



The Geometry Friends Game AI Competition

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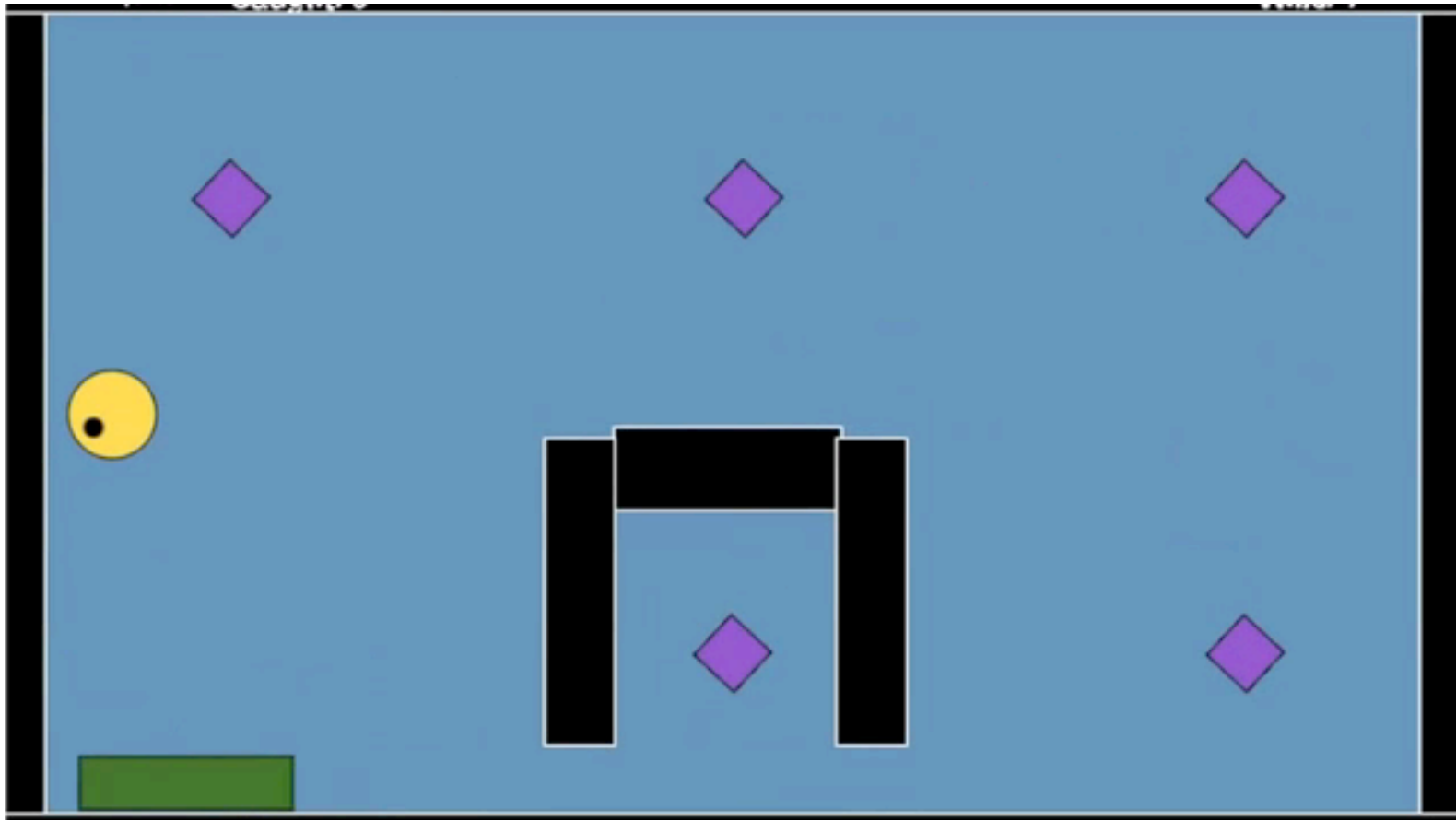
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INESC-ID

Research Vision

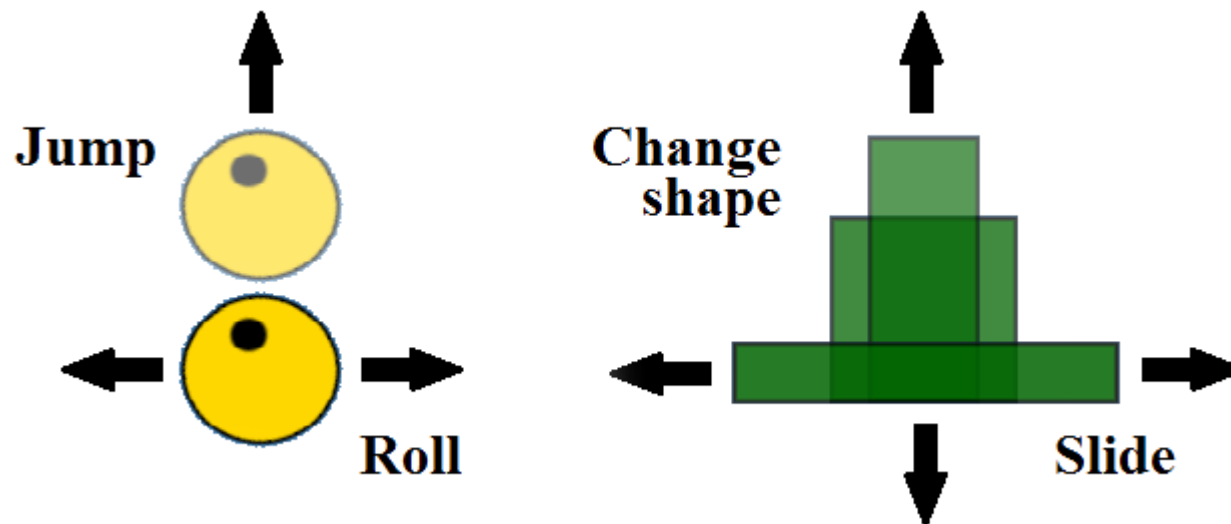
- Define a framework to foster research on collaborative game AI
- Support collaborative gameplay experiences
- Engaging humans and agents together

