# XXIII Board Game Studies Colloquium

# A Ludii analysis of the French Military Game

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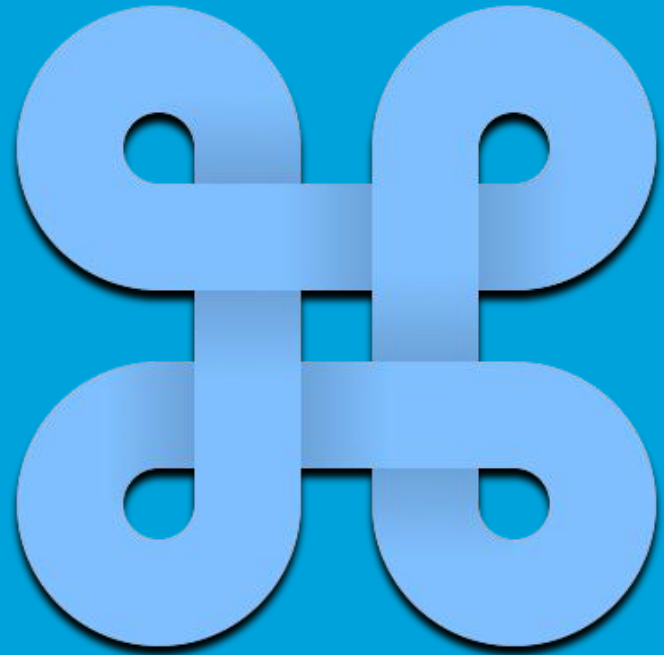
**Walter Crist**

**Matthew Stephenson**

**Dennis J.N.J. Soemers**

**Cameron Browne**

16/04/2021

**www.ludii.games**

Maastricht University

Digital Ludeme Project

CFV

UBO
Université de Bretagne Occidentale

erc
European Research Council
Established by the European Commission

# Outline

- Historical insight of the French Military Game (FMG) – *by Lisa*

- Ludii and French Military Game – *by Eric*

- Similar games in Ludii – *by Eric and Lisa*

- Prospects for the future

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# Historical insight of the FMG

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- Described (and analyzed) for the 1st time by the French mathematician Édouard Lucas.



Édouard Lucas (1842-1891)

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  - *La Nature*, 15ᵉ année, N°756, 26 novembre 1887, pp. 402-404.



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  - *La Nature*, 15$^e$ année, N°756, 26 novembre 1887, pp. 402-404.
  - *Récréations mathématiques Volume 3*, 1893, Paris : Gauthier-Villars, pp. 107-116.

RÉCRÉATIONS

MATHÉMATIQUES

PAR

M. ÉDOUARD LUCAS

« Je me représente la vaste enceinte des Sciences comme un grand terrain parsemé de places obscures et de places éclairées. Nos travaux doivent avoir pour but, ou d'étendre les limites des places éclairées, ou de multiplier sur le terrain les centres de lumières. L'un appartient au génie qui crée ; l'autre à la sagacité qui perfectionne ».

(DIDEROT. — *De l'interprétation de la Nature*.)

III

Le Calcul digital. — Machines arithmétiques.
Le Caméléon. — Les Fonctions de points.
Le Jeu militaire. — La Prise de la Bastille.
La Patte d'oie. — Le Fer à cheval.
Le Jeu américain. — Amusements par les Jetons.
L'Étoile nationale. — Rouge et Noire.

PARIS,

GAUTHIER-VILLARS ET FILS, IMPRIMEURS-LIBRAIRES,

QUAI DES GRANDS-AUGUSTINS, 55.

1893
(Tous droits réservés.)

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# Historical insight of the FMG

« *Less difficult than chess, the "Jeu militaire" is among the most instructive ones, and deserves to be recommended as a very useful distraction for officers and non-commissioned officer.* » (Lucas, 1893)
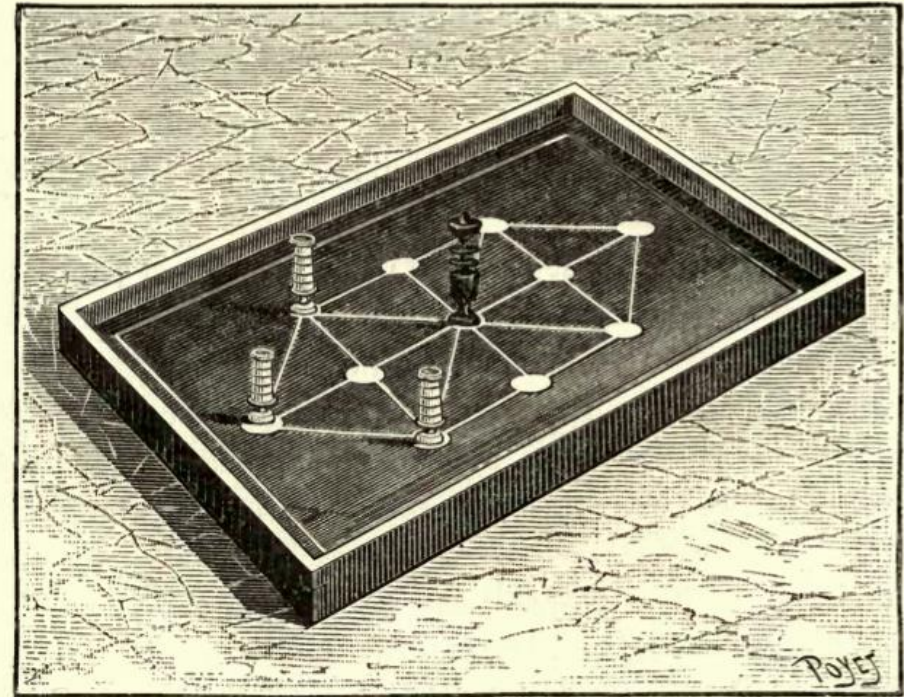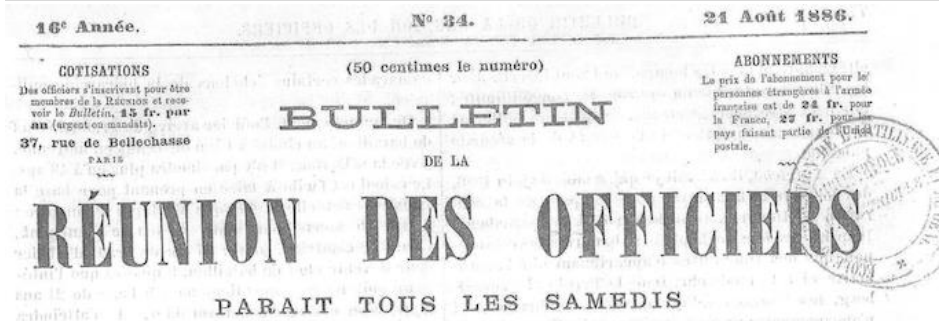
Le nouveau jeu militaire.

