Rendezvous-birds

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Abstract—Angry Birds is a popular video game in which players shoot birds at pigs and other objects. Because of complexities in Angry Birds, such as continuously-valued features, sequential decision making, and the inherent randomness of the physics engine, learning to play Angry Birds intelligently presents a difficult challenge for machine learning. A major goal of ours is to design an approach that learns the general task of playing Angry Birds rather than learning how to play specific levels. In our basic initial strategy, we try to act according to the environment. Our strategy comprises of several different small strategies to make a powerful big strategy. The aim is to design a heuristic which detects a weak point in the level and act wisely such that the score is maximized.

I. INTRODUCTION

Angry birds is an addictive video game first released in December, 2009. After this, the game was available across various platforms. For a human player, he could have various different strategies like targeting the pig or the blocks, etc. Here, the main aim is to make such a strong strategy that could help us gain maximum score by killing more pigs as well as destroying more blocks by using minimum number of birds. We are first considering the different target positions and then analyzing the different possibilities of reaching those target positions. Here, we are using a combination of various strategies to achieve the above goal. First of all, the Rolling Round Blocks Strategy helps us to gain maximum score in those levels where round blocks are available. Also, hitting the blocks at a height lower than the total height of the block helps us make more destruction to the structure. Similarly, strategies like Minimum Angle Strategy and others helps us to increase the efficiency of the agent. Apart from these, the tapping strategy for the blue and the yellow birds also proves to be very efficient when used wisely.

II. RELATED WORK

A lot of work is going on in this field to make the agent more effective and efficient so that it could itself decide on how to maximize the score. Similarly, our strategy also includes a combination of various different strategies which work together to accomplish the desired goal. These different strategies are required because every strategy takes into account a different factor. Various different kinds of strategies have been implemented by people all over the globe in this respect. These techniques also include various machine learning techniques. It is basically to train the agent so that it could choose the best available target position in order to maximize the score. The research in this field has a proof that the results of the Angry Birds Artificial Intelligence Competition held internationally are increasing drastically. Some of the work in this field is described below:

1) **Team Akbaba** - Their approach is to use search to find an appropriate parametrization for launching a bird. It means that they first search for the different target positions to reach the scene and then evaluate different possibilities to reach the it in terms of incoming angle and speed of the bird. They do not use the sling side search to search for an angle that maximizes their score. Instead, they start their search from the other side. To navigate through the search space faster, they search for the parameters of a shot in a hierarchical fashion.

2) **s-birds** - Their agent learnt by taking advice from a Heuristic Engine. Their heuristic engine uses Bottom Attack Principle which assumes that striking a most vulnerable block near the base of the structure would kill maximum number of pigs and would also cause maximum destruction to the structure. Their agent was basically using Reinforcement Learning so that it could choose a better trajectory and maximize its score.

3) **Datalab-birds** - Their agent used a utility function which selects a strategy from the given set of strategies which maximized that utility function. They used a combination of various different strategies to make their agent more powerful. It includes Dynamite Strategy, Building Strategy, Round blocks, Tapping time, etc. These are some of the very basic strategies which were combined of a powerful impact. They also used trajectory utility function which helped them in deciding the best trajectory from a given set of trajectories.

4) **Multi-armed Bandits Meta-Agent** - They included a combination of various basic strategies in their agent. These included Naive Strategy, LowKick Strategy, Tall-Wide Strategy and ClearTheWay Strategy. These strate-

gies targeted on hitting the structure near the pigs and not the pig itself, dividing a structure into different regions and providing a value to those regions so that it helps in the calculation of the heuristic function, and also considered future possibilities.

III. APPROACH AND STRATEGIES

Our approach to this is to find an optimal target position such that the score maximizes. That is, we search among the various target positions for a bird which would enhance the score better than any other target positions. Instead of checking for all the angles, we are checking the possible trajectories to the target positions. The strategy takes into account the following stage specific factors and decides onto which trajectory to choose for the particular bird along with the tap point in case of blue, white or yellow birds. The steps include selection of the trajectory and the target point. A combination of the below mentioned strategies help us to maximize the score.