Geometry Friends Gameplay



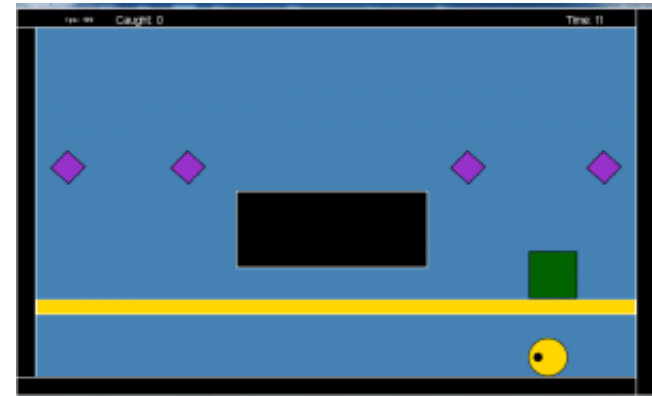
The Game

- 2 players physics-based puzzle platformer
- Two characters: the circle and the rectangle



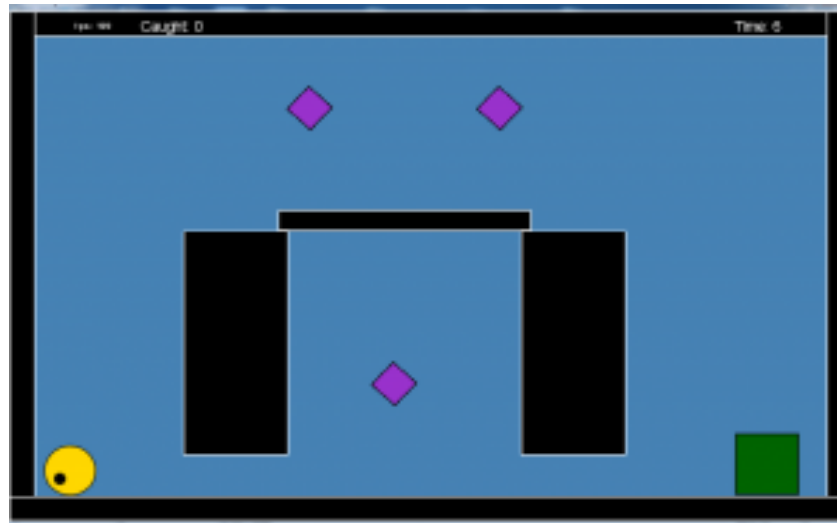
The Environment

- 2D world with physics
 - Attrition and gravity
 - “Realistic” collisions
 - with mass and spin
- Platforms
 - Black, Yellow and Green
 - Different colour blocks movement
- A set of of diamonds (collectibles)



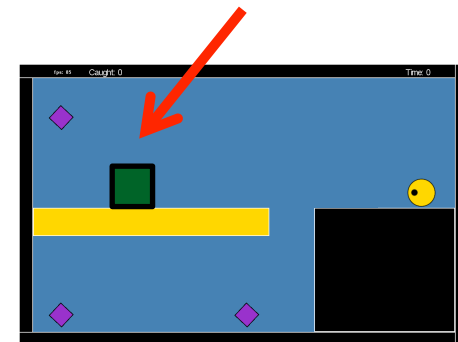
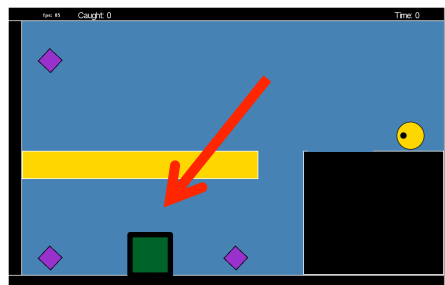
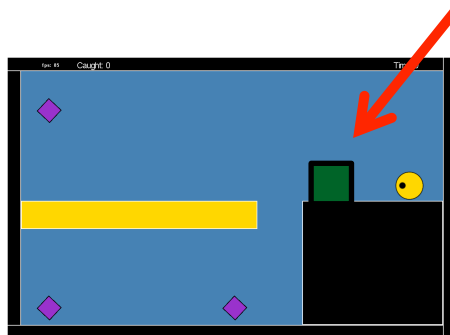
The Goal

