Angry Birds: a heuristic approach

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ABSTRACT
Angry Birds is popular and widely played video game. The main aim is to destroy pigs using minimum number of birds and maximize the score. We earn more points by doing more damage to the structure along with the pigs.
In our paper, we attempt to solve the levels by analyzing the structure and assigning scores to all directly reachable objects. Score are assigned according to the damage a particular block does when hit. The block with highest assigned score is chosen as target block to hit.

1. INTRODUCTION
Angry Birds was released on iOS on December 10, 2009. In this game players use a slingshot to launch birds at swine stationed on or within various structures, with intention of destroying pigs within the field. Pigs are protected by different structures which follow the law of physics. The fewer birds used and the more blocks we destroy, the higher the score. As player advances different types of birds appear with different abilities. This has been a challenging game because of numerous differences and difficulties between different levels. Various efforts are being made to develop an agent that plays the game intelligently.
A basic game platform (Version 1.31) is provided by the organizers that makes use of the Chrome version of the Angry Birds. It is implemented using Java and incorporates the following components:

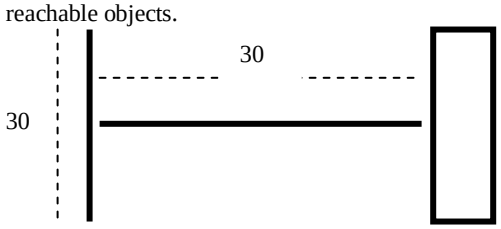
- Computer vision component:
  Analyses a video game frame and identifies the location, category and bounding box of all relevant objects plus the game score.
- Trajectory component:
  Calculates trajectories of birds and computes where to shoot from in order to hit a given location.
- Game playing component:
  Executes actions and captures screen shots.

There is a small amount of uncertainty that these components produce.
Our approach is based on spatial reasoning and representation. We used relations among different blocks. For reasoning of multiple aspects of relations, we use Extended Interval Algebra and based on several parameters we calculate heuristic value of individual blocks.

2. EXTENDED RECTANGLE ALGEBRA
There are 27 topological and dimensional relations defined in Extended Rectangle Algebra shown in Table 1. The basic objects on algebra is defined are rectangles.

Relation	Illustration	Interpretation
X b Y Y a X	----x---- ----y----	X takes place before Y
X m Y Y mi X	----x---- ----y----	X meets Y
X mom Y Y momi X	----x---- ----y----	Most part of X overlaps most part of Y
X lol Y Y loli X	----x---- ----y----	Less part of X overlaps less part of Y
X mol Y Y moli X	----x---- ---------y---------	Most part of X overlaps less part of Y
X lom Y Y lomi X	--------x-------- ----y----	Less part of X overlaps most part of Y
X ms Y Y msi X	-----x----- -------y-------	X starts Y and covers most part of Y
X ls Y Y lsi X	--x-- -------y-------	X starts Y and covers less part of Y
X ld Y Y ldi X	--x-- ---------y---------	X during left part of Y
X cd Y Y cdi X	--x-- -------y-------	X during Y and midperpendicular of Y through X
X rd Y Y rdi X	--x-- ---------y---------	X during right part of Y
X mf Y Y mfi X	-----x----- -------y-------	X finishes Y and covers most part of Y
X lf Y Y lfi X	--x-- --------y--------	X finishes Y and covers less part of Y
X eq Y	-------x------- -------y-------	X is equal to Y

3. Approach towards Angry Birds
3.1 Determining Reachable Objects
We analyzed reachable objects by considering coordinates of blocks bounded by rectangle. Each block's peripheral coordinates are compared with every other block's. If there is no other block that hinders the block being analyzed than it is added to the list of reachable objects.



Pseudo Code
Input: List all_Rect //includes pigs and blocks
Output: List Reachable //reachable objects
Procedure: init List Points
For all objects O in all_Rect
For i = 1 to 30
Add points (O.X-i, O.height/2) and (O.X-30,O.Y+i) to Points
For all objects S in all_Rects
If none of the S contains none of the points in Points
Add O to Reachable

3.2 Find Affected Objects

Affected objects will include supporters, supportees and neighbours.
To determine supporters and supporteees we considered two aspects: Firstly, direct support which can be vertical or horizontal and Secondly, angular support.

For direct support we used ERA :
If $R_{xy} \in$
$\{Ld, Rd, Cd, Ldi, Cdi, Rdi, Mom, Mol, Lom, Lol, Momi, Moli, Lomi, Loli, Ms, Ls, Msi, Lsi, Mf, Lf, Mfi, Lfi, Eq\}$ X $\{M\}$
➔y directly supports x (y is supporter of x or x is supportee of y)

For Angular Support
It determines angular support between two rectangles a and b. First find lower edge of angular object a by finding maxY and consequently derive line equation of lower edge. Then check if any point of b coincides with this line. If it returns true then b supports a.

