The serious side of coding for fun

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Working for fun

**Enjoyment** adds to long term retention on a task

**Discovery** is a powerful driver, contrasting with direct instructions

Gaming joins these two, and is hugely popular

Can we add these elements to coding?

Write a program to determine all the sets of effectively identical rooms in a maze. (A page of background, sample input and output given)
This puzzle is an interactive Coding Duel. Can you write code that matches a secret implementation? Other people have already won this Duel 1911 times! Help

using System;

public class Program {
    public static int[] Puzzle(int[] a, int[] b) {
        // Can you write code to solve the puzzle? Ask Pex to see how close you are.
        return null;
    }
}
Code Hunt programming game
Code Hunt programming game

SELECT SECTOR

00 TRAINING
01 ARITHMETIC
02 LOOPS
03 LOOPS 2
04 CONDITIONALS
05 CONDITIONALS 2
06 STRINGS
07 STRINGS 2
08 NESTED LOOPS
09 ID ARRAYS
10 JAGGED ARRAYS
11 ARRAYS 2
12 SEARCH SORT
13 CYPHERS
14 PUZZLES
Code Hunt programming game
Discover the arithmetic operation applied to 'x'.

```java
public class Program {
    public static int Puzzle(int x) {
        return 0;
    }
}
```
Discover the arithmetic operation applied to 'x'.

```java
public class Program {
    public static int Puzzle(int x) {
        return 0;
    }
}
```

<table>
<thead>
<tr>
<th>X</th>
<th>EXPECTED RESULT</th>
<th>YOUR RESULT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>0</td>
<td>1</td>
<td>Mismatch</td>
</tr>
<tr>
<td>✓</td>
<td>-1</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Discover the arithmetic operation applied to 'x'.

```java
public class Program {
    public static int Puzzle(int x) {
        return 1;
    }
}
```
Discover the arithmetic operation applied to 'x'.

```java
public class Program {
    public static int Puzzle(int x) {
        if (x == -1) {
            return 0;
        } else if (x == 0) {
            return 1;
        } else if (x == 1) {
            return 2;
        } else {
            return 0;
        }
    }
}
```
Discover the arithmetic operation applied to 'x'.

```java
public class Program {
    public static int Puzzle(int x) {
        return x + 1;
    }
}
```
You repaired and captured the code fragment.

**SKILL RATING:**

you wrote elegant code!

**TOTAL SCORE:** 6

[KEEP TRYING] [NEXT]
public class Program {
    public static int Puzzle(int lowerBound, int upperBound) {
        return lowerBound * upperBound;
    }
}

<table>
<thead>
<tr>
<th>LOWERBOUND</th>
<th>UPPERBOUND</th>
<th>EXPECTED RESULT</th>
<th>YOUR RESULT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>40320</td>
<td>8</td>
<td>Mismatch</td>
</tr>
<tr>
<td>15</td>
<td>24</td>
<td>244933328</td>
<td>360</td>
<td>Mismatch</td>
</tr>
<tr>
<td>16</td>
<td>17</td>
<td>272</td>
<td>272</td>
<td></td>
</tr>
</tbody>
</table>
public class Program {
    public static int Puzzle(int lowerBound, int upperBound) {
        return lowerBound * upperBound;
    }
}
Try to capture the code fragment!

```java
public class Program {
    public static int Puzzle(int lowerBound, int upperBound) {
        int r = 1;
        for(int i = lowerBound; i < upperBound; i++)
            r *= i;
        return r;
    }
}
```
It’s a game!

iterative gameplay
adaptive
personalized
no cheating
clear winning criterion
Audiences

**Students:** proceed through a sequence on puzzles to learn and practice.

**Educators:** exercise different parts of a curriculum, and track students’ progress

**Recruiters:** use contests to inspire communities and results to guide hiring

**Researchers:** mine extensive data in Azure to evaluate how people code and learn
Code Hunt Usage

Code Hunt has had several hundred thousands of users since launch in March 2014.

Stats from Visual Studio Analytics over the period May 22-June 26 indicate 40,235 users.

Stickiness (loyalty) is very high.

% Returning < 14 days

99.79%
Trend of active users by day

User Frequency
How long before my known users return?