- To collect all diamonds in the least amount of time

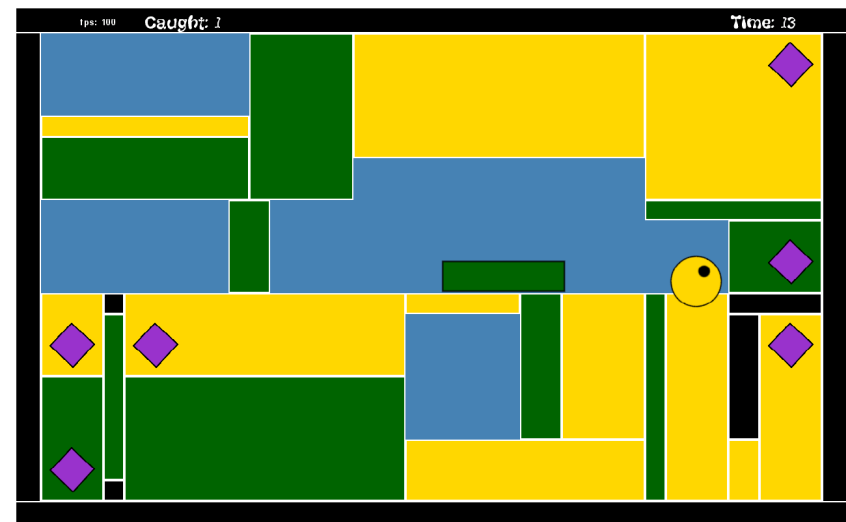
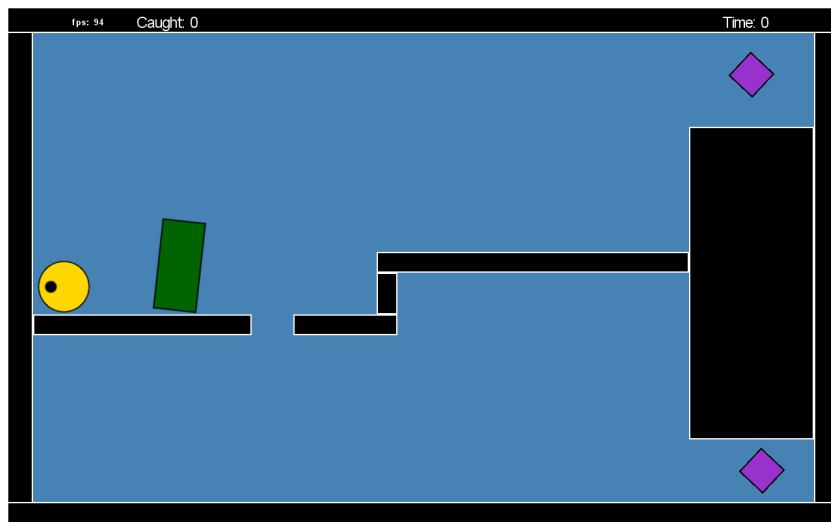
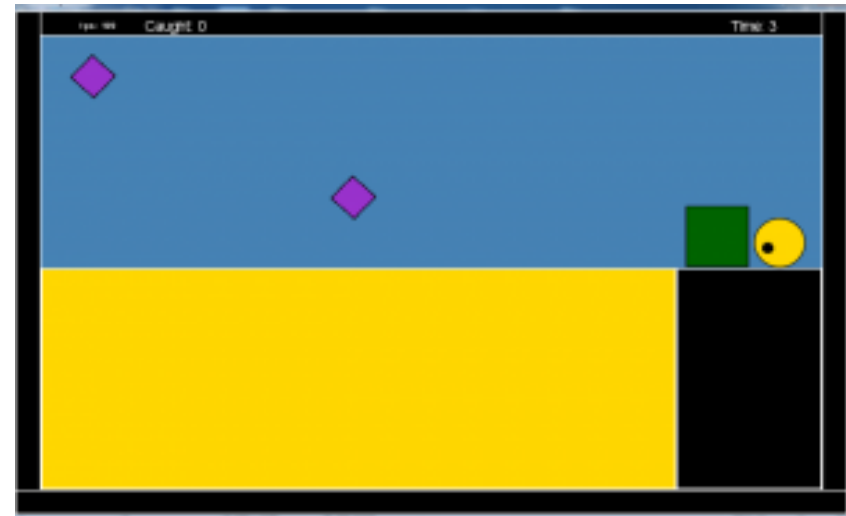
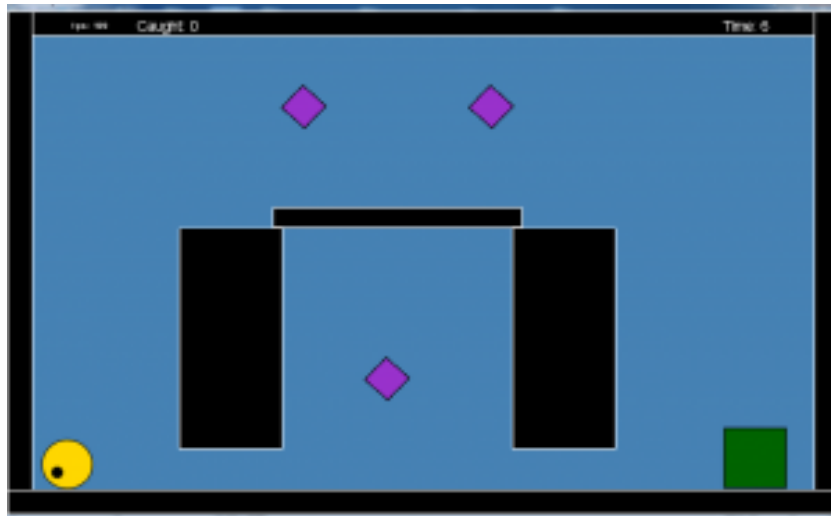


Geometry Friends Levels

- A level is:
 - The four walls
 - A set of (coloured) platforms
 - A set of collectibles
 - The initial position of the characters
 - The time limit



Sample Levels



AI Framework

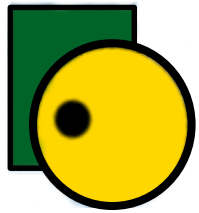
- Sensors
 - Platforms: position and colour
 - Collectibles: position
 - Characters: current position and velocity
 - Level: time and number of collected diamonds
- Actuators: on/off force switches
 - Circle: roll left, roll right, jump
 - Rectangle: slide left, slide right, morph up, morph down

