



## **Research Note**

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## **Human-Competitive Awards 2018**

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*W. B. Langdon*

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# 1 Human-Competitive Awards 2018: The “Humies”

The GECCO 2018 conference in Kyoto, Japan hosted the 15<sup>th</sup> annual “Humies” Awards.

The first annual “Humies” competition was held at the 2004 Genetic and Evolutionary Computation Conference (GECCO-2004) in Seattle (USA). With its generous prize money (provided by John Koza) it has become a staple of the Genetic and Evolutionary Computing calendar. The Humies offer the opportunity to the EC community to showcase its best work, work, which by definition, is better than human.



Figure 1: Erik Goodman presenting the first prize (and \$5 000) to Steve Smith for “A New Evolutionary Algorithm-Based Home Monitoring Device for Parkinson’s Dyskinesia” *Journal of Medical Systems* (2017) [1]. (Photo from Zdenek Vasicek. More photos at <http://www.cs.ucl.ac.uk/staff/W.Langdon/gecco2018>).

## 2 What it means to be Human-Competitive: Eight Criteria

Although the judges will eventually have to deliberate and then decide, to run a competition we need to be reasonably precise by what we mean by “Human-Competitive”. So to enter the Humie competition it is necessary to show that you satisfy one of the following 8 criteria, which were originally proposed by Koza in the 10<sup>th</sup> anniversary issue of GP+EM [5]<sup>1</sup>:

- (A) The result was patented as an invention in the past, is an improvement over a patented invention, or would qualify today as a patentable new invention.
- (B) The result is equal to or better than a result that was accepted as a new scientific result at the time when it was published in a peer-reviewed scientific journal.
- (C) The result is equal to or better than a result that was placed into a database or archive of results maintained by an internationally recognized panel of scientific experts.
- (D) The result is publishable in its own right as a new scientific result independent of the fact that the result was mechanically created.
- (E) The result is equal to or better than the most recent human-created solution to a long-standing problem for which there has been a succession of increasingly better human-created solutions.
- (F) The result is equal to or better than a result that was considered an achievement in its field at the time it was first discovered.
- (G) The result solves a problem of indisputable difficulty in its field.
- (H) The result holds its own or wins a regulated competition involving human contestants (in the form of either live human players or human-written computer programs).

## 3 Judges



Erik Goodman



Una-May O'Reilly



Wolfgang Banzhaf



Darrell Whitley



Lee Spector

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<sup>1</sup>We are now approaching the 20<sup>th</sup> anniversary of “Genetic Programming and Evolvable Machines” and there will be a special issue to celebrate.

## 4 Results

This year there were 16 entries. The judges selected nine to be finalists. The finals were held in front of the judges at this year's GECCO conference. As a result they awarded

- First prize: the Gold Award, \$5 000, to
  - Michael Lones (Heriot-Watt University, Edinburgh, UK),
  - Jane Alty (Consultant in Neurology, Leeds Teaching Hospitals),
  - Jeremy Cosgrove (Leeds Teaching Hospitals NHS Trust),
  - Philippa Duggan-Carter (Department of Neurology, Leeds General Infirmary),
  - Stuart Jamieson (Department of Neurology, Leeds General Infirmary),
  - Rebecca Naylor (York University),
  - Andrew Turner (York University), and
  - Stephen Smith (York University)

for “A New Evolutionary Algorithm-Based Home Monitoring Device for Parkinson’s Dyskinesia”  
Journal of Medical Systems (2017) [1]

- Second prize: the Silver award, \$3 000, went to
  - Stephen Kelly (PhD student at Dalhousie University, Canada) and Malcolm I. Heywood (Dalhousie University)

for “Emergent Solutions to High-Dimensional Multi-Task Reinforcement Learning”  
Evolutionary Computation (2018) [2].