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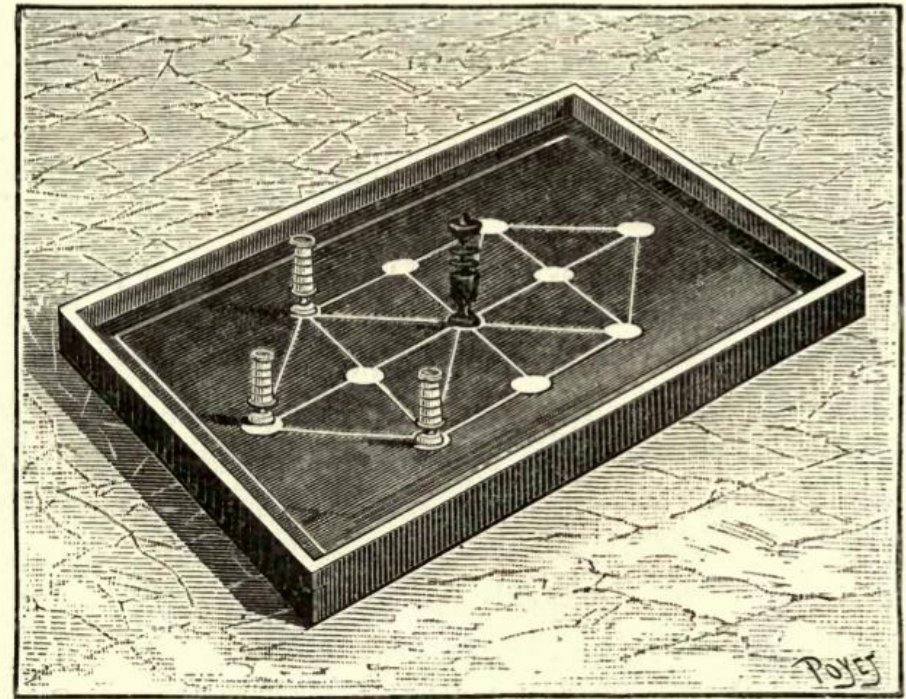
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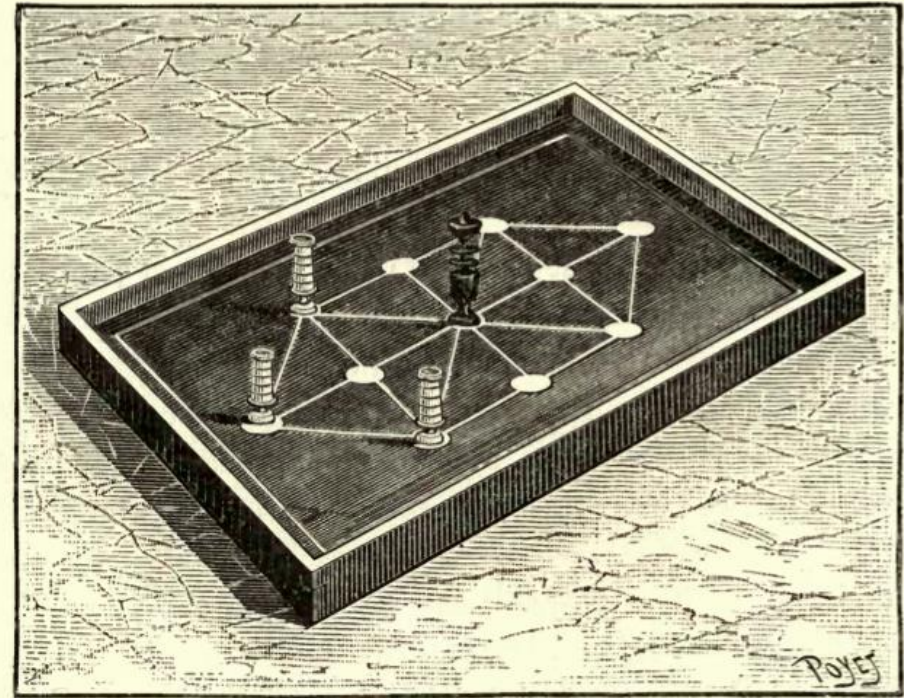
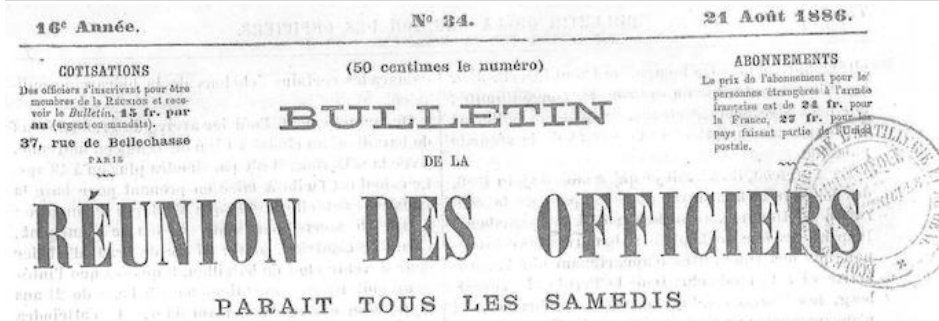→ Mentioned in a military newspaper in 1886.



Le nouveau jeu militaire.

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# Historical insight of the FMG

« *Bonuses of hundred "francs" are offered by the inventor to the persons who will win as many games as himself, and bonuses of thousand "francs" to those who would win more than half of them.* » (Lucas, 1893)



Le nouveau jeu militaire.



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# Historical insight of the FMG

➢ The rules:
● The army = black token (P1)
● The towers = white tokens (P2)
● Aim of the army: not being blocked by the towers.
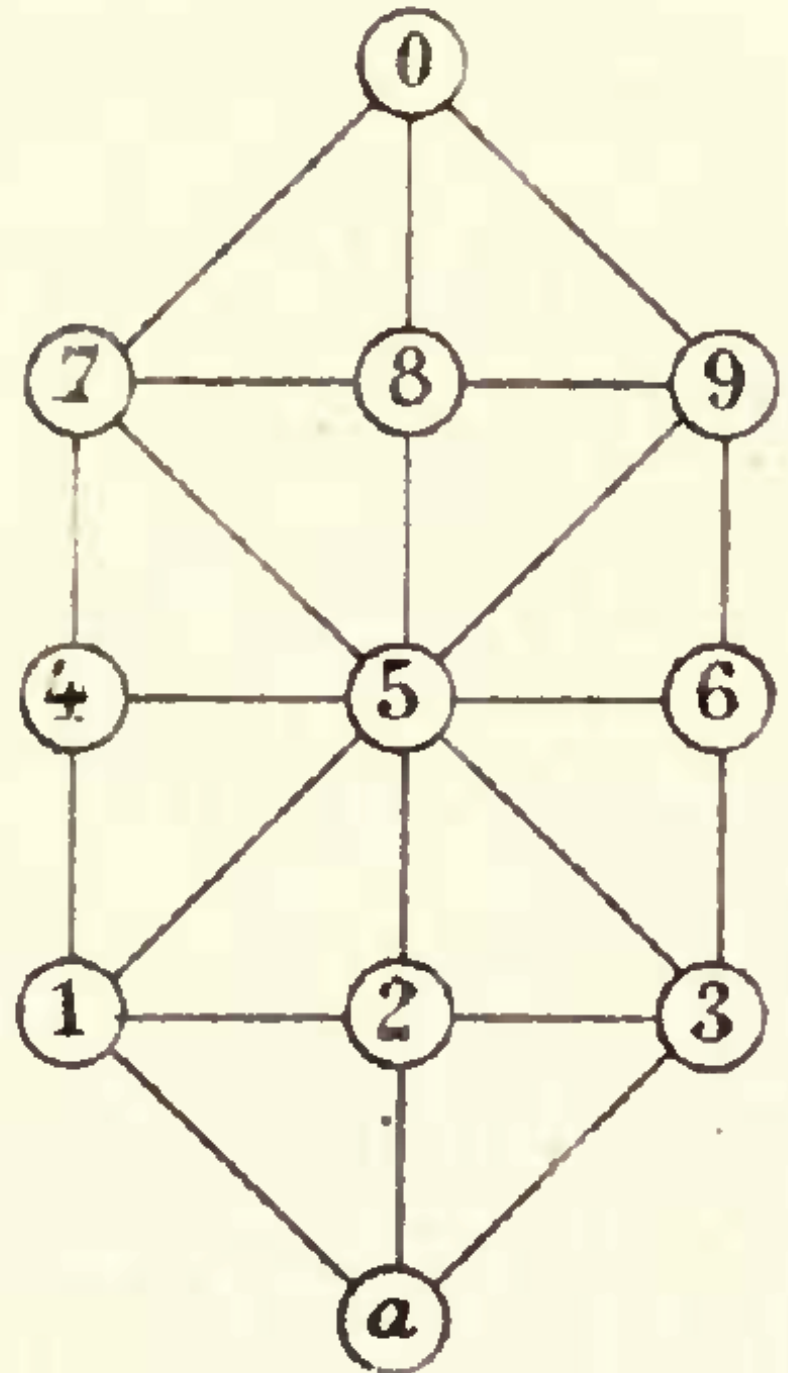● Aim of the towers: block the army.
➢ Moves :
● The army (P1) can move one step in any direction.
● Towers can move on step only forward and laterally (one tower at a time).



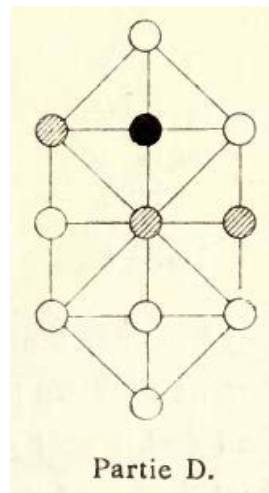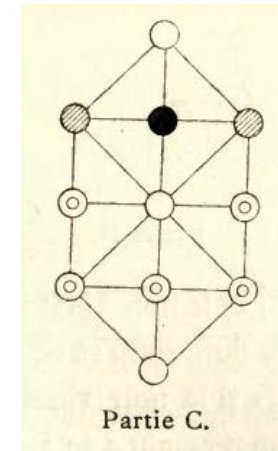Position initiale.



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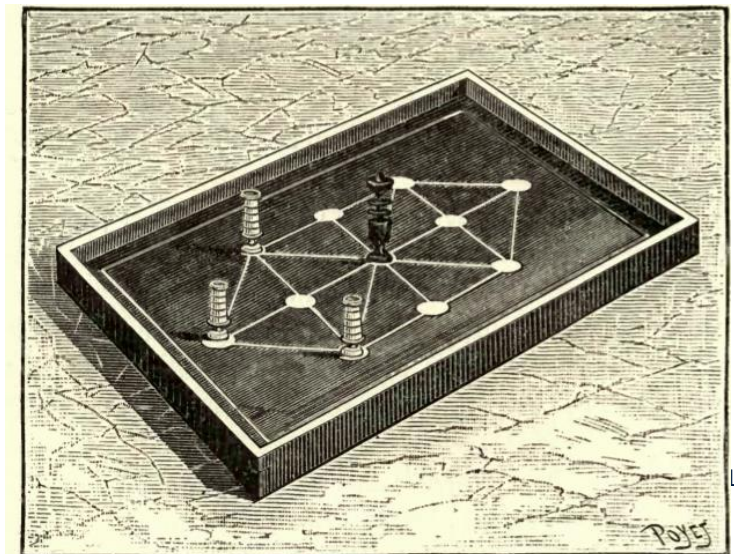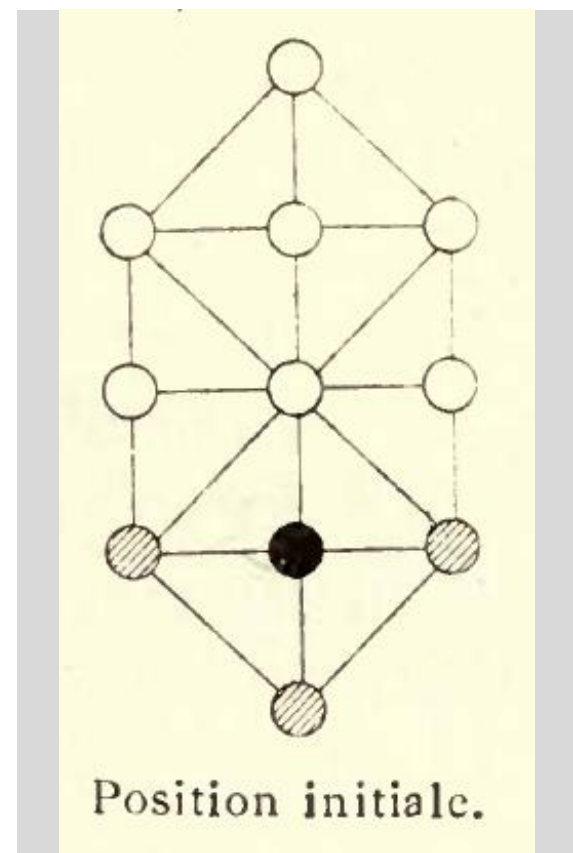
# Historical insight of the FMG