Last week

Active user key performance indicators

<table>
<thead>
<tr>
<th></th>
<th>Avg. Daily Users</th>
<th>Activities</th>
<th>Sessions</th>
<th>Activities per Session</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>854</td>
<td>1.65M</td>
<td>8.77k</td>
<td>187.91</td>
</tr>
</tbody>
</table>
Period 3-10 October, 2014

Languages

- English: 59.66%
- North America: 14.46%
- China: 8.96%
- Oceania: 1.44%
- South America: 8.96%
- Asia: 14.60%
- Europe: 59.66%
- Other: 8.94%
- Chinese: 2.06%
- French: 2.16%
- Czech: 2.28%
- Portuguese: 5.32%
- Spanish: 7.54%
- Russian: 10.67%
- Polish: 20.79%

Sessions: 8,769  Activities: 1,647,766

Sessions: 6,909  Activities: 1,444,846
Microsoft Research launches Code Hunt, an educational Web game for learning programming

Jade Mulders 27 May 2014 12:57 AM | 0

Blog originally posted on thenextweb.com

Microsoft Research today launched Code Hunt, a browser-based game for anyone interested in learning how to code by playing. The premise is straightforward: the player must write code to advance in the game.

The built-in tutorial introduces you to the game:

Greetings, program! You are an experimental application known as a CODE HUNTER. You, along with other code hunters, have been sent into a top-secret computer system to find, restore, and capture as many code fragments as possible. Your progress, along with your fellow code hunters, will be tracked. Good luck.

Code Hunt uses puzzles, which players explore by means of clues presented as test cases, and encourages players to iterate on their code to "capture" it. Their work is then scored depending on the elegance of their solution, and players are encouraged to continue on to the next challenge.
Survey results (735 respondents)

How much did the puzzle aspect of Code Hunt keep you interested in reaching a solution?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A lot</td>
<td>40.7%</td>
</tr>
<tr>
<td>Quite a bit</td>
<td>42.2%</td>
</tr>
<tr>
<td>Not really</td>
<td>17.1%</td>
</tr>
</tbody>
</table>

In your opinion, were your final solutions well-structured code?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, I kept tidying my code up</td>
<td>77.8%</td>
</tr>
<tr>
<td>Not really, there were extra statements in there</td>
<td>15.2%</td>
</tr>
<tr>
<td>My solutions were a mess but they worked</td>
<td>7.0%</td>
</tr>
</tbody>
</table>

We have many other statistics, but not so relevant to contests.
Contest Goals

- identify top coders
- make online competitions more fun

<table>
<thead>
<tr>
<th>2,353 players</th>
<th>41.0 average tries per level</th>
</tr>
</thead>
<tbody>
<tr>
<td>350 top players</td>
<td>7.6 average tries per level</td>
</tr>
</tbody>
</table>

Completed in 2014

- Beauty of Programming, Microsoft China – 2,500 players in four rounds
- TEALS – high schoolers across the USA
- Computer Science Teachers Association Conference
- High School Intern Boot Camp
- Imagine Cup September, Oct 2014 – April 2014
- LASER Summer School, Elba, September 2014

Upcoming

- Code Hunt Polska, 17 October 2014
Creating new contests

• Creating new puzzles
• Requires curation of a puzzle bank
• Original data about each puzzle
  • Group – numbers, arrays, strings, bools, binary
  • Subjective difficulty
  • Source – who wrote the puzzle
  • Features
• Each contest should have a sequence of sectors in increasing difficulty
• Avoid “Bad” puzzles early on – those that fool users
Leaderboard and Dashboard

Visible only to the organizer

Publically visible, updated during the contest
Code Hunt - the APCS (default) Zone

• Opened in March 2014
• 129 problems covering the Advanced Placement Computer Science course
• So far, over 45,000 users started.
Updating the puzzle bank statistics

• Updating the used field
• Modifying the difficulty rating based on user experience
• Options
  • Score – but the score is 1-3 and we know from the survey that 77% of users improve their code to get a 3
  • Tries – a fairly objective reflection of how long it took to find the pattern and program a correct solution
• CAVEAT!!! Users in areas with poor internet are known to use the Capture Code button less
Effect of difficulty on drop off in sectors 1-3