1) **Minimum Angle Strategy**

Once the trajectory is fixed or the target point is fixed, the trajectory with minimum angle and maximum speed is chosen.

The idea of using the minimum angle strategy is that the minimum angle would have more component of the horizontal velocity and hence it would provide more tangential force for rectangle type structures and it would also help to destroy the structures much more easily than the maximum angle strategy.
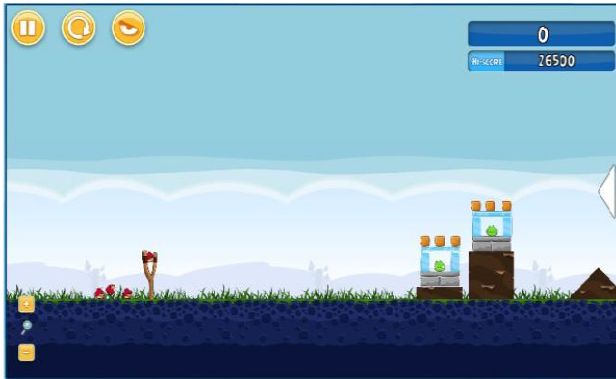

Figure 1. Level 6

This strategy is mostly helpful where a pig is covered by blocks on the three sides and the lower one (resting stage of the pig) could be anything. In the above shown level, this strategy proves to be very helpful and it fetches a very high score.

2) **Rolling Round Blocks and $(\frac{4}{5})^{th}$ Height Strategy**

If there is a round stone in some level and there is a pig to the right of it, then the target point is the round stone. So by rolling/moving that round stone the pigs could be killed and the structure can also be destroyed.

This strategy is applied only to the levels which have a round stone. From VisionMBR.java, the location of the round blocks would be fetched and if that block has a pig to its right then the bird would go with the minimum angle and with maximum velocity, and roll the round block. This rolling block would kill the pigs which come in its way and would also destroy the structure to earn more points. This would be helpful in the way that it is impossible to break the round stone, but it is possible to use it to destroy the rest of the structure and to kill the pigs.

For example, in level 3 of Poached Eggs, the round block is placed on top of a hill like structure and on rolling it, it will kill the 2 pigs which are situated after that hill. Also, if the round block is hit correctly, then it could also destroy the structure which is situated after the 2 pigs. Hence, the score for this level is maximized.
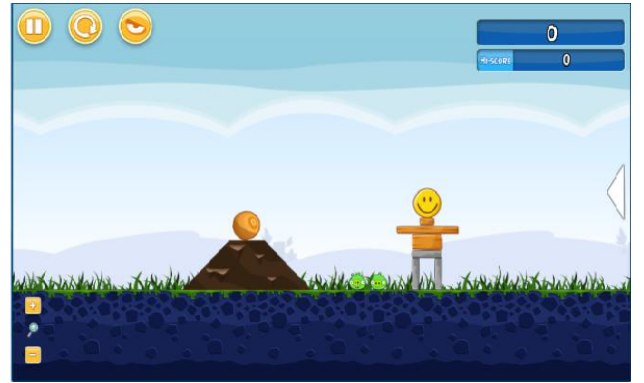

Figure 2. Level 3

Other possibility is that if a round is block is covered by some other blocks (like in Level 5) then, the hit is made on the $(\frac{4}{5})$ height* of the leftmost vertical block which is below and which touches the block on which the round block is resting.