- Positions are numbered.
- Initial position: black on 2 and whites on 1, *a* and 3.
- <u>Notation</u> : 1*a*3 – 2

# Historical insight of the FMG

➢ 7 endgames are identified and completely analyzed by Lucas.



Partie A.



Partie B.



Partie C.



Partie D.



Partie E.



Partie F.

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12
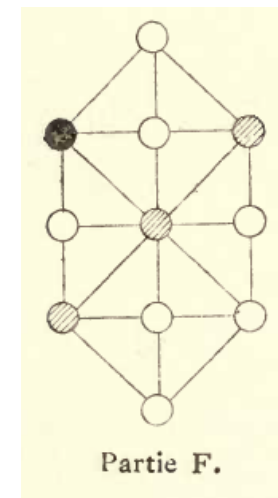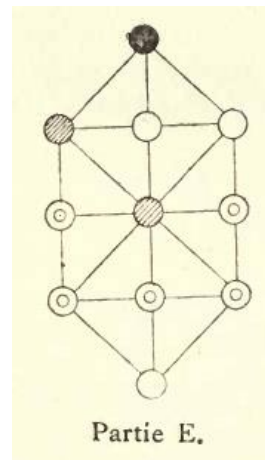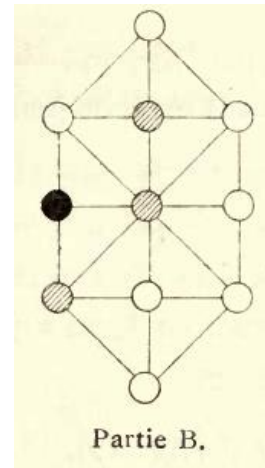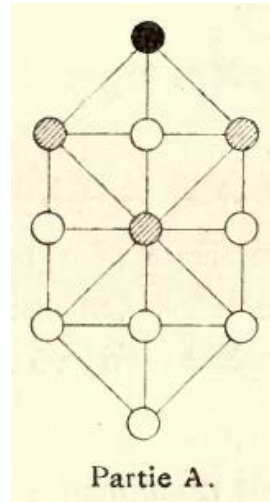
# Historical insight of the FMG

Example 1 : endgame C.



Partie C.

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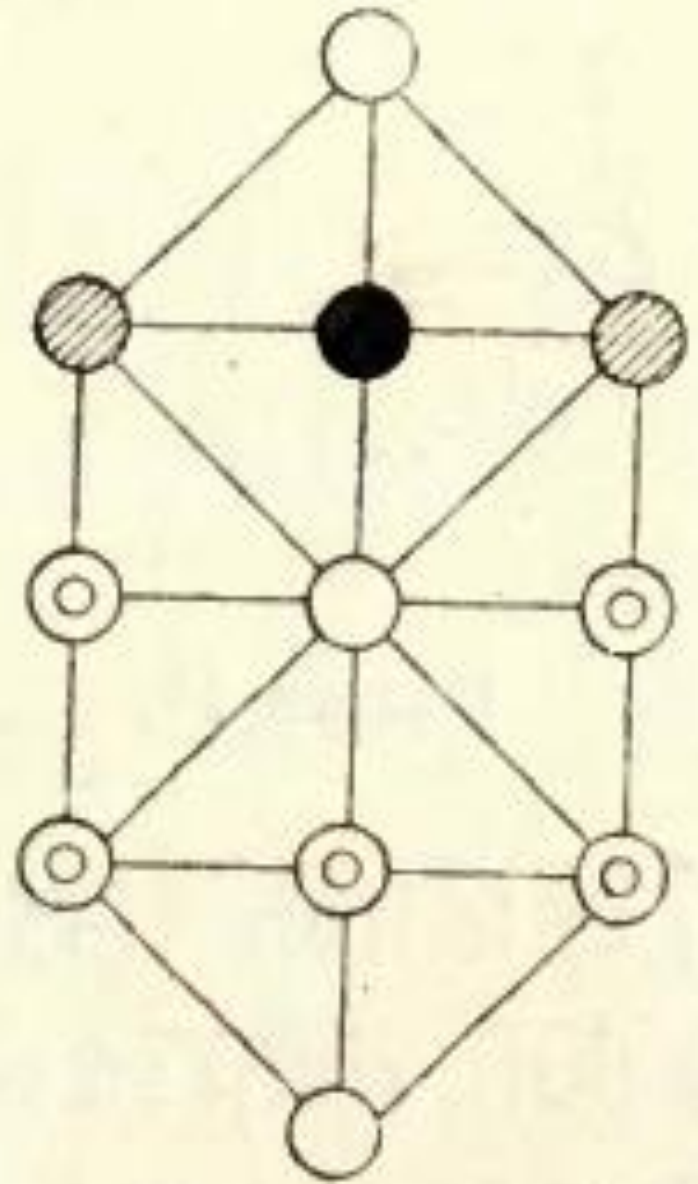
# Historical insight of the FMG

Example 1 : endgame C.
- White wins in two moves.
- (The 3rd tower can be anywhere on the spotted positions.)



Partie C.

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# Historical insight of the FMG

Example 1 : endgame C.

- White wins in two moves.
- (The 3rd tower can be anywhere on the spotted positions.)
- White plays the 3rd tower on the center (5).
- Black plays on 0.
- White moves the tower from 5 to 8.
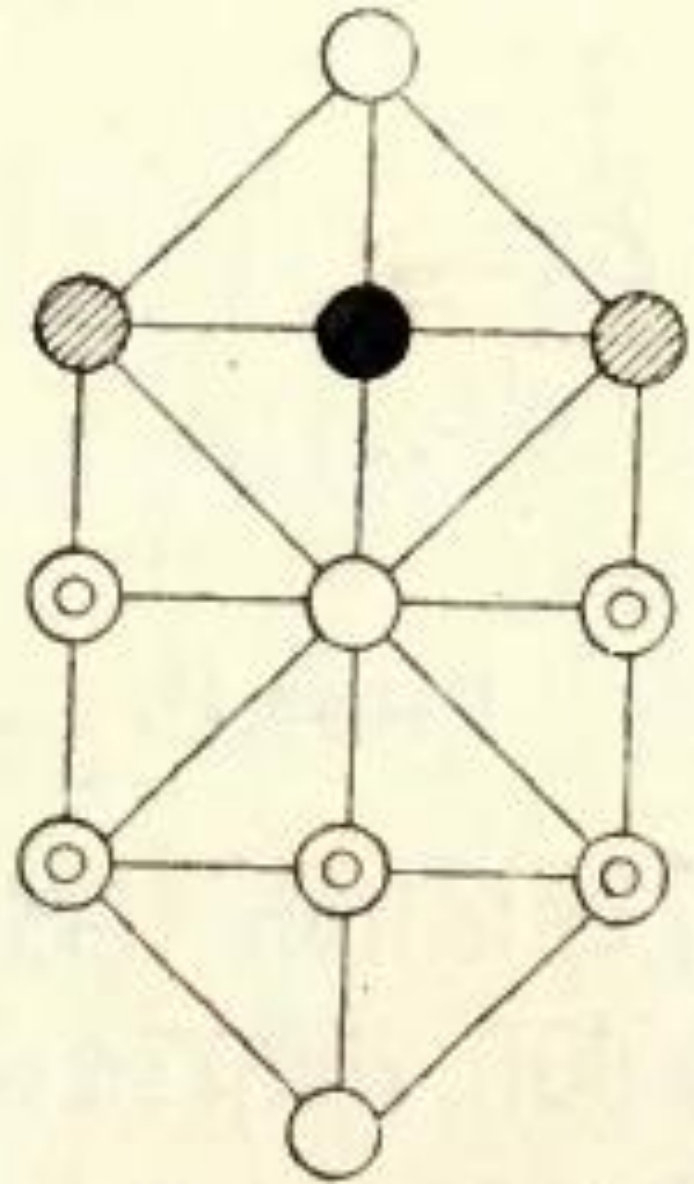
Notation:  179 - 8



Partie C.