Percentage or 1000 Winners

Sector Level

Percentage drop off from previous

Winners

0 5 10 15 20 25 30 35 40 45 50

1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 1.10 1.11 1.12 1.13 1.14 1.15 2.1 2.2 2.3 2.4 2.5 2.6 2.7 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8
Formula for perceived difficulty

For a particular puzzle

\[ a + b \times \text{tries} + c \times \text{tries} \times \text{distance} \]

\( a = 1, \ b = 0.05, \ c = 0.02, \) or for APCS \( c = 0.001 \)

tries are the average tries for all winners
distance is the number of levels so far

Examples

<table>
<thead>
<tr>
<th>Players</th>
<th>Tries</th>
<th>Sector.Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1683</td>
<td>8.88</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Original difficulty was 2

\[ D = 1 + 8.88/20 + 8.88 \times 29 / 1000 \]
\[ = 1.74 \]

<table>
<thead>
<tr>
<th>Players</th>
<th>Tries</th>
<th>Sector.Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>376</td>
<td>45.08</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Original difficulty was 2

\[ D = 1 + 45.08/20 + 45.08 \times 69 / 1000 \]
\[ = 6.36 \]
## How players perceive difficulty

**BoP China (same community)**  
\(a=1, b=0.05, c=0.02\)

<table>
<thead>
<tr>
<th></th>
<th>Subjective difficulty</th>
<th>Perceived difficulty</th>
<th>Starting players</th>
<th>Ending players</th>
<th>Levels with average tries over 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>BoPQuali</td>
<td>1.59</td>
<td>2.86</td>
<td>13773</td>
<td>307</td>
<td>3 out of 17 = 18%</td>
</tr>
<tr>
<td>BoPPrelimA</td>
<td>2.17</td>
<td>1.93</td>
<td>1017</td>
<td>125</td>
<td>3 out of 6 = 50%</td>
</tr>
<tr>
<td>BoPPrelimB</td>
<td>2.50</td>
<td>1.97</td>
<td>141</td>
<td>131</td>
<td>2 out of 6 = 33%</td>
</tr>
<tr>
<td>BoPSemi</td>
<td>2.60</td>
<td>2.49</td>
<td>1164</td>
<td>113</td>
<td>2 out of 10 = 20%</td>
</tr>
</tbody>
</table>

**CSTA and TEALS (identical contests)**  
\(a=1, b=0.05, c=0.02\)

<table>
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<tr>
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<th>Perceived difficulty</th>
<th>Starting players</th>
<th>Ending players</th>
<th>Levels with average tries over 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEALS (students)</td>
<td>1.96</td>
<td>5.22</td>
<td>61</td>
<td>3</td>
<td>5 out of 23 = 22%</td>
</tr>
<tr>
<td>CSTA (teachers)</td>
<td>1.96</td>
<td>4.38</td>
<td>14</td>
<td>4</td>
<td>7 out of 23 = 30%</td>
</tr>
</tbody>
</table>
## Planned Developments

### Technical enhancements

- Catalog tool for puzzles
- Editing tool for universes
- Automatic testing tool for new universes
- Universe management tool
- Crowdsourcing puzzle creation
- Live feed showing active game play
- Website integrated dashboard
- Content testing of Office Mix plug in
- Maintaining the Java translator
- Support for user-defined types (objects)
- Management tool for data access
- Plug-in infrastructure for new APIs

### Community engagement

- New content semi-annually
- Working with contest Organizers
- Building a research community
- Building a user community
- Collecting usage statistics and answering bug reports

Some of these can be done by stakeholders/partners
Summary:
Code Hunt: A Game for Coding

For **individuals** (K12, introductory courses, geeks)

For **competitions** at any level, world-wide or in house

Based on long-term **research** on symbolic program analysis (Pex, Z3)

Works with **Java** and C#

Runs in any modern **browser**

Now working on **tablets** and **phones**

[www.codehunt.com](http://www.codehunt.com)

[aka.ms/codehuntpolska](http://aka.ms/codehuntpolska)