Even if there is a pig in place of a round block, then also the $(\frac{4}{5})$ height* strategy works better than hitting the left block at its upper edge.
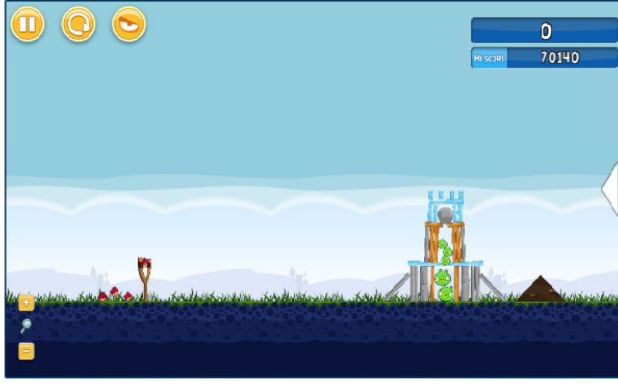
Figure 3. Level 5

This would disturb the balance of the round block and the block would fall down causing damage to the structure and the pigs below.

* - Here, $(\frac{4}{5})^{th}$ height selection is based on practical observation.

3) **Heuristic Based Pig Hit Strategy**

A heuristic function is used to decide the best target position to shoot the bird. Various factors have been taken into consideration while making the heuristic function like type of blocks and pigs around it.

The aim here should be to maximize the number or pigs that are killed in a single throw. This could be decided with the help of the heuristic function. So, the possible trajectories are examined and then the trajectory with the maximum number of pigs is taken. Like in the below case, if the bird is shot at the topmost pig, then it will bounce back and would kill the other 3 pigs too. This is based on probability that if something is located near a pig then on shooting that pig destruction to those elements could also be made.
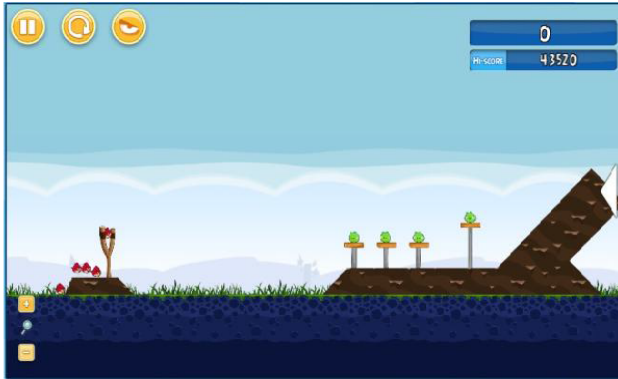

Figure 4. Level 2

Also, a particular trajectory is rejected if that trajectory

is found useless in terms of score and this strategy is not taken by the agent anymore. With the word, "useless trajectory", we refer to those angle and speed combination, which didn't fetch much score or which missed its target completely.

This can be visualized by a spanning tree which would decide the best possible trajectory for the bird. If there is just one pig then above strategies could work out but if there are more than one pigs to be shot, a tree has to be made. This tree would tell that how much could a bird score if it hits a particular target by considering the score earned by killing the pig and breaking different kinds of blocks.

This would also tell us whether more than one pigs can be shot with a bird or not. If yes, then whether it is beneficial or not as compared to killing the pigs one by one, as every non used bird gives us 10,000 bonus points. The tree would consist of the score obtained by killing different pigs or a combination of pigs. So, the path with the maximum score would be chosen for best results.

Suppose there are 3 birds and 3 pigs. Now, for the first bird, the possibilities are that it could hit pig 1, pig 2, pig 3 or any two of them. So, in all it has 6 choices. Now for each choice of it, bird 2 has either 1 (if 1 pig is left) or 3 (if 2 pigs are left) choices. Similarly, the third bird has either 1 (if 1 pig is left) or 0 (if no pig is left) choices. So, the size of the tree to find the best shot is also not too huge.

So, after doing this, we will get a score for each of these cases based on the heuristic function made by including the score gained by estimating the number of different blocks that could be broken, the pigs that can be killed and the number of unused birds. This would provide us a fairly good estimate and would help us to choose a path associated with maximum score.

The heuristic function is defined below:

$$h(n) = \sum_{i=0}^{i=a} p(n) + \sum_{i=0}^{i=b} i(n) + \sum_{i=0}^{i=c} w(n) \qquad (1)$$

where,
h(n) - heuristic function
p(n) - points for killing 1 pig
a - estimated pigs killed by a bird in one shot
i(n) - points for breaking 1 ice block
b - estimated ice blocks broken by a bird in one shot
w(n) - points for breaking 1 wooden block
c - estimated wooden blocks broken by a bird in one shot

The values assigned to the wood and ice blocks is +1 and to the pigs is +5. The summation of these values decide whether a particular target is to be chosen or not.