Maastricht University
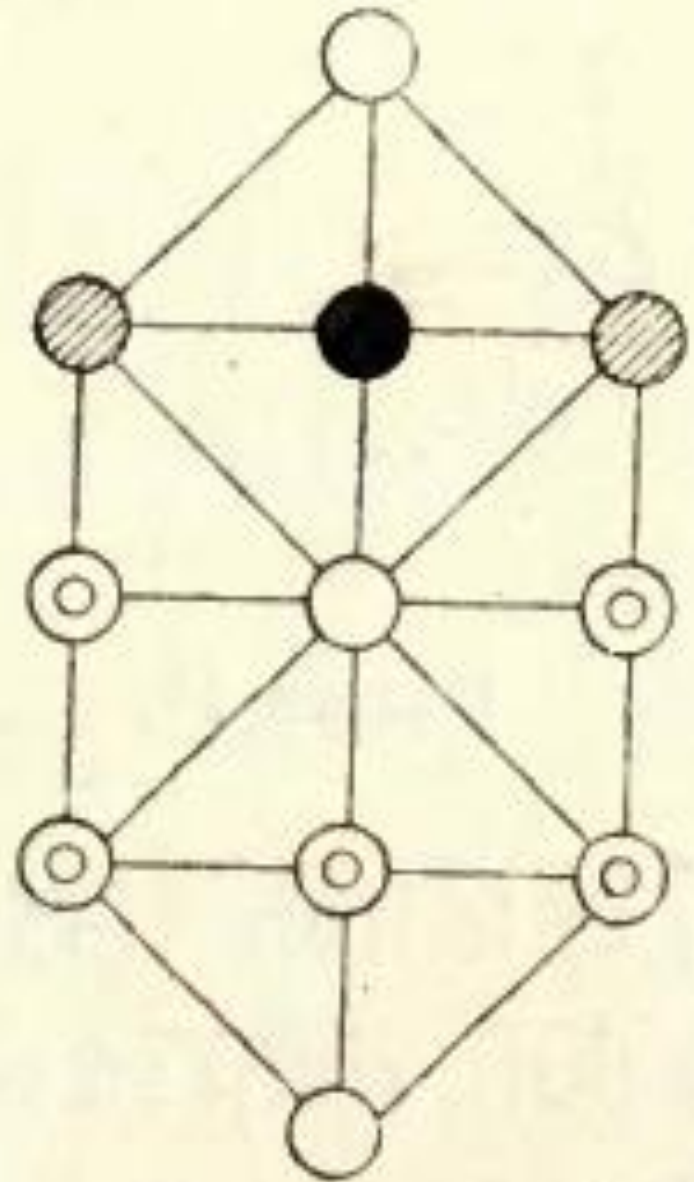
# Historical insight of the FMG

Example 2 : endgame F.



Partie F.

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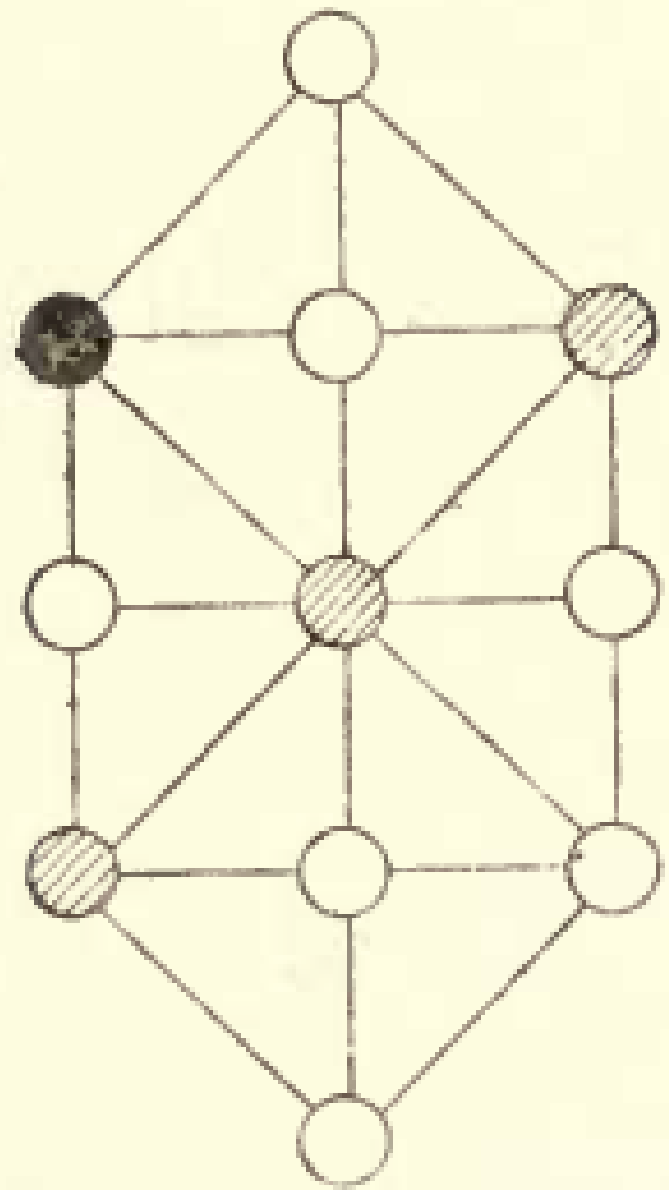
# Historical insight of the FMG

Example 2 : endgame F.

- White wins in three or four moves.



Partie F.

Maastricht University
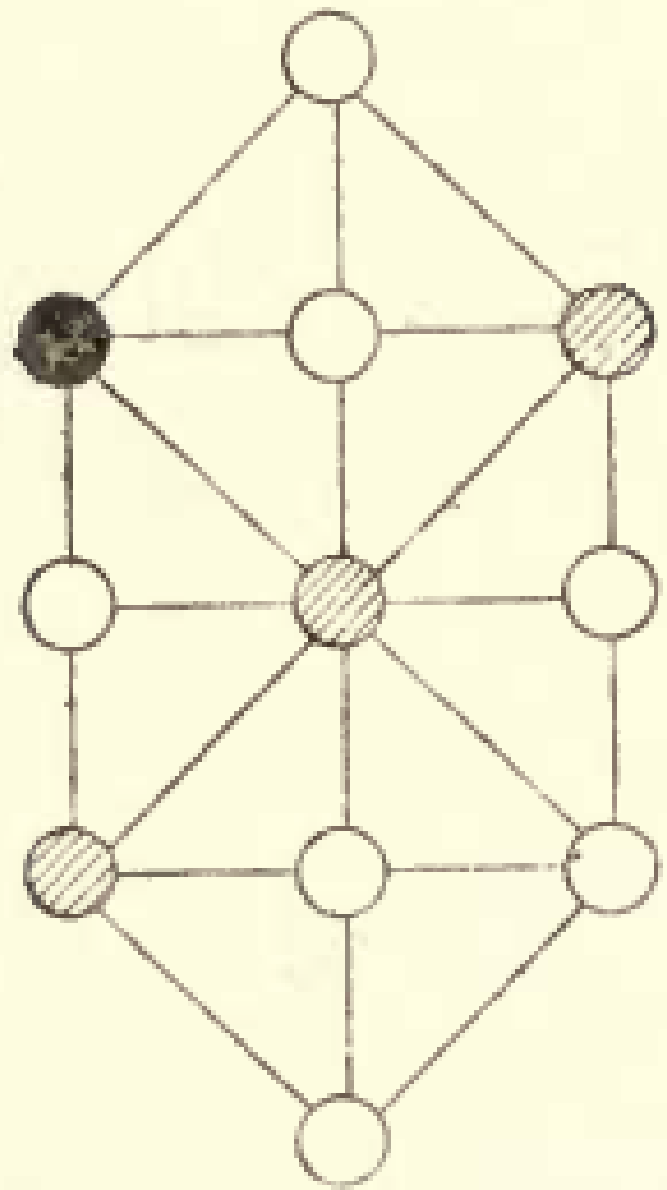
# Historical insight of the FMG

Example 2 : endgame F.

● White wins in three or four
  moves.

$1^59$  7  $4^59$  |  8  $5^79$  o  $7^89$  »  »
              |  o  $4^79$  8  $5^79$  o  $7^89$



Partie F.

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# Historical insight of the FMG

➢ 7 endgames are identified and completely analyzed by Lucas.

➢ Then he provides an array which summarizes all the games.

# Historical insight of the FMG

➤ 7 endgames are identified and completely analyzed by Lucas.

➤ Then he provides an array which summarizes all the games.



« *In few hours we can master the game, and win the prize of hundred "francs" offered by the leaflet as many times as we want. But it's about finding the address of the banker; this problem is more difficult than the previous one.* » (Lucas, 1893)

# Historical insight of the FMG



- 1887 (then 1893) : Lucas' analysis

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# Historical insight of the FMG





- 1887 (then 1893) : Lucas' analysis

- 1943 : Fred Schuh, *Wonderlijke Problemen, Zutphen*: W. J. Thieme & Cie, pp. 189-192. Translated in 1968 in English, reissued in 2015.

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/!\ Black can place his piece wherever he wants at the beginning + White win if Black is blocked on 0…

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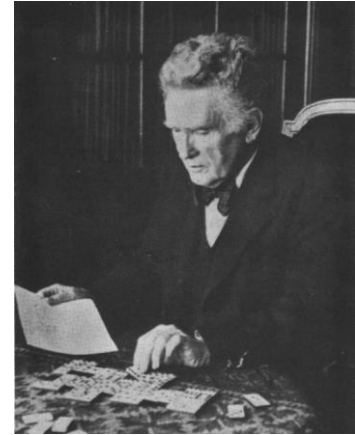
/!\ Black can place his piece wherever he wants at

the beginning + White win if Black is blocked on 0…

→Does it change something? Eric and Ludii will tell

   right now!