Challenges for the AI in GF

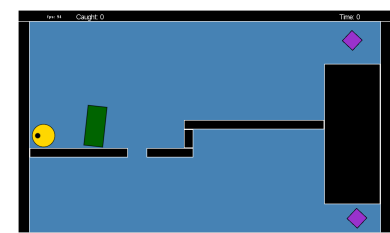
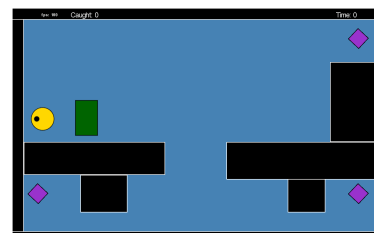
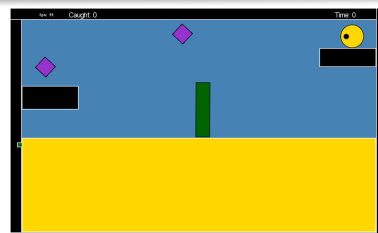
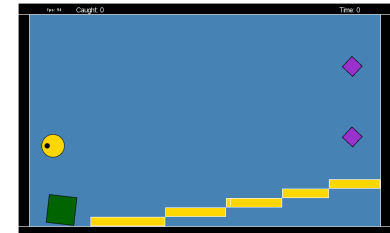
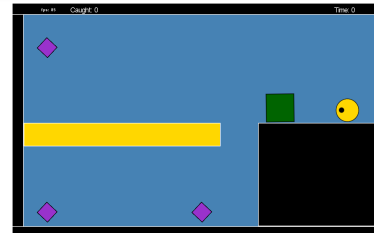
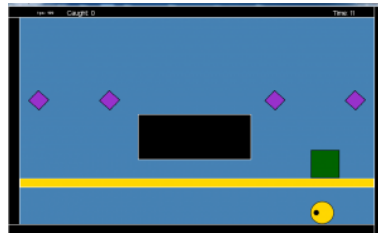
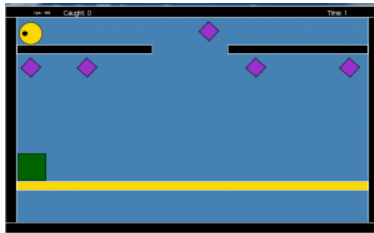
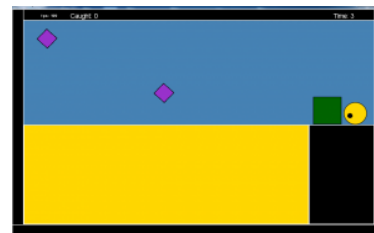
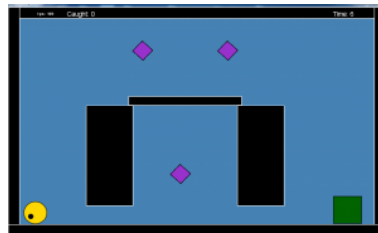
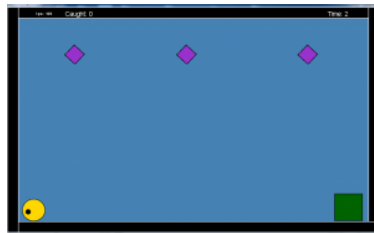
- Collaborative combined task and motion planning
 - Devise collaborative plans
 - Determine the order of collectibles, assign to characters, identify joint action points
 - Devise motion control plans
 - Determine actuators' activation timeline, coordinate with the other character
- Do the above in real-time