This would be judged by observing the surrounding of the pig. If there are many objects in its surrounding, the chances of more destruction are quite high. So, this would be a judgment kind of heuristics where we estimate the score that could be obtained so that we could choose the best possible target.

If the result from this strategy is a tie between 1 or more target locations (like in Level 6), then the nearest pig amongst them would be chosen. The Nearest Pig Hit Strategy is described in the next part.

4) **Highest and Nearest Pig Hit Strategy**

If the previous strategy turns out to be a tie, then the target point is selected on the basis of the arrangement of pigs. The pig which is highest and nearest (leftmost) to the bird is selected.

First the height would be checked and then the nearest condition. If there is a tie among the height two pigs, then the nearest pig is chosen. There are 2 sub-cases here:

a) *If there is a structure covering the pig and the pig is at some height above the ground, the leftmost vertical block that touches the horizontal block (from below) on which pig lies is selected and the target point is $(\frac{4}{5})^{th}$ the height* of this block.*

b) *If there is a structure covering the pig and the pig lies on the ground, then the leftmost vertical block from the pig is selected and the target point is $(\frac{4}{5})^{th}$ the height* of this block.*

* - Here, $(\frac{4}{5})^{th}$ height* selection is based on practical observation.

This strategy also turns out to be nice in the sense that when there are 2 or more than 2 pigs placed near to each other, then hitting the pig nearest to the launching position of the bird with a lower angle gives us a higher probability that the other pig which is second nearest to the bird would also be killed by the horizontal motion of the bird after hitting the first (nearest) pig. So, it is always wiser to hit the nearest pig first. In level 2, where 3 pigs are on the same level close to each other and the fourth one was at a higher level but far away from the launching position of the bird.
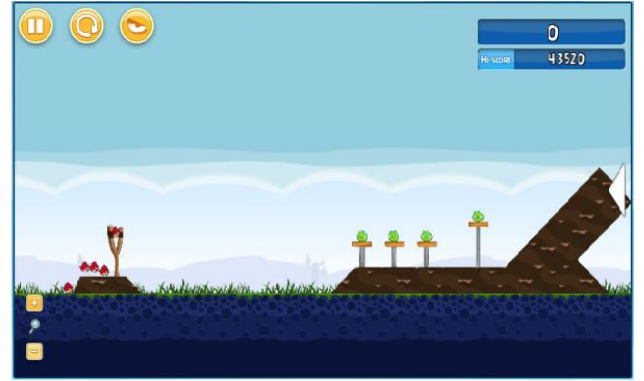

Figure 5. Level 2

So, hitting the highest pig here would make the bird bounce back and kill the rest of the 3 pigs as well. Hence, in just a single shot all the four pigs are killed and the score is maximized as well.

Now, if the nearest bird is covered by blocks and is above the ground, then the hit is made on the $(\frac{4}{5})^{th}$ height* of the leftmost vertical block which touches the horizontal block (from below) on which the pig is resting. This strategy would damage the structure as well as kill the pig as the pig is resting on the structure and when the structure below it is damaged, the upper structure would also be damaged and the pig would get killed.
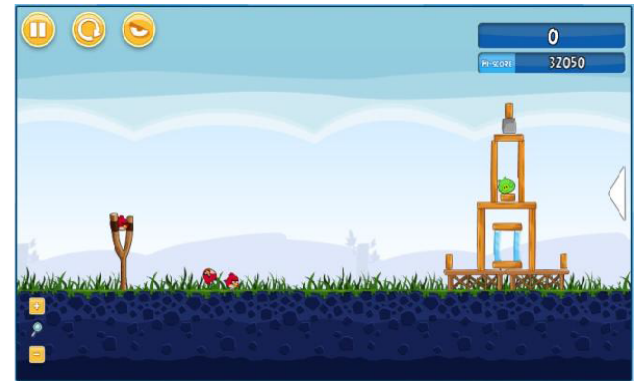