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# The Digital Ludeme Project

- Five-year research project since 2018.
- Aim:
  - ➢ Model 1,000 key traditional strategy games.
  - ➢ Single playable database.
  - ➢ Reconstruct missing knowledge.

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# Ludii

- **General Game System** capable of modeling all the games of the DLP project (and more). Currently **670 games implemented**.

- Uses **Ludemes** to describe games. Granular description, break games down corresponding to **game and math concepts**.

- Some Ludii principles:
    - **Clear** = Capacity for the game description to be understable.
    - **Simple** = Short description.
    - **Efficient** = Number of playouts per second.



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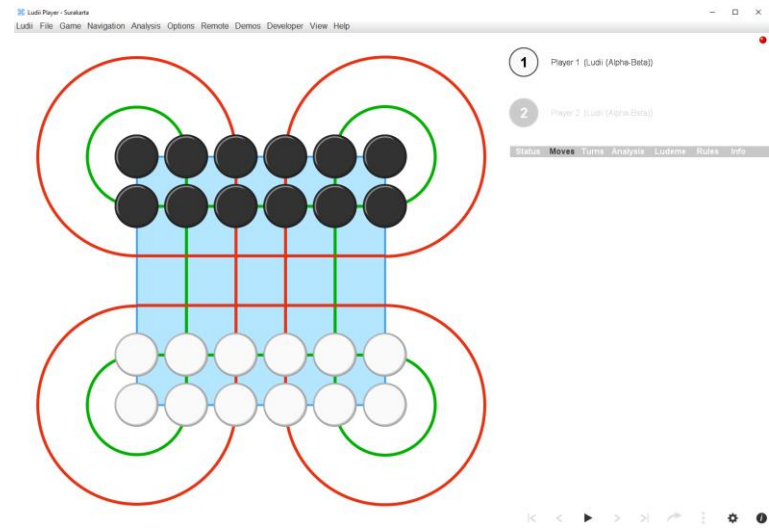
**www.ludii.games**

# Tic-Tac-Toe (TTT) In Ludii
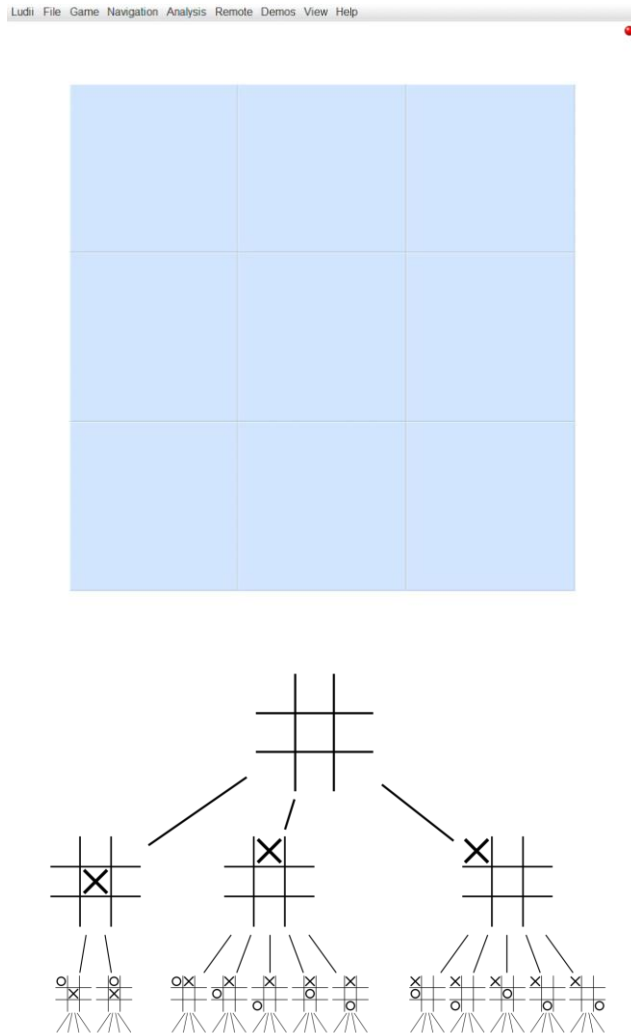


```
(game "Tic-Tac-Toe"
 (players 2)
 (equipment {
    (board (square 3))
    (piece "Disc" P1)
    (piece "Cross" P2)
 })
 (rules
  (play
   (move Add
    (to (sites Empty))
   )
  )
  (end
   (if
    (line 3)
     (result Mover Win)
    )
   )
  )
 )
)
```

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# Analysis of a game with Ludii

- Ludii can estimate in a few minutes different metrics. Examples:
  - Game Length : Avg number of moves per trial. (7 for TTT)
  - Branching factor: Avg legal moves per turn. (4.5 for TTT)
  - Game-tree complexity: Num of possible trials. (10^5 for TTT)

- Strategy analysis, such as forced win.

- Game and Math. concepts involved: ludii.games/searchConcepts.php

# Game Concepts Taxonomy (extract)

▼ 3.3 **Play**: Rules of general play.
  ▼ 3.3.1 **Moves**: Moves.
    ▼ 3.3.1.1 **Add**: Add move.
      3.3.1.1.1 Add Decision: Decide to add pieces.
    ▼ 3.3.1.2 **Step**: Step move.
      3.3.1.2.1 Step Decision: Decide to step.
      3.3.1.2.2 Step To Empty: Decide to step to an empty site.
      3.3.1.2.3 Step To Friend: Decide to step to a friend piece.
      3.3.1.2.4 Step To Enemy: Decide to step to an enemy piece.
    ▼ 3.3.1.3 **Slide**: Slide move.
      3.3.1.3.1 Slide Decision: Decide to slide.
      3.3.1.3.2 Slide To Empty: Slide move.
      3.3.1.3.3 Slide To Enemy: Slide move.
      3.3.1.3.4 Slide To Friend: Slide move.
    ▼ 3.3.1.4 **Leap**: Leap move.
      3.3.1.4.1 Leap Decision: Decide to leap.
      3.3.1.4.2 Leap To Empty: Decide to leap to an empty site.
      3.3.1.4.3 Leap To Friend: Decide to leap to a friend piece.
      3.3.1.4.4 Leap To Enemy: Decide to leap to an enemy piece.
    ▼ 3.3.1.5 **Hop**: Hop move.
      3.3.1.5.1 Hop Decision: Decide to hop.
      3.3.1.5.2 Hop More Than One: Hop more than one site.
      3.3.1.5.3 Hop Enemy To Empty: Hop an enemy to an empty site.
      3.3.1.5.4 Hop Friend To Empty: Hop a friend to an empty site.
      3.3.1.5.5 Hop Enemy To Friend: Hop an enemy to a friend piece.
      3.3.1.5.6 Hop Friend To Friend: Hop a friend to a friend piece.
      3.3.1.5.7 Hop Enemy To Enemy: Hop an enemy to a enemy piece.
      3.3.1.5.8 Hop Friend To Enemy: Hop a friend to an enemy piece.
    ▼ 3.3.1.6 **Sow**: Sowing stones.
      ▼ 3.3.1.6.1 **Sow Effect**: Sowing moves with effect on final hole.
        3.3.1.6.1.1 Sow Capture: Sowing with capture.
        3.3.1.6.1.2 Sow Remove: Sowing with seeds removed.
        3.3.1.6.1.3 Sow Backtracking: Sowing uses backtracking captures.
      ▼ 3.3.1.6.2 **Sow Properties**: Sowing properties.
        3.3.1.6.2.1 Sow Skip: Sowing in skiping some holes.
        3.3.1.6.2.2 Sow Origin First: Sowing in the origin hole first.
        3.3.1.6.2.3 Sow C W: Sowing is performed CW.
        3.3.1.6.2.4 Sow C C W: Sowing is performed CCW.
    ▼ 3.3.1.7 **Bet**: Bet move.
      3.3.1.7.1 Bet Decision: Decide to bet.
    ▼ 3.3.1.8 **Vote**: Vote move.
      3.3.1.8.1 Vote Decision: Decide to vote.
    3.3.1.9 Promotion: Promote move.
    ▼ 3.3.1.10 **Remove**: Remove move.
      3.3.1.10.1 Remove Decision: Decide to remove pieces.
    ▼ 3.3.1.11 **From To**: Move a piece from a site to another.
      3.3.1.11.1 From To Decision: Decide to move a piece from a site to another.
      3.3.1.11.2 From To Within Board: Move a piece from a site to another withing the board.
      3.3.1.11.3 From To Between Containers: Move a piece from a site to another between 2 different containers.
      3.3.1.11.4 From To Empty: Move a piece to an empty site.
      3.3.1.11.5 From To Enemy: Move a piece to an enemy site.
      3.3.1.11.6 From To Friend: Move a piece to a friend site.
    3.3.1.12 Rotation: Rotation move.
    3.3.1.13 Push: Push move.
    3.3.1.14 Flip: Flip move.
    ▼ 3.3.1.15 **Swap Pieces**: Swap pieces move.
      3.3.1.15.1 Swap Pieces Decision: Decide to swap pieces.
    ▼ 3.3.1.16 **Swap Players**: Swap players move.
      3.3.1.16.1 Swap Players Decision: Decide to swap players.
    3.3.1.17 Take Control: Take control of enemy pieces.
    ▼ 3.3.1.18 **Shoot**: Decide to shoot.
      3.3.1.18.1 Shoot Decision: Decide to shoot.
    3.3.1.19 Priority: Some moves are priority.
    3.3.1.20 By Die Move: Each die can correspond to a different move.
    3.3.1.21 Max Moves In Turn: Maximise the number of moves in a turn.
    3.3.1.22 Max Distance: Maximise the distance to move.
    ▼ 3.3.1.23 **Set Move**: Set Moves.
      3.3.1.23.1 Set Next Player: Decide who is the next player.
      3.3.1.23.2 Move Again: Set the next player to the mover.
      3.3.1.23.3 Set Value: Set the value of a piece.
      3.3.1.23.4 Set Count: Set the count of a piece.
    3.3.1.24 Choose Trump Suit: Choose the trump suit.
    ▼ 3.3.1.25 **Pass**: Pass a turn.
      3.3.1.25.1 Pass Decision: Decide to pass a turn.
    3.3.1.26 Roll: Roll at least a die.
    ▼ 3.3.1.27 **Graph Moves**: Graph moves.
      3.3.1.27.1 Set Cost: Set the cost of a graph element.
      3.3.1.27.2 Set Phase: Set the phase of a graph element.
    ▼ 3.3.1.28 **Propose**: Propose a vote.