The Competition

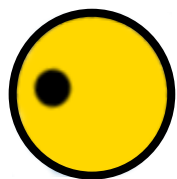
- Started in 2013 (at CIG Niagara Falls, Canada)
- 3 Tracks
 - Cooperation (main track)
 - Two AI agents
 - Single player
 - Rectangle
 - Circle
- Each track includes 10 levels
 - 5 public and 5 private



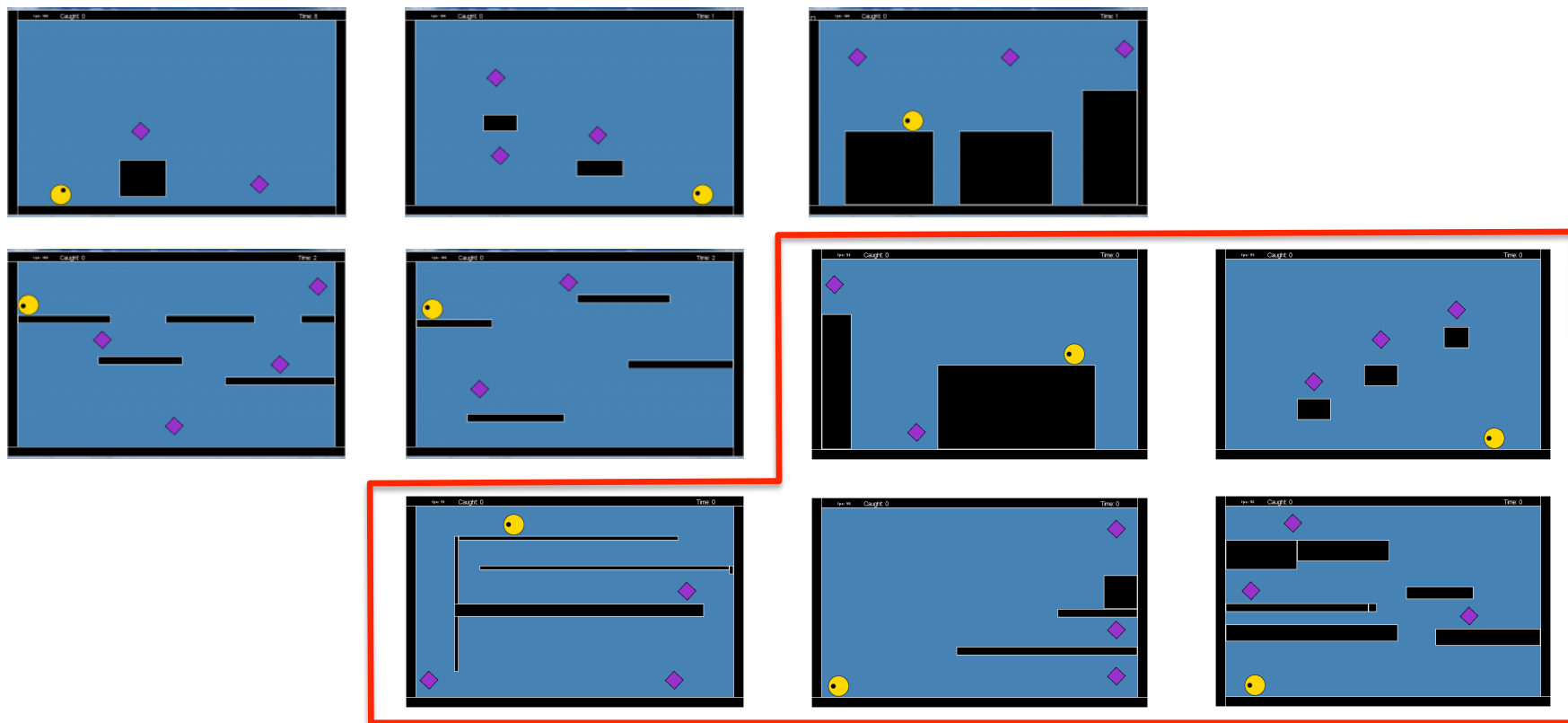
2014 Cooperation Track



Private Levels



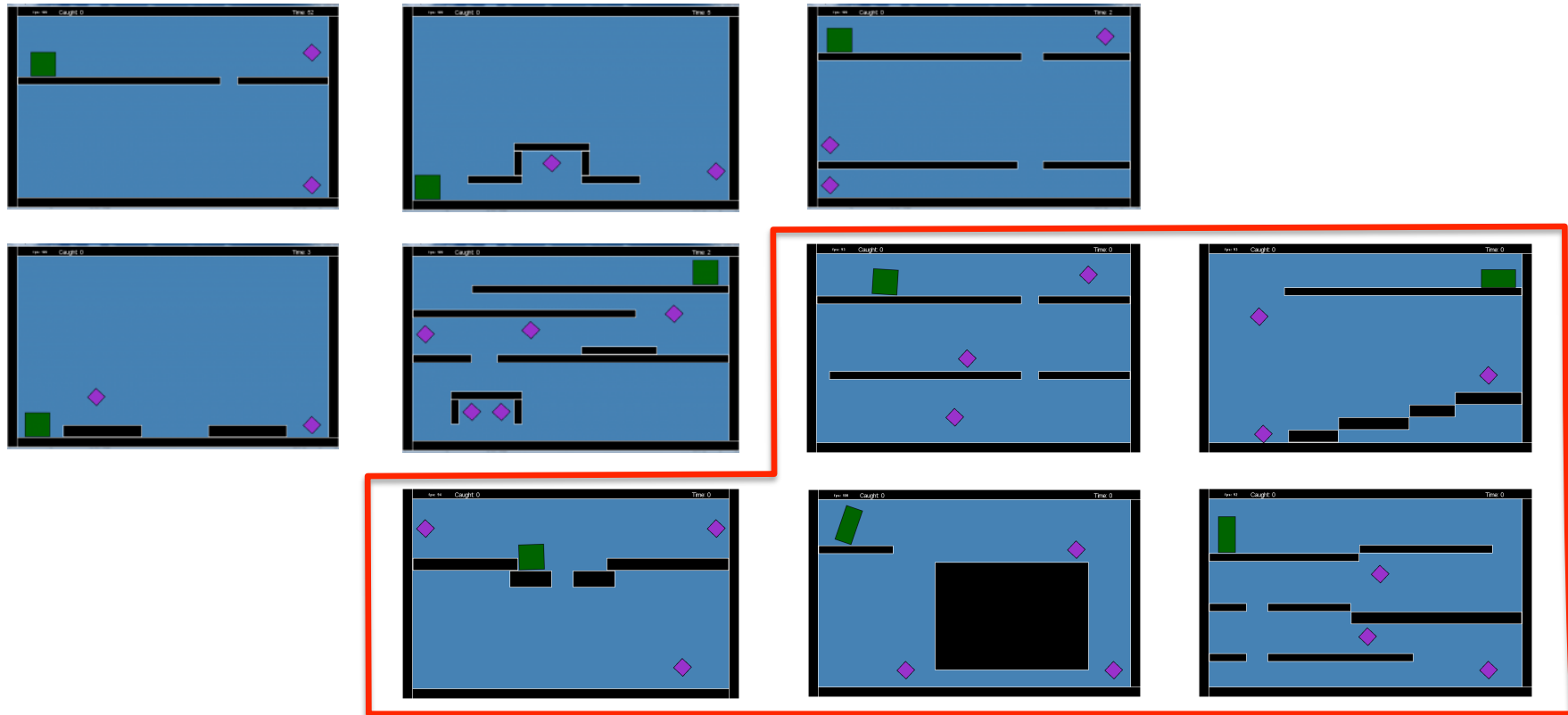
2014 Circle Track



Private Levels



2014 Rectangle Track



Private Levels

Scoring

- Get score for each **diamond collected**
- Bonus for **solving** the level
- Bonus for the **time** remaining
- Final score is the average of 10 runs

$$\text{SCORE}_i = V_{completed} \times \frac{(T_{max} - t)}{T_{max}} + (V_{collect} \times N_{collect})$$

2014 Submissions

- Cooperation Track
 - **CIBot** – Sejong University
- Circle Track
 - **CIBot** – Sejong University
 - **KUAS-IS** Lab – National Kaohsiung University of Applied Sciences
- Rectangle Track
 - **CIBot** – Sejong University
 - **KUAS-IS** Lab – National Kaohsiung University of Applied Sciences
 - **OPU-SCOM** – Department of Computer Science and Intelligent Systems, Osaka Prefecture University

Approaches

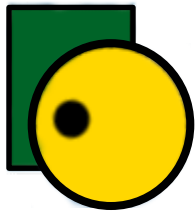
- Rectangle Track
 - **CIBot**: MTCS, Directed graph representation
 - **KUAS-IS**: A*, Q-learning
 - **OPU-SCOM**: 2 Layers AI (global and local strategy), Hierarchical task plan, Dijkstra, PSO

Approaches

- Circle Track
 - **CIBot**: Dijkstra, (greedy) rule-based system
 - **KUAS-IS**: A*, Q-learning
- Cooperation Track
 - **CIBot**: same as the above (Dijkstra, MTCS, Directed graph representation) with a two-step performance (individual and cooperation modes)

