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# AngryHEX: An Angry Birds-playing Agent based on HEX-Programs

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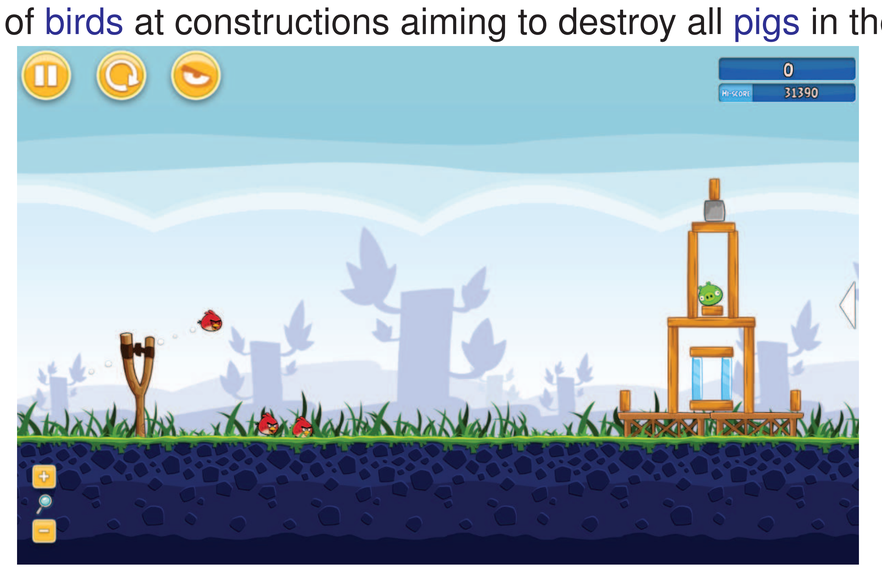
## 1. Motivation

- Angry Birds (`http://www.angrybirds.com`) is a strategic arcade video game where the player uses a slingshot to shoot a limited number of birds at constructions aiming to destroy all pigs in the field




- **Goal:** Construct a declarative agent which plays the game
- **Challenge:** Plan optimal shots under consideration of physics
- **Our means:** HEX-programs, i.e., Answer Set Programming (ASP) with external sources and other extensions

## 2. Architecture of our Agent

- We use the provided framework (browser plugin, vision module etc.)
- Actual reasoning is done in a HEX-program (logic program) to compute the desired target given the scene information from the vision module
- Agent extracts the target from the models of a HEX-program

It builds on tactic and strategy:

- The tactic is realized declaratively as a HEX-program that aims at completing one level, i.e., computing optimal shots
- The strategy decides which level to play next
  1. it first tries to play each level once
  2. it plays levels where the agent has maximum difference to the best scores
  3. it plays levels where the agent performs better than the best scores but has minimum difference to the best scores

## 3. HEX-Programs

- HEX-programs extend ASP by external sources
- Rule bodies may contain external atoms $\&p[q_1,\ldots,q_k](t_1,\ldots,t_l)$,
  $p$ ... external predicate name
  $q_i$ ... predicate names or constants: $\tau(\&p,i) \in \{\mathbf{pred},\mathbf{const}\}$
  $t_j$ ... terms
  Semantics:
  $1+k+l$-ary Boolean oracle function $f_{\&p}$:
  $\&p[q_1,\ldots,q_k](t_1,\ldots,t_l)$ is true under assignment $\mathbf{A}$ iff $f_{\&p}(\mathbf{A},q_1,\ldots,q_k,t_1,\ldots,t_l)=1$.

### Example

This program computes the set of all postfixes of string *angry*, where $\&tail[x](y)=1$ iff $y$ is $x$ after dropping the first character:

$$\Pi=\left\{\begin{array}{ll} r_1\colon string(angry). & \\ r_2\colon postfix(X) & \leftarrow string(X). \\ r_3\colon postfix(Y) & \leftarrow postfix(X),\&tail[X](Y). \end{array}\right\}$$

## 4. HEX-Encoding for Angry Birds Tactic

We use a HEX-program to compute the desired target:

- **Input:** Scene information is encoded as facts (positions, size and rotation angles of pigs, ice, wood and stone blocks, slingshot etc.; extracted by the vision module of the agent)
- **Output:** Models of the HEX-program contain a dedicated atom encoding the desired target
- Physics simulation results can be accessed by the HEX-program via external atoms, e.g.,
  - decide if object $B$ falls if $A$ falls
  - decide which objects intersect with the trajectory of a bird after hitting a given object
  - compute distances between objects
  - etc.

Tactic implemented by the HEX-program:

- Consider each shootable target (objects which have a direct and unobstructed path from the slingshot)
- Compute the estimated damage on each other object (discrete values) if the given target is hit (e.g. because it intersects with the trajectory of the bird, or because it rests on the target), taking different bird types into account
- Rank the targets (=answer sets) using weak constraints: we add malus points for each pig, where the number of added malus points decreases with increasing likelihood that the pig is destroyed

## 5. Preliminary Benchmark Results

| Level | ABC-AI | ABC-IS | HEX | Avg Adv |
|---|---|---|---|---|
| level 1 | 27550 | 30490 | **32090** | 3070 |
| level 2 | 52420 | 34600 | **53460** | 9950 |
| level 3 | 33460 | 41070 | **42370** | 5105 |
| level 4 | 18690 | **27990** | 27970 | 4630 |
| level 5 | 36280 | 62780 | **63300** | 13770 |
| level 6 | 17870 | 17500 | **34810** | 17125 |
| level 7 | 22510 | 20560 | **45710** | 24175 |
| level 8 | **47400** | 40440 | 38730 | -5190 |
| level 9 | 35600 | 42500 | **43160** | 4110 |
| level 10 | 41530 | 43970 | **55660** | 12910 |
| Sum | 333310 | 361900 | **437260** | 89655 |

ABC-AI and ABC-IS are our last year’s contestants based on plain ASP and a procedural implementation, respectively

(The scores of our agent are as by July 30, 2013 and may be different/higher at the competition)

## 6. Outlook

Possible improvements:

- Combine objects which behave like a single one
- Plan over multiple shots
- Realize strategies declaratively (currently implemented in Java)

## 7. References


- Angry Birds (2013).
  Angry birds ai competition benchmarks `http://aibirds.org/benchmarks.html`.
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  Effective Integration of Declarative Rules with External Evaluations for Semantic-Web Reasoning.
  In *3rd European Semantic Web Conference (ESWC’06)*, volume 4011 of *LNCS*, pages 273–287. Springer.


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