▼ 3.3.2 **Capture**: Game involved captures.
    3.3.2.1 Replacement Capture: Capture in replacing.
    3.3.2.2 Hop Capture: Capture in hopping.
    3.3.2.3 Hop Capture More Than One: Capture in hopping many sites.
    3.3.2.4 Direction Capture: Capture pieces in a direction.
    3.3.2.5 Enclose Capture: Capture in enclosing.
    3.3.2.6 Custodial Capture: Capture in custodial.
    3.3.2.7 Intervene Capture: Intervene capture.
    3.3.2.8 Surround Capture: Ccapture in surrounding.
    3.3.2.9 Capture Sequence: Capture pieces in a sequence at the end of the turn.
    3.3.2.10 Max Capture: Maximise the number of captures.
  ▼ 3.3.3 **Conditions**: Conditions checked.
    ▼ 3.3.3.1 **Space Conditions**: Space conditions.
      3.3.3.1.1 Line: Line Detection.
      3.3.3.1.2 Connection: Connected regions detection.
      3.3.3.1.3 Group: Detect a group.
      3.3.3.1.4 Contains: Detect if a site is in a region.
      3.3.3.1.5 Loop: Loop detection.
      3.3.3.1.6 Pattern: Pattern detection.
      3.3.3.1.7 Path Extent: Path extent detection.
      3.3.3.1.8 Territory: Territory detection.
      3.3.3.1.9 Fill: Check region filled by pieces.
      3.3.3.1.10 Distance: Check distance between two sites.
    ▼ 3.3.3.2 **Move Conditions**: Move conditions.
      3.3.3.2.1 Stalemate: Detect stalemate.
      3.3.3.2.2 Can Move: Check if a piece (or more) can make specific move(s).
      3.3.3.2.3 Can Not Move: Check if a piece (or more) can not make specific move(s).
    ▼ 3.3.3.3 **Piece Conditions**: Piece conditions.
      3.3.3.3.1 No Piece: No piece detection.
      3.3.3.3.2 No Target Piece: No target piece detection.
      3.3.3.3.3 Threat: Piece under threat detection.
      3.3.3.3.4 Is Empty: Empty site detection.
      3.3.3.3.5 Is Enemy: Occupied site by enemy detection.
      3.3.3.3.6 Is Friend: Occupied site by friend detection.
      3.3.3.3.7 Line Of Sight: Line of sight of pieces used.
    3.3.3.4 Progress Check: Progress condition.
  ▼ 3.3.4 **Directions**: Directions used.
    ▼ 3.3.4.1 **Absolute Directions**: Absolute directions used.
      3.3.4.1.1 All Directions: All directions used.
      3.3.4.1.2 Adjacent Direction: Adjacent directions used.
      3.3.4.1.3 Orthogonal Direction: Orthogonal directions used.
      3.3.4.1.4 Diagonal Direction: Diagonal directions used.
      3.3.4.1.5 Off Diagonal Direction: Off diagonal directions used.
      3.3.4.1.6 Rotational Direction: Rotational directions used.
      3.3.4.1.7 Same Layer Direction: Same layer directions used.
    ▼ 3.3.4.2 **Relative Directions**: Directions used.
      3.3.4.2.1 Forward Direction: Forward direction used.
      3.3.4.2.2 Backward Direction: Backward direction used.
      3.3.4.2.3 Forwards Direction: Forwards direction used.
      3.3.4.2.4 Backwards Direction: Backwards direction used.
      3.3.4.2.5 Rightward Direction: Rightward direction used.
      3.3.4.2.6 Leftward Direction: Leftward direction used.
      3.3.4.2.7 Rightwards Direction: Rightwards direction used.
      3.3.4.2.8 Leftwards Direction: Leftwards direction used.
      3.3.4.2.9 Forward Left Direction: Forward left direction used.
      3.3.4.2.10 Forward Right Direction: Forward right direction used.
      3.3.4.2.11 Backward Left Direction: Backward left direction used.
      3.3.4.2.12 Backward Right Direction: Use backward right direction.
      3.3.4.2.13 Same Direction: Same direction of the previous move used.
      3.3.4.2.14 Opposite Direction: Opposite direction of the previous move used.
  ▼ 3.3.5 **Information**: Information.
    3.3.5.1 Hide Piece Type: Hide piece type.
    3.3.5.2 Hide Piece Owner: Hide piece owner.
    3.3.5.3 Hide Piece Count: Hide number of pieces.
    3.3.5.4 Hide Piece Rotation: Hide piece rotation.
    3.3.5.5 Hide Piece Value: Hide piece value.
    3.3.5.6 Hide Piece State: Hide the site state.
    3.3.5.7 Invisible Piece: Piece can be invisible.
  ▼ 3.3.6 **Phase**: Phases of play.
    3.3.6.1 Num Play Phase (IntegerData): Number of play phases.
  3.3.7 Scoring: Involve scores.
  3.3.8 Piece Count: Many pieces of the same type on a site.
  3.3.9 Sum Dice: Use sum of all dice.
▼ 3.4 **End**: Rules for ending the game.
  ▼ 3.4.1 **Space End**: Space ending rules.
    3.4.1.1 Line End: End in making a line.
    3.4.1.2 Connection End: End if connected regions.
    3.4.1.3 Group End: End in making a group.
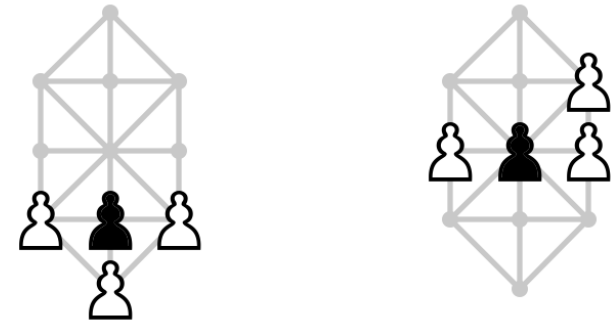    3.4.1.4 Loop End: End in making a loop.

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# FMG in Ludii
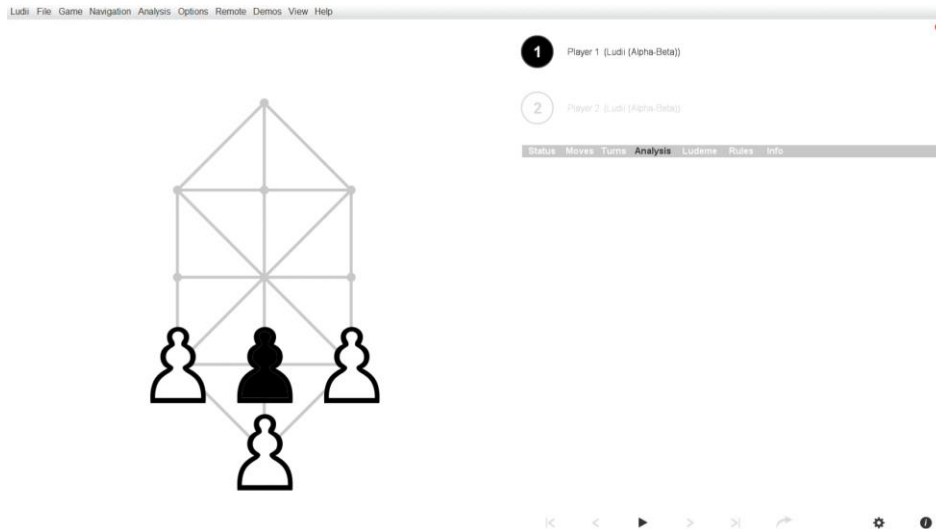


## Forced Win for White (as described by Lucas)

| Estimation | 30s, ~ 800,000 p |
|---|---|
| Game Length | ~18.32 |
| Branching Factor | ~4.22 |
| Game-tree Complexity | 10^11 |

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**French Military Game** (*Hare and Hounds*)

Leaderboard



**Period**

Modern

**Category** Board, Space, Blocking

**Description**

Originated in 19th Century France invented by Édouard Lucas. It is a simple hunt game with a poorly understood history.