Results

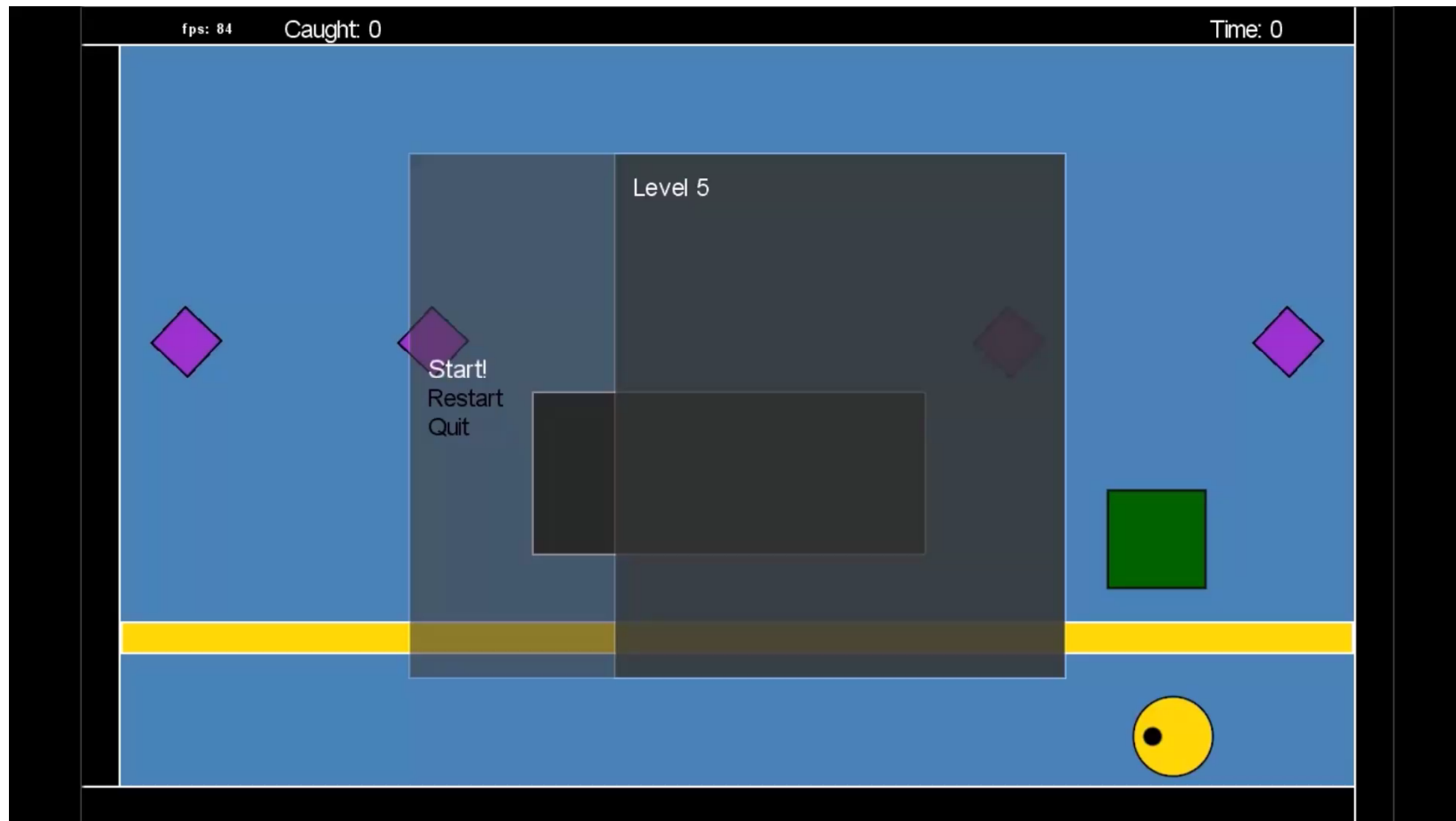
- Tests run on
 - Intel Core i7 @ 2.4GHz
 - 16 GB de RAM
 - Windows 8.1 (64-Bit)



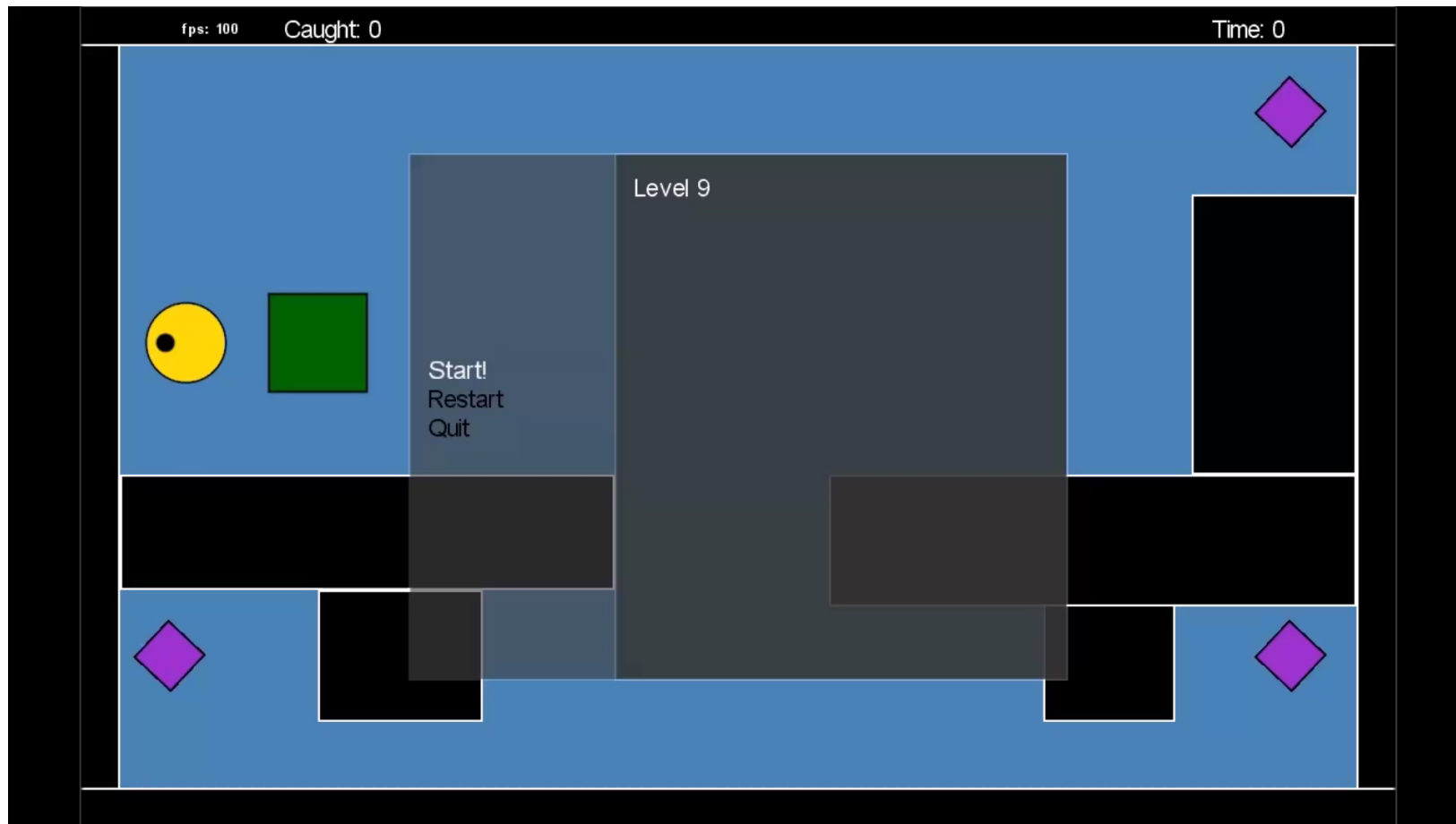
Cooperation Track: CI Bot

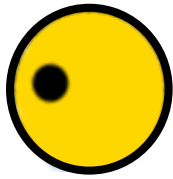
Level	Runs Completed	Diamonds	Time (Limit) – sec.	Score
1	10	3 (3)	31.66 (90)	948
2	10	3 (3)	32.49 (90)	939
3	10	2 (2)	13.83 (35)	805
4	10	5 (5)	62.03 (110)	936
5	10	4 (4)	74.37 (100)	656
6	0	0 (3)	0 (60)	0
7	0	1 (2)	60 (60)	100
8	0	0 (2)	90 (90)	0
9	0	0 (3)	55 (55)	0
10	0	1 (2)	35 (35)	100
TOTAL SCORE				4484