Figure 6. Level 1

Another case could be such that the pig is resting on the ground or some other hill like structure. In this case, the leftmost vertical block to the left of the pig is selected and then the hit is made on the $(\frac{4}{5})$ height* of that leftmost vertical block.
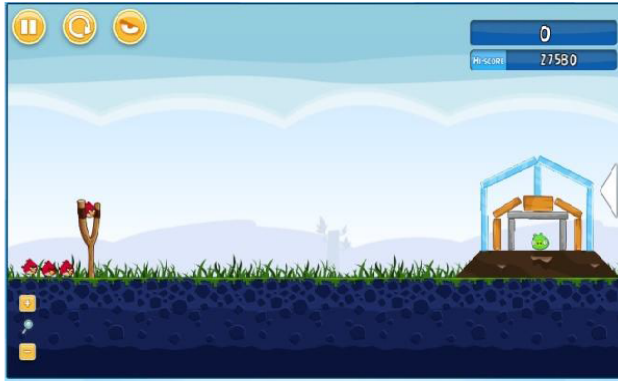
Figure 7. Level 4

- Here, $(\frac{4}{5})^{th}$ height* selection is based on practical observation.

5) **Splitting Strategy for Blue Bird**

The blue bird splits into 3 birds on tapping which helps to increase the impact 3 times. The location for tapping for this bird should be chosen such that the 3 birds do not fly too far.
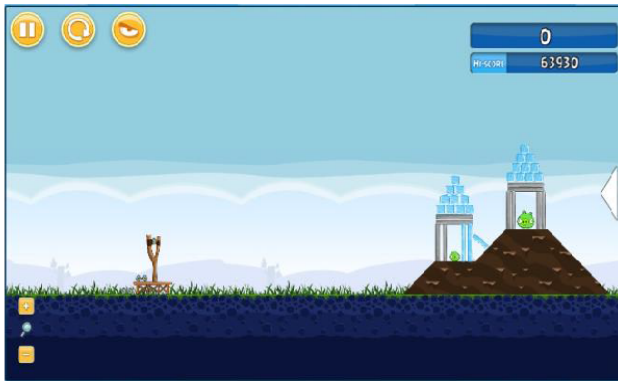

Figure 8. Level 10

The blue bird has an ability of splitting up into 3 birds on tapping once after it is launched. After splitting, the 3 birds which are generated are go in 3 different trajectories. One goes with the actual angle, one with a speed less than the actual angle and one with the speed more than the actual angle.

The splitting for this bird should be done once the bird has crossed the highest point in its trajectory so that the 3 birds do not fly too far. To be precise, the bird should be splitted when it is very close to its target so that the force of all the 3 birds is concentrated at a particular location. By doing so, we can use thrice the power of the single bird at one point. If there is a tall structure, then these could be very useful in hitting

the structure at 3 positions (lower, middle and higher) to do maximum possible damage.

6) **Tapping Strategy for Yellow Bird**

The location for tapping the yellow bird is to be chosen very wisely as after tapping, the trajectory of the bird changes. So, considering the factor of the change in the trajectory, the tapping should be used in such a manner that it provides the maximum possible destruction.

Note that our aim here is maximum pig kills with minimum birds along with maximizing score by breaking the blocks wherever possible

