Game Theory Second Practice Test Report

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Abstract—**Article provides the overview of the algorithm which is used by the final agent to play the Snowball fight and a statistics of our agent against other agents within the tournaments.**

Index Terms—**N-minutes-period Agent (*NMP*), Calm-Anger Agent (*CA*), Calm-Until-Last-Minute Agent (CULM)**

I. INTRODUCTION

A. Goal of the project

Our goal was to implement an agent in Java (JDK 17) to play the Snowball fight game in tournament between course students. In each play, the fight is played between two opponents. The winner of the play is the agent who has smaller number of snowball on his play filed. However, we needed to implement an agent to win the game tournament between almost 60 other agents of other students.

Several agents were implemented and tested in tournaments between them, and the most preferred one was chosen as the **final agent** for the Practice Test outcome.

B. Kinds of Agents

- **N-minutes-period Agent** (*NMP*)- agent who shoots to the opponent field each N minutes.
- **Calm-Anger Agent** (*CA*) - agent who shoots each 4 minutes. It shoots to hot filed from the start unless opponent shoots in our agent's field (in this case *CA* starts to shoot to the opponents field till the end of the play). On the last minute of the play it always shoots to the opponents field.
- **Calm-Until-Last-Minute Agent** (*CULM*) - agent who shoots to the hot field each 4 minutes. On the last minute of the play it always shoots to the opponents field.

NOTE: In tables they are mentioned like N_i (e.g. 4_0), CA_i, $CULM_i$.

II. FINAL AGENT OVERVIEW

Final agent is *CULM* Agent.

A. Function of Snowballs

The maximum number of snowballs the agent can throw depends on how much minutes passed after the last agent's shot and defined by equation:

$$f(x) = \left\lfloor \frac{15 \times e^x}{15 + e^x} \right\rfloor \tag{1}$$

B. Algorithm of Agent

My **final agent** is *CULM* Agent. The agent shoots to the hot field when it gets information that 4 minutes passed from its last shot. On the last minute of the play it always shoots to the opponents field.

III. TESTING

A. N-minutes-period Agents

First, let us analyze the maximum number of snowballs **per shot** any agent can throw (Fig. 1).
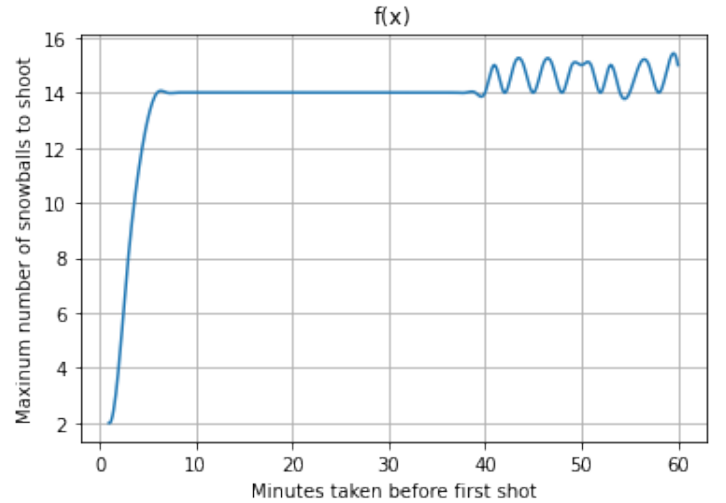

Fig. 1. Maximum number of snowballs per shot depending on minutes passed after last shot.

It is obvious agent does not need to wait more than 6 minutes, since it will not be able to throw its snowballs so

often as it can with strategy of waiting for 6 minutes (but shots contain almost the same number of snowballs).

Second, let us analyze the maximum number of snowballs that can be thrown **during one play** (Fig. 2).
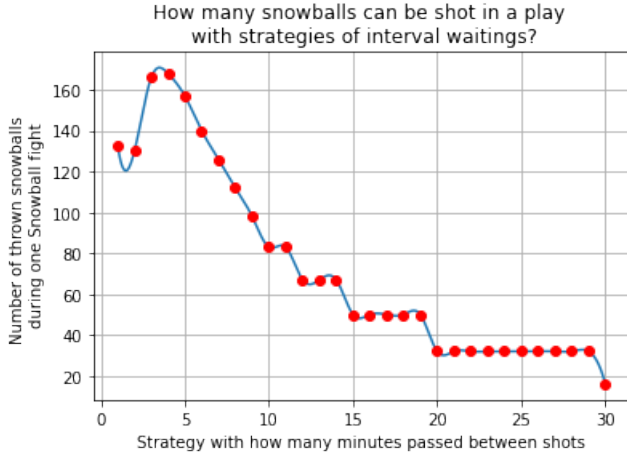

Fig. 2. Maximum number of snowballs per play with strategies of minutes passed after last shot.