Cooperation: Success



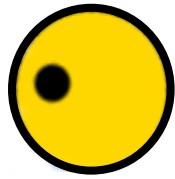
Cooperation: Failure





Circle Track: CIBot

Level	Runs Completed	Diamonds	Time (Limit) – sec.	Score
1	10	2 (2)	12.67 (20)	567
2	10	3 (3)	19.89 (45)	858
3	10	3 (3)	14.84 (60)	1053
4	0	1.2 (4)	80 (80)	120
5	0	1 (2)	70 (70)	100
6	0	1 (2)	40 (40)	100
7	10	3 (3)	26.19 (60)	864
8	0	0 (3)	40 (40)	0
9	10	3 (3)	50.00 (80)	675
10	0	0 (3)	100 (100)	0
TOTAL SCORE				4337



Circle Track: KUAS-IS

Level	Runs Completed	Diamonds	Time (Limit) – sec.	Score
1	10	2 (2)	5.81 (20)	910
2	0	2 (3)	45 (45)	200
3	0	0 (3)	60 (60)	0
4	0	1 (4)	80 (80)	100
5	0	0 (4)	0 (70)	0
6	0	0 (2)	0 (40)	0
7	0	0 (2)	60 (60)	0
8	0	0 (3)	0 (40)	0
9	0	0 (3)	0 (80)	0
10	0	0 (3)	0 (100)	0
TOTAL SCORE				1210

Circle: Success



Circle: Failure





Rectangle Track: CIBot

Level	Runs Completed	Diamonds	Time (Limit) – sec.	Score
1	10	2 (2)	12.46 (40)	889
2	10	2 (2)	10.05 (25)	798
3	9	2.9 (3)	32.83 (80)	880
4	10	2 (2)	9.06 (20)	747
5	10	5 (5)	41.64 (90)	1037
6	0	1 (3)	40 (40)	100
7	10	3 (3)	20.93 (50)	881
8	10	3 (3)	21.95 (60)	934
9	0	2 (3)	35 (35)	200
10	0	0 (3)	35 (35)	0
TOTAL SCORE				6466



Rectangle Track: KUAS-IS

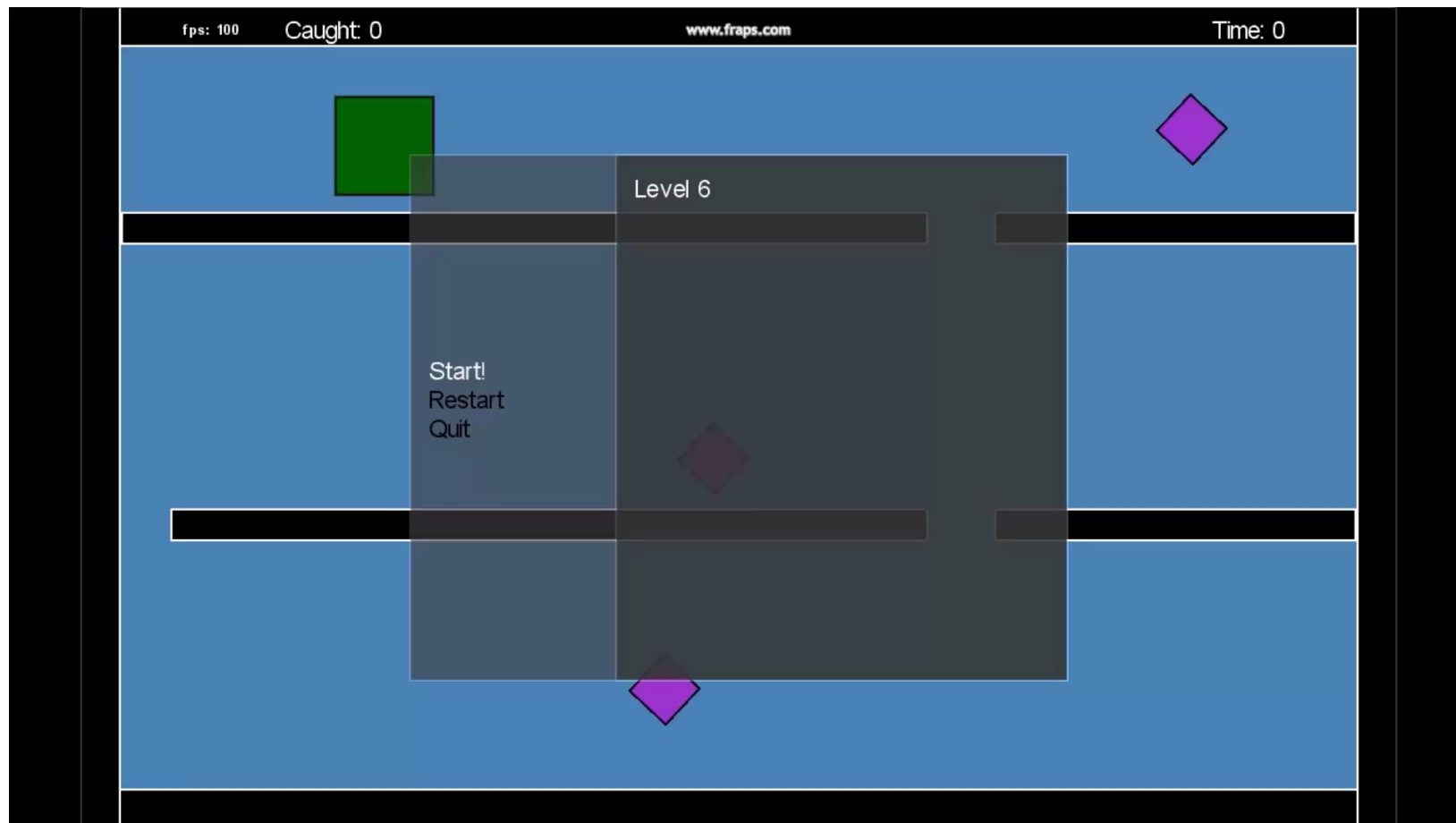
Level	Runs Completed	Diamonds	Time (Limit) – sec.	Score
1	0	1 (2)	40 (40)	100
2	6	1.6 (2)	20.97 (25)	321
3	0	1 (3)	80 (80)	100
4	9	1.8 (2)	10.53 (20)	653
5	0	2.7 (2)	90 (90)	270
6	0	0.7 (3)	28.00 (40)	70
7	3	2 (3)	37.89 (50)	342
8	6	2.4 (3)	38.98 (60)	590
9	0	0 (3)	0 (35)	0
10	0	0.8 (3)	35 (35)	80
TOTAL SCORE				2526