**Rules**

The French Military Game is played by two players. One player takes the part of three white towers, the other the part of a single black army piece. First the army moves his piece, then the towers move one of his pieces, play alternating thereafter until the game is ended. A tower piece may move one step along a marked line in any forward or sideways direction. Tower pieces cannot move backwards, diagonally or otherwise, towards the end of the board from which they started. The army may move one step in any direction along a marked line. The army wins by passing the towers and reaching the end of the board from which they started. The towers win by trapping the army so that it cannot move in its turn.

Edourd Lucas, 1887 "La Nature".

These rules were taken from the Default ruleset.

**All Rulesets**

Described rulesets
Default
Gardner Described by M. Gardner.

**Ludeme Description**

French Military Game.lud

**Concepts**

Browse all concepts for French Military Game here.

**Identifiers**

DLP.Games.368

# Concepts analysis of FMG (some extracts)

| Numerical concepts | Value |
|---|---|
| Num Players | 2 |
| Num Playable Sites | 11 |
| Num Columns | 3 |
| Num Rows | 5 |
| Avg Directions | 4 |
| Num Start Components | 4 |
| Num Component Types | 2 |
| Num Top Sites | 1 |
| Num Bottom Sites | 1 |
| Num Right Sites | 3 |
| Num Left Sites | 3 |

| Game concepts |
|---|
| Alternating |
| Pieces placed on Board |
| Step moves |
| Step to Empty |
| Adjacent Directions |
| Forward Directions |
| Leftward Direction |
| Rightward Direction |
| Played on Vertices |
| Reach End |
| Stalemate End |

All concepts here: ludii.games/concepts.php?gameId=368

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# Any Starting Position for Black, Blocked on top (Schuh version)
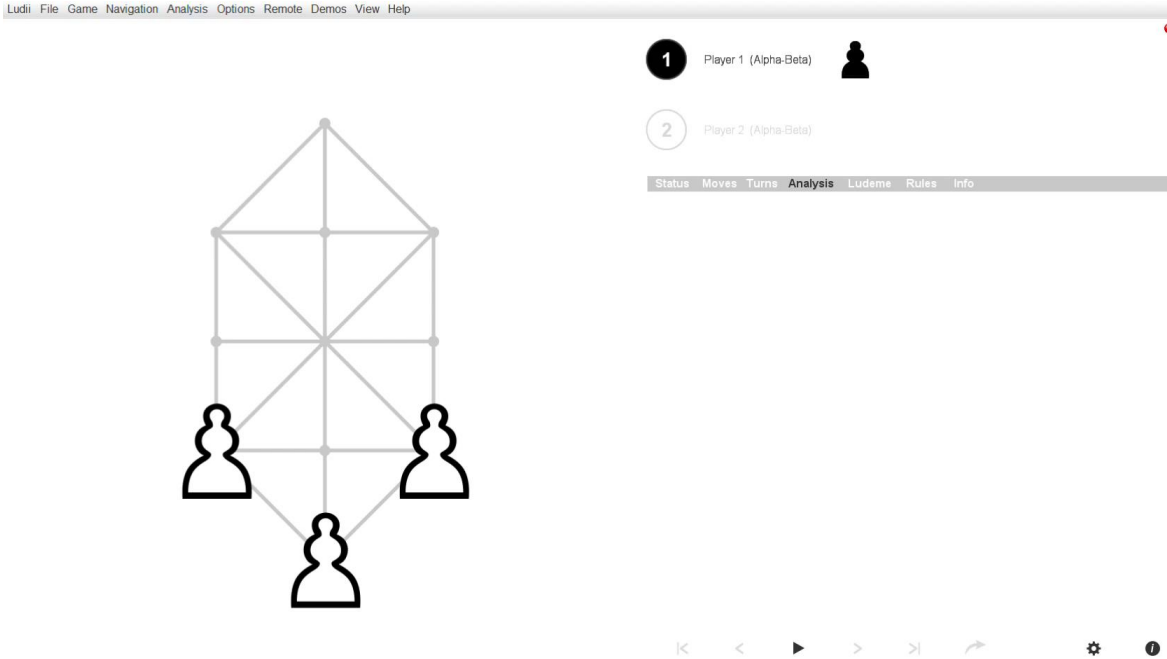


**Forced Win for Black**

| Estimation | 30s, ~ 800,000 p |
|---|---|
| Game Length | ~18.22 |
| Branching Factor | ~4.62 |
| Game-tree Complexity | 10^12 |

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# ALMOST Any Starting Position for Black, Blocked on top
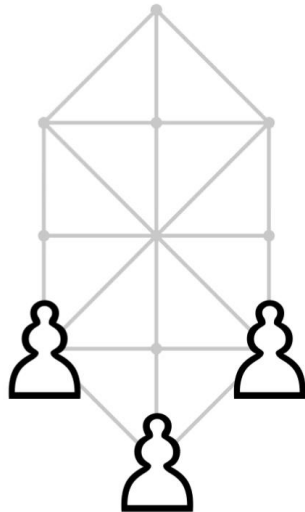


**Forced Win for White**

| Estimation | 30s, ~ 700,000 p |
|---|---|
| Game Length | ~18.34 |
| Branching Factor | ~4.66 |
| Game-tree Complexity | 10^12 |

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# ALMOST Any Starting Position for Black, NOT Blocked on top
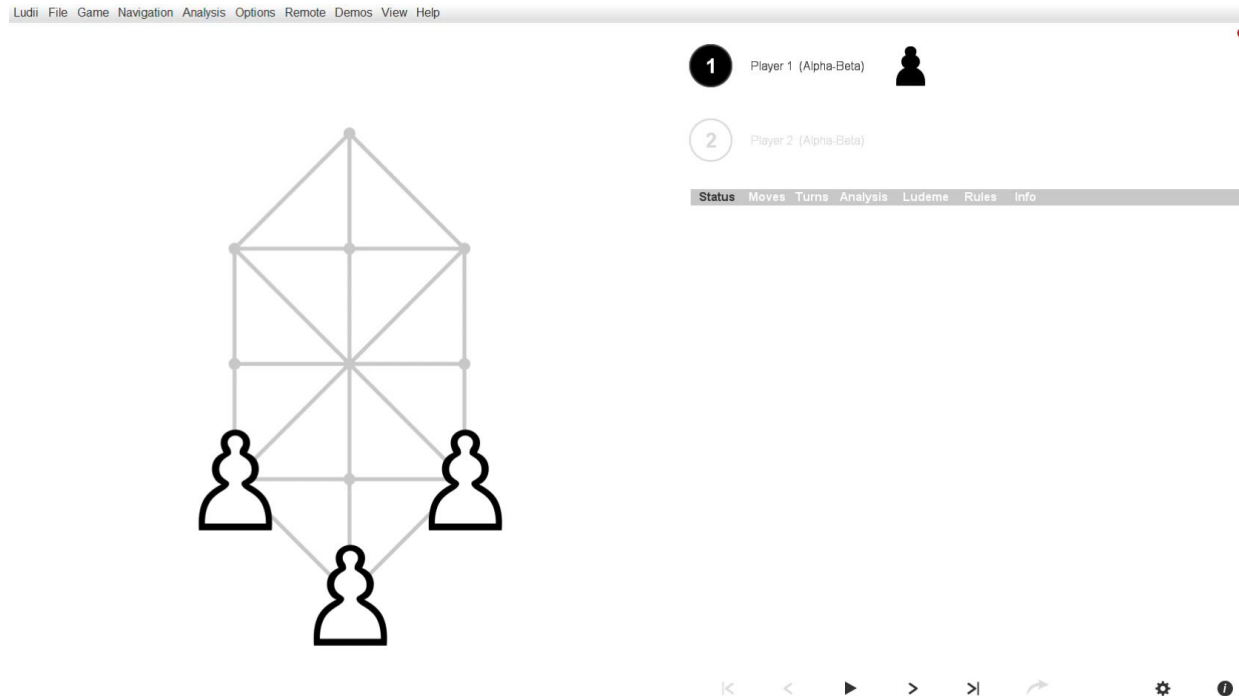


**Forced Win for Black**

| Estimation | 30s, ~ 700,000 p |
|---|---|
| Game Length | ~19.90 |
| Branching Factor | ~4.57 |
| Game-tree Complexity | 10^13 |

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# No Sideway moves for White
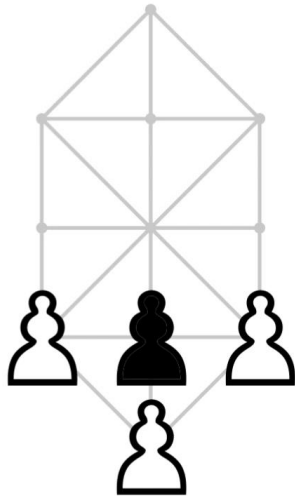


**Forced Win for Black**

| Estimation | 30s, ~ 750,000 p |
|---|---|
| Game Length | ~16.27 |
| Branching Factor | ~3.54 |
| Game-tree Complexity | 10^9 |