To determine neighbours, we considered Left closest and Right closest objects.

Left Closest Object of x:
First find all objects to the left of x and then find the closest.
To find all objects to the left:
For $\forall_y \in O$
$R_{xy} \in$
$\{B, Ld, Cd, Rd, Ldi, Cdi, Rdi, Mom, Mol, Lom, Lol, M, Mfi, Lfi\}$
X $\{Ld, Cd, Rd, Ldi, Cdi, Rdi, Mom, Mol, Lom, Lol, Momi, Moli, Loli, Lomi, Ms, Ls, Msi, Lsi, Mf, Lf, Mfi, Lfi, Eq\}$
➔ Add y to Left.

To find closest:
For $\forall_{y,z} \in$ Left
$R_{yz} \in$
$\{B, Ld, Cd, Rd, Mom, Mol, Lom, Lol, M, Ls, Ms\}$ X {A, A$\in$ $all\ relations$}
➔ Delete y from left else delete z.

3.3 Calculate heuristic value

Once we have a list of affected objects for each of the reachable objects, we can calculate its heuristic value. A heuristic value of an object reflects the amount of destruction a hit to the object can cause. The quality of a shot can be determined by the scoring scheme defined as: if an object in the affected list of the target object is not a pig, add 1 to the score; else if it is a pig add 10 to the score. Destroying a pig should yield a higher score because the main aim of the game is to destroy all pigs. Hence our approach aims to select a shot which directly or indirectly destroys at least one pig.

3.4 Select Target Object

Clearly for making our shot affect the most, we should select the target object to be such that it has the maximum heuristic value.

4. RESULTS

We compare our results for 1-21 levels of freely available Poached Eggs Levels with top 8 teams of the Angry Birds AI Competition in 2013 and 2014.

Levels	**INR Rangers (our Agent)**	PlanA+	DataLab Birds	AngryHex (2013)	WISC	AngryHex (2014)	Angry Concepts	Beau Rivage	Hungry Birds
1	32270	30480	31620	30390	29030	**32660**	29410	29760	31210
2	60490	**62370**	52000	54160	52180	52580	52250	43160	53860
3	**42040**	40620	41890	41890	41950	41910	41320	40500	**42040**
4	28160	**29000**	19790	28000	27850	19690	**28160**	**28680**	20980
5	63610	**69440**	**70320**	**64440**	**65810**	**68090**	**64160**	61000	**65700**
6	36410	**36970**	15700	24990	24640	25180	15660	33540	28430
7	36910	32020	**45720**	36900	25520	24680	24630	**45780**	**40580**
8	55150	47320	43190	24860	**55810**	43330	47170	49150	27020
9	48840	26440	**50420**	**49570**	33680	42740	48670	33110	**50710**
10	**67020**	56830	56710	50570	39170	54890	48290	42200	53070
11	**62160**	47240	50650	53510	50000	53570	56130	57420	56260
12	55790	**58210**	53420	**57750**	54980	54860	**58600**	55600	55410
13	**53040**	34010	32010	42010	32450	41200	50360	35190	30130
14	**86160**	65640	55640	58190	65060	57150	58050	62770	59780
15	50940	**54910**	46450	46550	49200	41100	43340	47270	41040
16	58260	**57530**	**57380**	**63430**	**63430**	**61470**	**55000**	**55890**	**55310**
17	50820	**51990**	48570	46820	**54750**	50260	45990	49880	43530
18	49910	52120	45730	50020	44740	48050	44030	38820	46770
19	0	39440	35470	38470	37370	36780	37880	29780	32690

20	0	45980	54680	46970	47980	39010	43730	37020	56050
21	0	64620	73680	65190	67560	71120	61200	75870	60870
Total	**937980**	1002380	981120	974670	963160	960320	954030	952390	951440

We played 3 times and best scores are provided. For each level there were maximum of 3 trials. In about 5 out of 21 levels, we scored highest. Teams scoring more than our agent are represented in bold.

5. Team Description

5.1 Isha Jain

Isha Jain is currently a third year student pursuing her BTech (ICT) from Dhirubhai Ambani Institute of Information and Communication Technology (DA-IICT).

5.2 Naincy Bordia

Naincy Bordia is currently a third year student pursuing her BTech (ICT) from Dhirubhai Ambani Institute of Information and Communication Technology (DA-IICT). Her area of interest lies in Human Computer Interaction.

5.3 Rajvi Dhimar

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6. REFERENCES

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