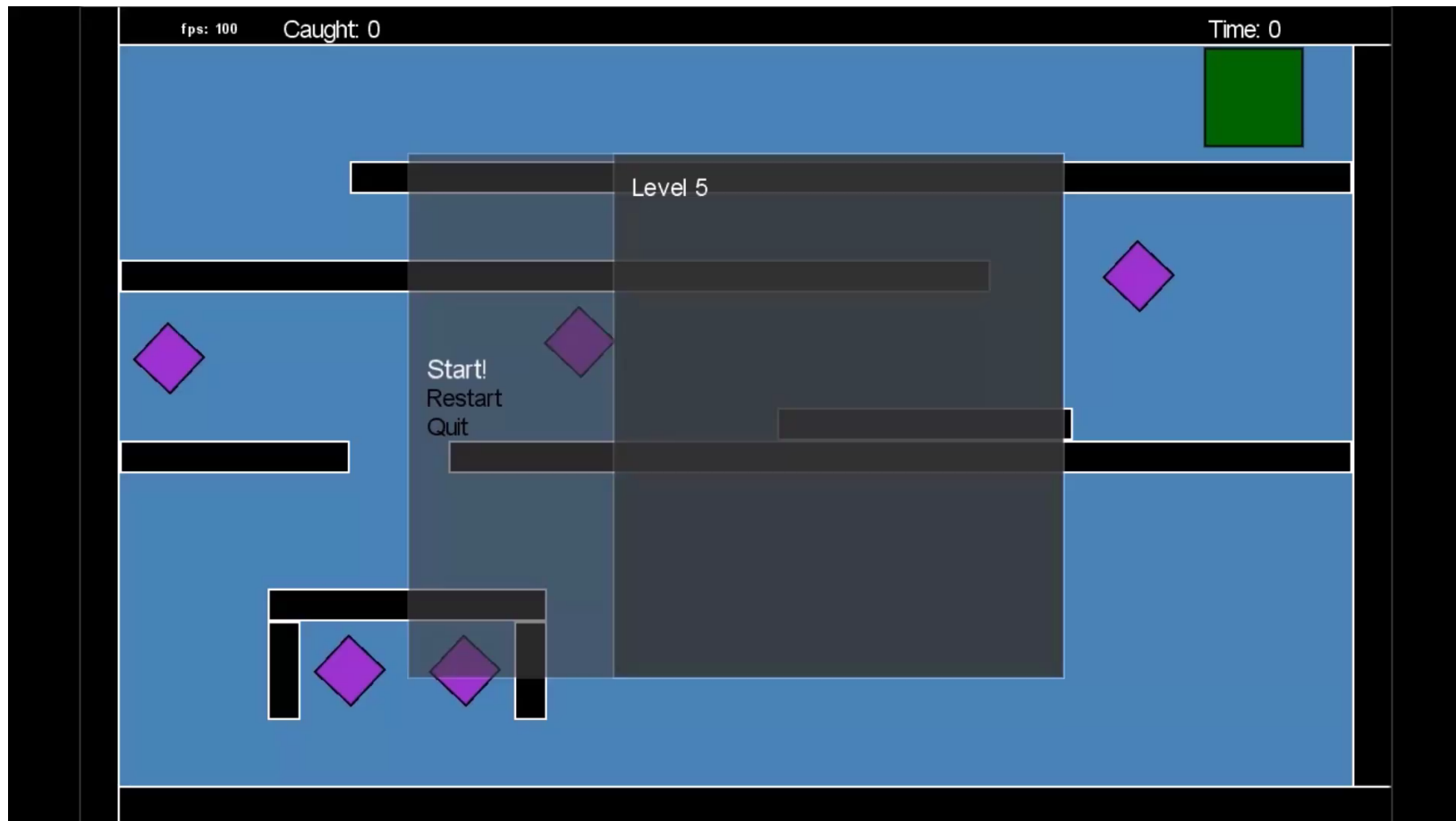
Rectangle Track: OPU-SCOM

Level	Runs Completed	Diamonds	Time (Limit) – sec.	Score
1	10	2 (2)	12.12 (40)	897
2	10	2 (2)	8.34 (25)	866
3	10	3 (3)	23.17 (80)	1010
4	10	2 (2)	10.79 (20)	661
5	0	1 (5)	90 (90)	100
6	10	3 (3)	19.68 (40)	808
7	0	2 (3)	50.00(50)	200
8	0	1.8 (3)	54.00 (60)	180
9	10	3 (3)	19.14 (35)	753
10	0	0 (3)	35 (35)	0
TOTAL SCORE				5475

Rectangle: Success



Rectangle: Failure



Final Classification

	Cooperation Track	Circle Track	Rectangle Track
1	CIBot (4484)	CIBot (4337)	CIBot (6466)
2		KUAS-IS (1210)	OPU-SCOM (5475)
3			KUAS-IS (2526)

Discussion

- General over-fitting to the public levels
- Greedy solutions often led to dead-ends
- The need for competence at two levels became salient in the Rectangle Track
 - Better task planning: OPU-SCOM
 - Better motion planning: CIBot
- Same good results in all tracks

Conclusions and Future Work

- Geometry Friends is a good test-bed for cooperative AI
 - Still a lot solve
- Future work
 - Level Generation Track
 - Generate levels for 2 players
 - Human Agent Track
 - Limited communication
 - Believability
 - Good experience
 - Should not take the fun out of the Human
 - » E.g. solve the puzzle immediately



The cooperation game AI competition.

Looking forward for your
submissions

<http://gaips.inesc-id.pt/geometryfriends>