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# Similar Games

- Haretavl (Scandinavia)
- Vignone Game (Italy)
- Stenge Reven (Norway)
- La Liebre Perseguida (Spain)
- Janes Soppi (Estonia)
- Jåggå Hårrån pi Tåppin (Norway)
- Hund efter Hare (Denmark)
- Haretavl Horsens (Denmark)
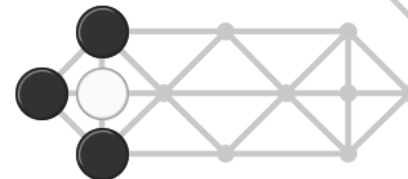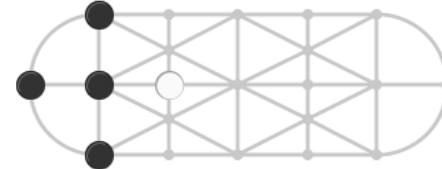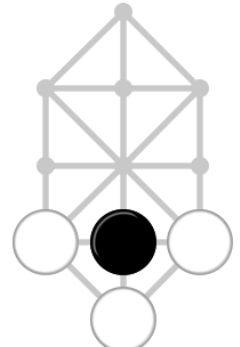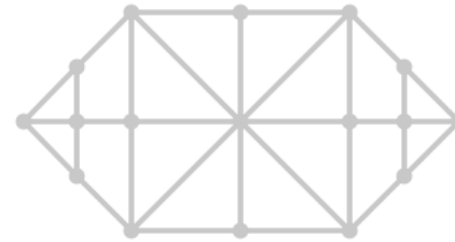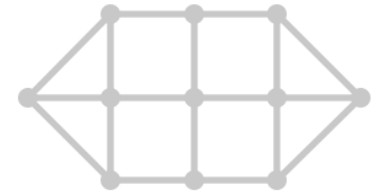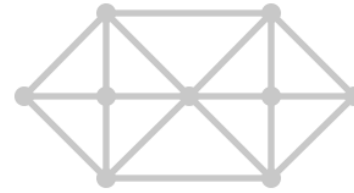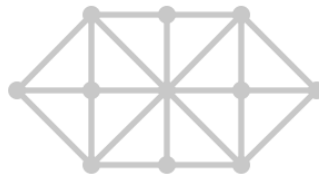
«Michaelsen, P. (2014). "Haretavl - Hare and Hounds as a Board Game." In M. Teichert (ed.), *Sport und Spiel bei den Germanen: Nordeuropa von der römischen Kaiserzeit bis zum Mittelalter*. Berlin: De Gruyter.»

# Haretavl
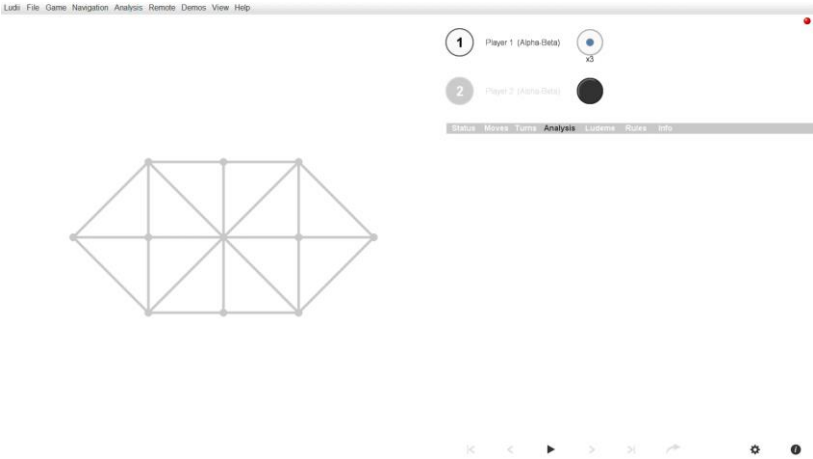


## Forced Win for White

| Estimation | 30s, ~ 20,000 p |
|---|---|
| Game Length | ~1313.24 |
| Branching Factor | ~5.89 |
| Game-tree Complexity | 10^87 |

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**Haretavl** (*Harespil*)

Leaderboard
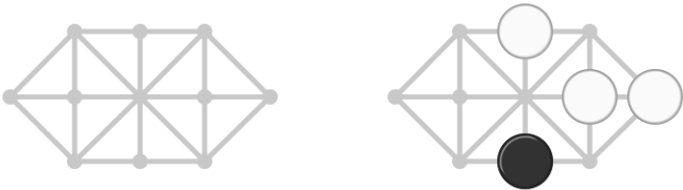


**Period** Modern

**Region** Northern Europe, Western Europe

**Category** Board, Space, Blocking

### Description

Haretavl is a blockade game from Scandinavia. It is documented from the nineteenth century, but older boards which have the same design are known from the Middle Ages, and thus the game may be much older.

### Rules

Square board, divided into eight equal triangles, with the central horizonal line extended past the square on either side and lines connecting the end point to the two nearby cornes of the square One player plays as the hare, the other player as three hounds. Players take turns placing one of their pieces on the board. When a player has placed all their pieces, they move to an adjacent empty spot. When the hounds block the hare from being able to move, the hounds win.

Michaelsen 2014.

### Origin

Scandinavia

### Ludeme Description

Haretavl.lud

### Concepts

Browse all concepts for Haretavl here.

### Reference
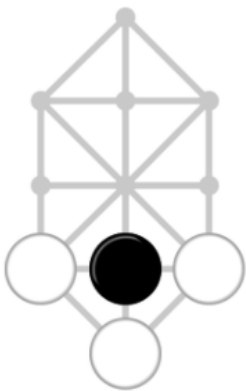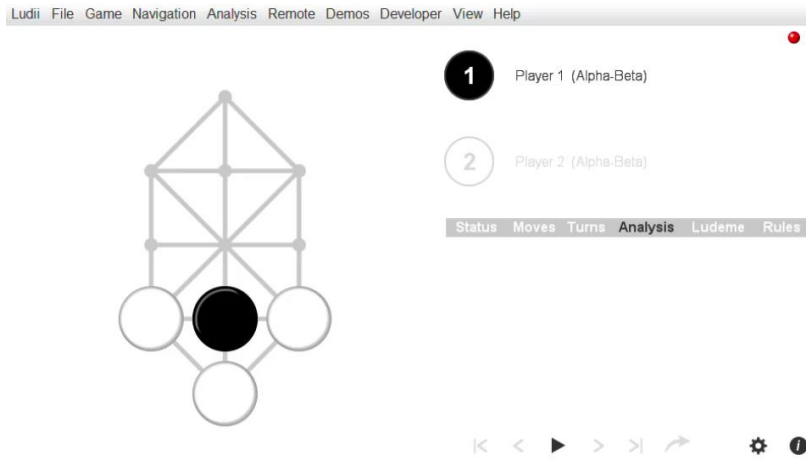
Michaelsen 2014.

# La Liebre Perseguida

## Forced Win for Black

| Estimation | 30s, ~ 750,000 p |
|---|---|
| Game Length | ~16.15 |
| Branching Factor | ~3.54 |
| Game-tree Complexity | 10^9 |

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## Description

La Libre Perseguida is a hunt game played in Spain. One player plays as the hare, and the other as three galgos (Spanish greyhounds).

## Rules

A square, with diagonals and lines connecting the midpoints. Two triangles on opposite sides of the triangle. One player plays as three galgos, which are placed on the three points of one of the triangles. The other player plays as one hare, which begins on the point between two of the galgos. The hare may move in any direction along the lines on the board, but must move to the central point of the board on its first move. The galgos may move forward orthogonally or diagonally; they may never move horizontally and may only move backwards if the galgo which starts on the apex of the triangle has moved and the piece to move backwards has not yet moved. If the galgos block the hare from being able to move, they win, if the hare moves past the galgos it wins.

Hernandéz 1901/1904: 183.

## Origin

Spain

## Concepts

Browse all concepts for La Liebre Perseguida here.

## Reference

Michaelsen 2014: 208.

## Identifiers

DLP.Games.1335

# Reconstruct Games thanks to Math Analysis

**Haretavl (Horsens)**



**Period** Modern

**Region** Northern Europe

**Category** Reconstruction, Board, Hunt

**Description**

This game board was documented in the area of Horsens, Denmark in the nineteenth century. It belongs to a family of boards common throughout the Baltic region that are used for blockade and hunt games.

**Rules**

Four rectangles arranged in a cross shaped board, with a square in the center and triangles on the end of each arm. Diagonals are drawn in each rectangle and the square. Lines are drawn from the apex of a triangle, through the intersections of the diagonals, to the opposite triangle's apex.

DLP evidence

**Origin**

Denmark

**Concepts**

Browse all concepts for Haretavl (Horsens) here.

**Reference**

Mihcselsen 2014: 203-204.

**Jåggå Hårrån pi Tåppin** (*Jagga Harran pi Tappin*)



**Description**

Jåggå Hårrån pi Tåppin is a hunt game played in Norway.

**Rules**

A square, with diagonals and lines connecting the midpoints. Two triangles on opposite sides of the square, with a line drawn from the apex to the midpoint of the base. One player plays as three hounds, the other as a hare. The hounds begin on one triangle of the board, and must trap the hare in the triangle on the opposite end of the board.

**Origin**

Norway

**Concepts**

Browse all concepts for Jåggå Hårrån pi Tåppin here.

**Reference**

Michaelsen 2009: 154.

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# Conclusion and Future Works

- Ludii can validate or help to prove some game analysis.

- Using Mathematical analysis to reconstruct games.

- Making analysis of more traditional games.
  Do you have some ideas of some good examples?

**Please Share** ☺

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# Thank you! Any questions?

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**Digital Ludeme Project**

www.ludeme.eu

DKE

# www.ludii.games

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