From the graph it is obvious that the agent will be able to throw more snowballs using the strategy when it waits for 4 minutes between shots. But we need to see it in the tournament between agents (Table I) which confirms this.

TABLE I
TOURNAMENT TABLE BETWEEN NMPs

	1_0	2_0	3_0	4_0	5_0	6_0	7_0	8_0	9_0	10_0
1_0		160	198	204	196	181	165	151	140	126
2_0	160		198	204	196	181	165	151	140	126
3_0	122	122		166	158	143	127	113	102	88
4_0	116	116	154		152	137	121	107	96	82
5_0	124	124	162	168		145	129	115	104	90
6_0	139	139	177	183	175		144	130	119	105
7_0	155	155	193	199	191	176		146	135	121
8_0	169	169	207	213	205	190	174		149	135
9_0	180	180	218	224	216	201	185	171		146
10_0	194	194	232	238	230	215	199	185	174	

And the scores - snowballs that stays in the field after all plays (Table II).

TABLE II
NUMBER OF ALL SNOWBALL IN THE FIELD OF THE AGENTS AFTER ALL PLAYS

	Number of balls after all plays	Rating place
1	1521	6
2	1521	7
3	1141	2
4	1081	1
5	1161	3
6	1311	4
7	1471	5
8	1611	8
9	1721	9
10	1861	10

B. Calm-Angry Agent

Does it succeed more in the game than the best *NPM* agent?

Let us consider a fight between Calm-Angry Agent and 4-minutes-period Agent:

TABLE III
CALM-ANGRY AGENT VS. 4-MINUTES-PERIOD AGENT

	CA_0	4_i
CA_0		160
4_i	152	

So it is obvious that *CA* Agent is worse if it is the only such agent in the tournament. And what if we have at least 2 *CA* Agents and several best 4-minutes-period Agents?

TABLE IV
TOURNAMENT TABLE BETWEEN AGENT

AGENTS	CA_0	CA_1	4_0	4_1	4_2	4_3	
CA_0		1	160	160	160	160	641
CA_1	1		160	160	160	160	641
4_0	152	152		160	160	160	784
4_1	152	152	160		160	160	784
4_2	152	152	160	160		160	784
4_3	152	152	160	160	160		784
							total

As we can see from the result Table IV, having one more *CA* Agent allows to win the the whole tournament.

Finally, if we have 60 4-minutes-period Agents and 2 *CA* Agents, the last ones will win the whole tournament. Their score is 9606, when 4-minutes-period Agents one is 9738.

C. Calm-Until-Last-Minute AgenT

How can *CULM* Agent influence result of the tournament?

TABLE V
NUMBER OF ALL SNOWBALL IN THE FIELD OF THE AGENTS AFTER ALL PLAYS

	Number of balls after all plays	Rating place
$CULM_0$	960	1
$CULM_1$	960	1
CA_0	978	2
CA_1	978	2
4_0	1116	3
4_1	1116	3
4_2	1116	3
4_3	1116	3
4_4	1116	3
4_5	1116	3

From Table V we can see *CULM* can help to *CA* Agent and they will be at the top of the tournament.

But who is better then (Table VI)?

Of course, *NMP* is more efficient when there only 1 *CULM* and/or *CA*, but it will be less efficient if there are few agents of each type.

TABLE VI
CA vs. CULM vs. NMP$_4$

	CULM	CA	4
CULM		6	157
CA	6		160
4$_i$	9	149	

IV. TEST FILE

For the testing of agents I used the *"AndreyStarodumovTesting.java"* file where we are able to change the amount of agents and their types using the function **definePlayers()** of the **AndreyStarodumovTesting** class.

To test agents there was created **TestAgent** which is the common class for *NPM*, *CA*, and *CULM* Agents depending on parameter used for the constructor.

V. CONCLUSION

In the tournament between all students, it is not obvious which agent should we use. But let us suppose that there will be several *CA* and *CULM* Agents in the tournament. In such way *CULM* Agent will be able too cooperate with this ones and be at the top of the tournament. Is it risky? Yes. But it's worth.