The yellow bird has an ability of speeding up when it is tapped after launching. After speeding up, the trajectory of the bird changes and it follows another strategy according to its new speed. To prevent much diversion of the trajectory, the tapping should always be done after the bird has crossed the maximum height of its trajectory. While doing so, the impact of the bird on the structure can be increased and more blocks can be broken in a single go. If the bird is tapped before reaching the target block, then on speeding also its trajectory would not change much and the increased speed would cause a lot of destruction as well.
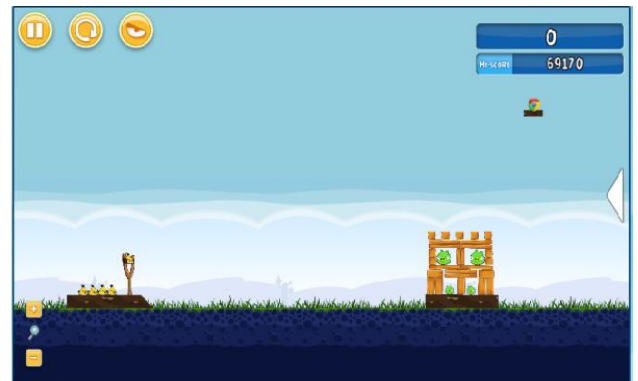

Figure 9. Level 16

7) **Utilization of Bird Specialty**

In case of a mixture of birds, the target points are selected according to the bird on the sling so that each bird could do maximum damage to the structure according to its specialty.

When there is a mixture of birds to be shot, then based on the order in which the birds are arriving at the sling, we choose different hitting points for the birds where they are good at. For example, the blue bird is good at

breaking ice blocks. So, when the blue bird is on the sling, we choose the position where there are maximum ice blocks. Similarly, the red bird is used for stone blocks and yellow bird for wood blocks.
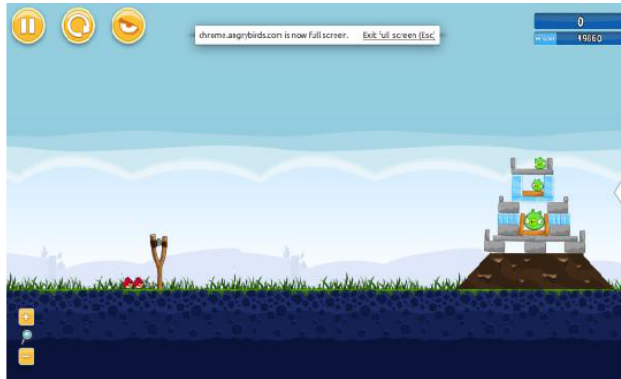

Figure 10. Level 13

Here, we can see that in stages 11, 12, 13, 19 and 21, we are getting a mixture of birds and the structure also has different types of blocks. By using this strategy, we ensure that each bird is utilized to its maximum. Otherwise, if a blue bird is targeted on a wooden block or any other combination apart from the desired one, then it would be of no use.

8) **TNT Hit Strategy**

This strategy aims at targeting a TNT block if a pig is in a range around the TNT block. Its utility is maximum here as along with the block the pig would also get killed. Also, the other blocks which are in its vicinity are also destroyed. Hence, the score is maximized.

IV. **RESULTS**

The test results of the Rendezvous-birds are quite nice. The agent is mostly getting 2 and 3 stars in all the levels. The agent worked nicely in the levels. The final score of our agent in all the 21 levels is 939570. This score is quite decent as compared to the last years' Angry Birds AI challenge.

V. **TEAMMATE DESCRIPTION**

The team consists of three members - Mayank Ladha, Madhav Khakhar and Shivang Kar.

1) **Mayank Ladha (201201019)**
Mayank Ladha is a pre-final year student at Dhirubhai Ambani Institute of Information and Communication Technology (DA-IICT) and is currently pursuing his Bachelor of Technology in Information and Communication Technology. His broad interest lies in the field of Algorithms and Programming.

2) **Madhav Khakhar (201201054)**
Madhav Khakhar is a pre-final year student at Dhirubhai Ambani Institute of Information and Communication Technology (DA-IICT) and is currently pursuing his Bachelor of Technology in Information and Communication Technology.His broad interest lies in the field of Algorithms.

3) **Shivang Kar (201201060)**
Shivang Kar is a third pre-final student at Dhirubhai Ambani Institute of Information and Communication Technology (DA-IICT) and is currently pursuing his Bachelor of Technology in Information and Communication Technology. His major interests lies in the field of Networking.