- Finally the judges decided to split the third prize, the Bronze award, evenly between two finalists (\$1,000 each):
  - \* Emma Hart (Napier University, Edinburgh, UK)
  - \* Kevin Sim (Napier University),
  - \* Barry Gardiner (INRA, Bordeaux, France) and
  - \* Kana Kamimura (Shinshu University, Japan)

for “A Hybrid Method for Feature Construction and Selection to Improve Wind-damage Prediction in the Forestry Sector” (GECCO 2017) [3]

- \* Milan Ceska (Brno University of Technology, Czech Republic),
- \* Jiri Matyas (PhD student at Brno University of Technology),
- \* Vojtech Mrazek (PhD student at Brno University of Technology),
- \* Lukas Sekanina (Brno University of Technology),
- \* Zdenek Vasicek (Brno University of Technology), and
- \* Tomas Vojnar (Brno University of Technology)

for “Approximating Complex Arithmetic Circuits with Formal Error Guarantees: 32-bit Multipliers Accomplished”  
Proceedings of International Conference On Computer Aided Design (ICCAD 2017) [4].

Details of all the Humie entries can be found on <http://www.human-competitive.org/awards>

## **4.1 Winner**

Parkinson's Dyskinesia is an incurable severe form of Parkinson's disease where the patient suffers from involuntary jerking movements and muscle spasms (dyskinesia). However it can be treated with drugs, e.g. Levodopa. Lones et al. [1] were awarded first prize for the invention of a home based monitoring device that allows dyskinesia to be measured as a patient goes about their daily routine (Figure 2). The degree of shaking helps doctors to recommend drug dosage. The patented monitor uses a predictive model which was trained using Cartesian Genetic Programming [6]. It has been approved for European clinical use and is already in routine use internationally (three large UK Hospitals, Leeds, Harrogate and Scarborough) and one in China (Ruijin Hospital, Shanghai).

To paraphrase the winning entry, they showed the successful application of evolutionary computing (CGP) to resolve a challenging and life-affecting clinical condition (i.e. Parkinson's dyskinesia). They have published a health economic assessment [7] which shown that not only will the introduction of the technology significantly improve the quality of life but also has the potential to save the UK's National Health Service over £84m per year.

## **4.2 Runner up**

Google's successfully application of Deep Learning on highly parallel hardware (GPUs) to games, particularly GO, is well known. More recently they have have success with applying it to play computer based video games using only the visual cues available to human players (i.e. the pixels on the screen). A particular benchmark is the Atari 2600 suite of games [8].

To paraphrase Kelly and Heywood, they applied Genetic Programming [9] and were able to match the quality of deep learning but their evolved model was at least three orders of magnitude smaller allowing real time performance without specialized hardware support. This means the evolved solutions execute on a laptop computer faster than any form of solution employing Deep Learning.

## **4.3 Bronze Prize: Storm Damage to Forests**

Storms can cause severe damage to trees. For example, in 2009, a storm lead to losses of  $\approx 1.8 \cdot 10^9$  euros to forests in south-west France. Genetic Programming [9] gave much better models of storm damage, giving better predictions of the causes leading to damage and so leading to improved forest management [10].

## **4.4 Bronze Prize: Evolving an Approximate 32-bit multiplier**

Many very clever people have worked on digital electronic circuits to do arithmetic for many years. In just a few hours, using Cartesian Genetic Programming [6], Milan Ceska et al. were able to evolve arithmetic circuits (e.g. for addition or multiplication) which trade-off circuit size versus accuracy in a principled way, with formal guarantees on the maximum permitted error.

## **5 Next year**

The 16<sup>th</sup> Humie awards will be held next year together with GECCO in Prague, the capital of the Czech Republic, 13-17 July 2019. Do not forget to enter the competition <http://www.human-competitive.org>

# LID-Monitor



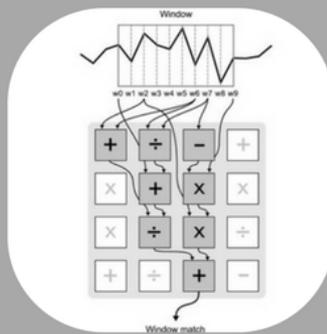
- Measures limb movements
- Non-invasive
- Easy to use



