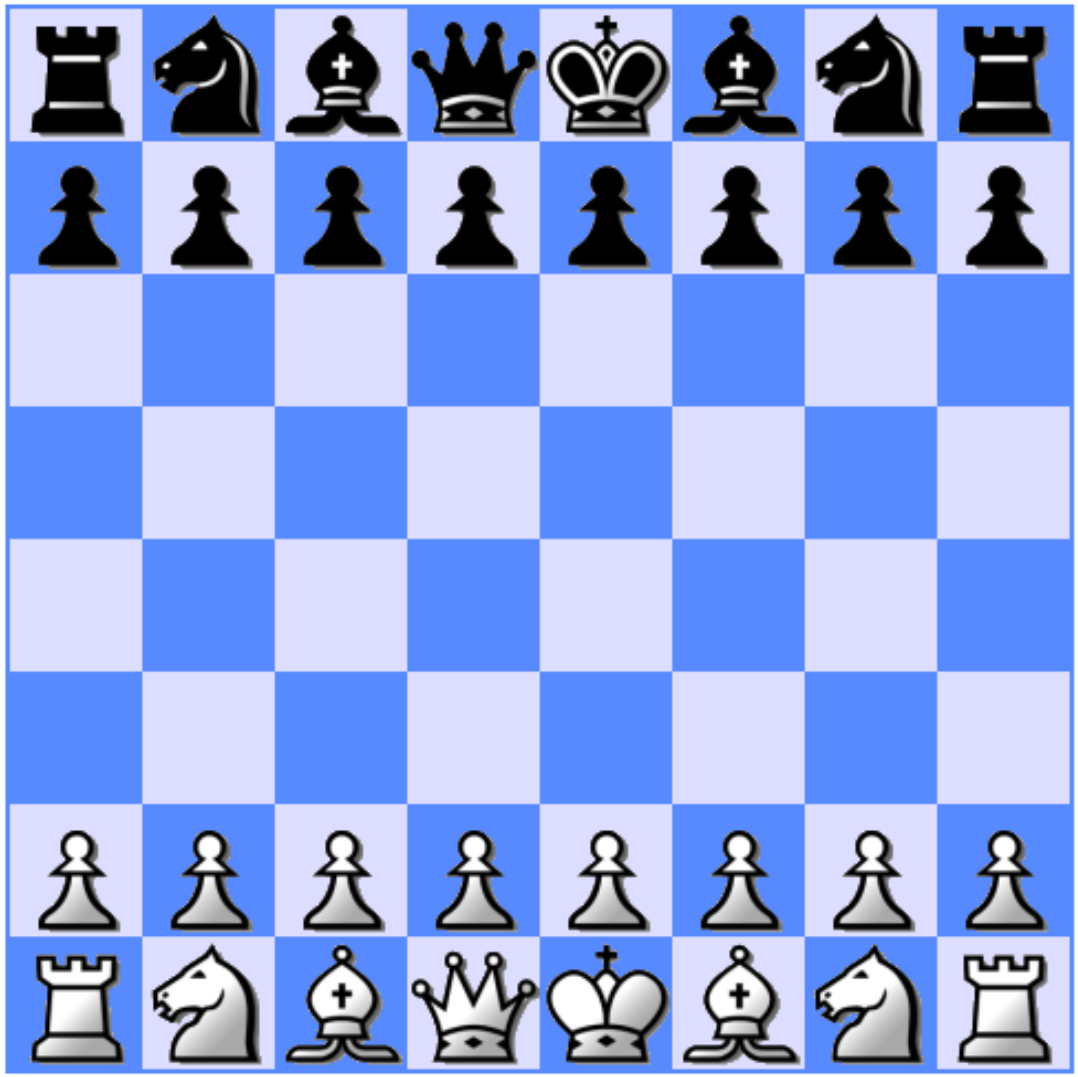
EXAMPLE



CONCLUSIONS

- System that produces creatively played chess games.
- Can be used as a tool to let engines look for novelty and principles.
- Internally and externally evaluated.
  - Internal evaluation: Creative games can and were produced.
  - External evaluation: The produced games are creative but comments on the sacrificial nature of the engines.
- Future work: transformational creativity possibilities:
  - Swapping engines.
  - Swapping/adding definitions.

QUESTIONS?



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https://github.com/wulfdewolf/creative-chess-producer.