

# Impasse – Game and AI – i6306739 – Amit K. Jadhav

**Individual Project for Intelligent Search and Games Course – Sept Oct 2022**

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# Outline

- Impasse Game in Ludii
- Evaluation Function
- Functionalities Implemented
- Playable AIs



# Impasse Game in Ludii

- Play rules – Priority for each piece to move
  - 3 Basic Moves (Single Slide, Double Slide, Transpose)
  - 2 Special Moves (Crown, Bear Off)
- Impasse Move → if no moves for any piece
- Boundary conditions – 2 crownable pieces, Compound moves (Slide + Bear Off + Crown, Impasse + Crown)

# Evaluation Function

- Material Score (#Opponent Pieces – #Own Pieces)
- Position Score *(ref supporting material – slides 9 to 11)*
- Blocking Score *(ref supporting material – slides 9 to 11)*
- Random Element
- Player-To-Move Score

*(supporting material here)*

# Functionalities & Enhancements Implemented

- Minimax (*not Negamax*)
- Alpha Beta Pruning
- Iterative Deepening
- Move Ordering
- Transposition Table (using the existing Data structure from Ludii AI Resources)
- Adaptive Time Control
- Enhanced Evaluation
- Aspiration Window

# Playable AIs

- **AI1** – (Minimax + AB)
- **AI2** – AI1 + (Iterative Deepening + Move Ordering + Transposition Table + Enhanced Evaluation)
- **AI3** – AI2 + (Adaptive Time Control for Iterative Deepening)
- **AI4** – AI3 + (Aspiration Window)

# Referred Material

- [T. Marsland 1986](#) (A review of Game tree Prunings)
- [Ludii & LudiiAI Github](#) repositories by Eric/Dennis
- Impasse Game by Mark Steere  
([https://www.marksteeregames.com/Impasse\\_rules.pdf](https://www.marksteeregames.com/Impasse_rules.pdf))
- Ludii Portal (<https://ludii.games/>)

# THANK YOU



# My Evaluation Logic

**Handwritten Evaluation Logic:**

**Top Left:** A list of numbers (1-15) and letters (A-E) arranged in a grid-like pattern, possibly representing a game state or a sequence of moves.

**Top Center:** A small diagram showing a square with a circle inside, labeled with '0' and '1'.

**Top Right:**

- ~~Crown~~ → max reduction
- ~~(7)~~
- min reduction (1)

**Center:** A 4x4 grid with dots, representing a game board. Arrows point from the grid to the following calculations:

- 21 (2) = 42
- 20 (2) = 40
- 13 (2) = 26
- 14 (2) = 28

**Right Side:**

- 136 (-7)
- Endgame
- Impasse
- 129 to win

**Bottom Left:**

- 526 = 1x1x2x2x3x3x4x4
- 408 = 1x2x3x3x4x4x4x4
- 614 = 1x2x3x3x4x4x4x4
- 2304 = 1x2x2x3x3x4x4x4

**Bottom Center:**

- Slide
- range → max reduction
- min reduction (1)
- max reduction (14)

**Bottom Right:**

- Bedroff → max reduction
- (7)
- min reduction (1)

**Bottom Left (Calculation):**

- 13632
- paths possible to tally slides pieces of player

**Bottom Right (Calculation):**

- 1 turn - 7 paths = 1 way
- 2 turns  $\frac{6}{1}$  paths = 3 ways
- 2 turns  $\frac{5}{2}$  paths = 5 ways
- 2 turns  $\frac{3}{4}$  paths = 5 ways
- 3 turns  $\frac{1}{3}$  paths = 5 ways

# Positional Penalties per Piece Type

Row No.	Board Square Locn.	WS	WD	BS	BD	
7	57, 59, 61, 63	NA	21	14	NA	WS $\equiv$ White Single
6	48, 50, 52, 54	8	20	13	15	WD $\equiv$ White Double
5	41, 43, 45, 47	9	19	12	16	BS $\equiv$ Black single
4	32, 34, 36, 38	10	18	11	17	BD $\equiv$ Black Double.
3	25, 27, 29, 31	11	17	10	18	
2	16, 18, 20, 22	12	16	9	19	
1	9, 11, 13, 15	13	15	8	20	
0	0, 2, 4, 6	14	NA	NA	21	

NOTE:- The penalties for each position have been listed in the left side table.

$\swarrow$   
 $(14 - i // 8)$

$\downarrow$   
 $(14 + i // 8)$

$\downarrow$   
 $(7 + i // 8)$

$\swarrow$   
 $(21 - i // 8)$

# 1 Sample Manually Scored Game – Ludi AI Vs. MCTS Hybrid

MANUAL SAMPLE GAME-PLAY TESTING OF MY EVALUATION							
LUDI AI VS. MCTS HYBRID							
Move No.	Score	W/B	W/B	Move No.	Score	W/B	Move No.
1	4/4	33	2/4	1	4/4	75/66	33
2	4/1	34	2/2	2	8/5	72/68	34
3	4/4	35	3/2	3	12/9	80/70	35
4	1/2	36	1/2	4	13/11	81/72	36
5	4/2	37	1/4	5	17/13	82/76	37
6	3/1	38	4/2	6	20/14	86/78	38
7	5/1	39	3/4	7	25/15	89/82	39
8	2/1	40	3/1	8	27/16	92/83	40
9	2/2	41	2/1	9	29/18	94/84	41
10	5/2	42	2/1	10	34/20	96/85	42
11	1/2	43	4/7	11	35/22	100/92	43
12	2/1	44	2/1	12	37/23	102/93	44
13	1/1	45	2/4	13	38/24	104/97	45
14	3/1	46	1/7	14	41/25	105/104	46
15	2/3	47	3/5	15	43/28	108/109	47
16	1/3	48	4/2	16	44/31	112/111	48
17	2/2	49	3/5	17	46/33	115/116	49
18	1/1	50	1/1	18	47/34	116/117	50
19	1/2	51	1/1	19	48/36	117/118	51
20	1/2	52	1/5	20	49/38	118/123	52
21	3/3	53	1/2	21	52/41	119/125	53
22	3/1	54	5/6	22	55/42	124/131	54
23	1/1	55	4/1 W	23	56/43	128/Win	55
24	3/1	56		24	59/44		
25	1/2	57		25	60/46		
26	1/1	58		26	61/47		
27	1/3	59		27	62/50		
28	2/3	60		28	64/53		
29	4/3	61		29	68/56		
30	2/2	62		30	70/58		
31	1/2	63		31	71/60		
32	2/2	64		32	73/62		