- Continuous monitoring of dyskinesia in the patient's home



Data uploaded via smartphone or dock



Data analysed using evolutionary algorithms



Summary allows Dr to adjust medication

Figure 2: Schematic of ClearSky's Parkinson's Disease system which won the Gold Humie at GECCO-2018. Monitoring Levodopa-induced dyskinesia (LID) gives the patient's doctor information about the severity and frequency of patient shaking (dyskinesia) events and so allows them to better adjust the dosage of Levodopa. Top left: the mobile monitor and logging system. These are worn at home by Parkinson's patient (Top Right). Bottom Centre: the logged data are analysed by an algorithm evolved using Cartesian Genetic Programming and the results are presented to the patient's doctor (Bottom Right).

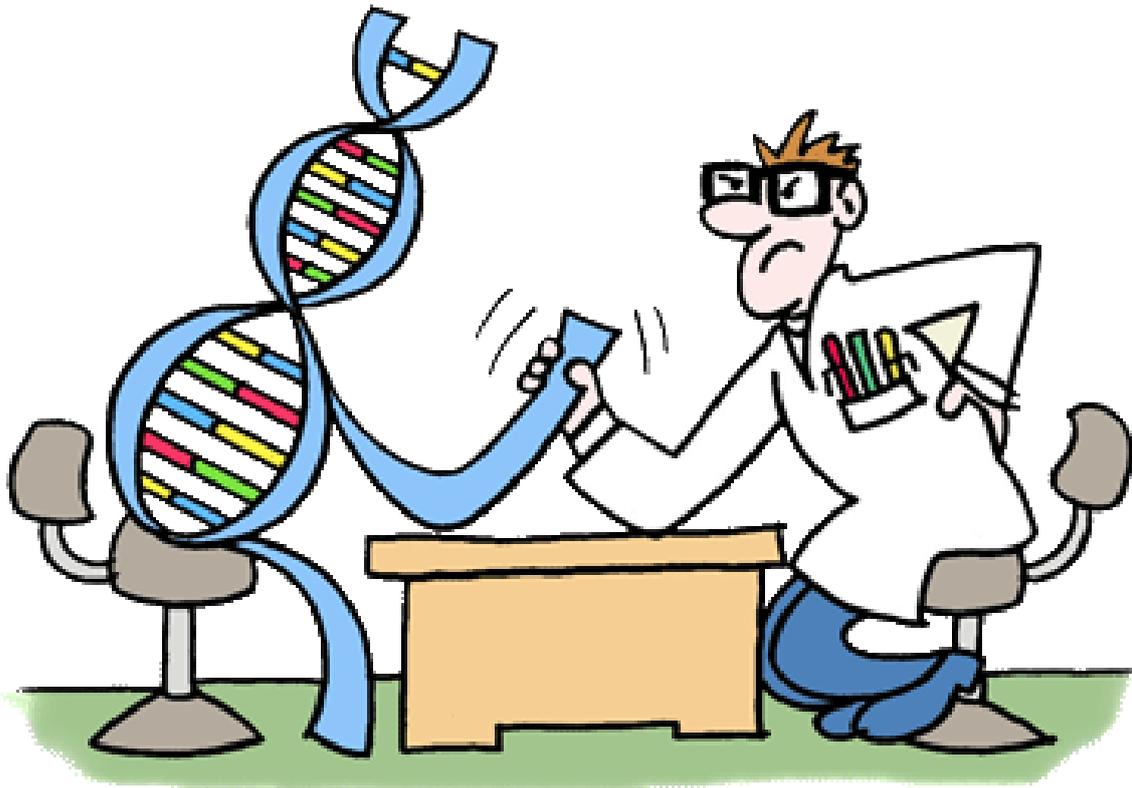


Figure 3: The Humies logo shows evolutionary computation, in the shape of an artificial intelligence double spiral DNA, arm wrestling a human expert (shown as a white coated “boffin”). The goal of the “Humies” Awards is to show case human competitive results, produced by genetic or evolutionary computation

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