The Genetic and Evolutionary Computation Conference

GECCO 2011
Human Competitive Awards

Evolving Two Dimensional Strip Packing Heuristics

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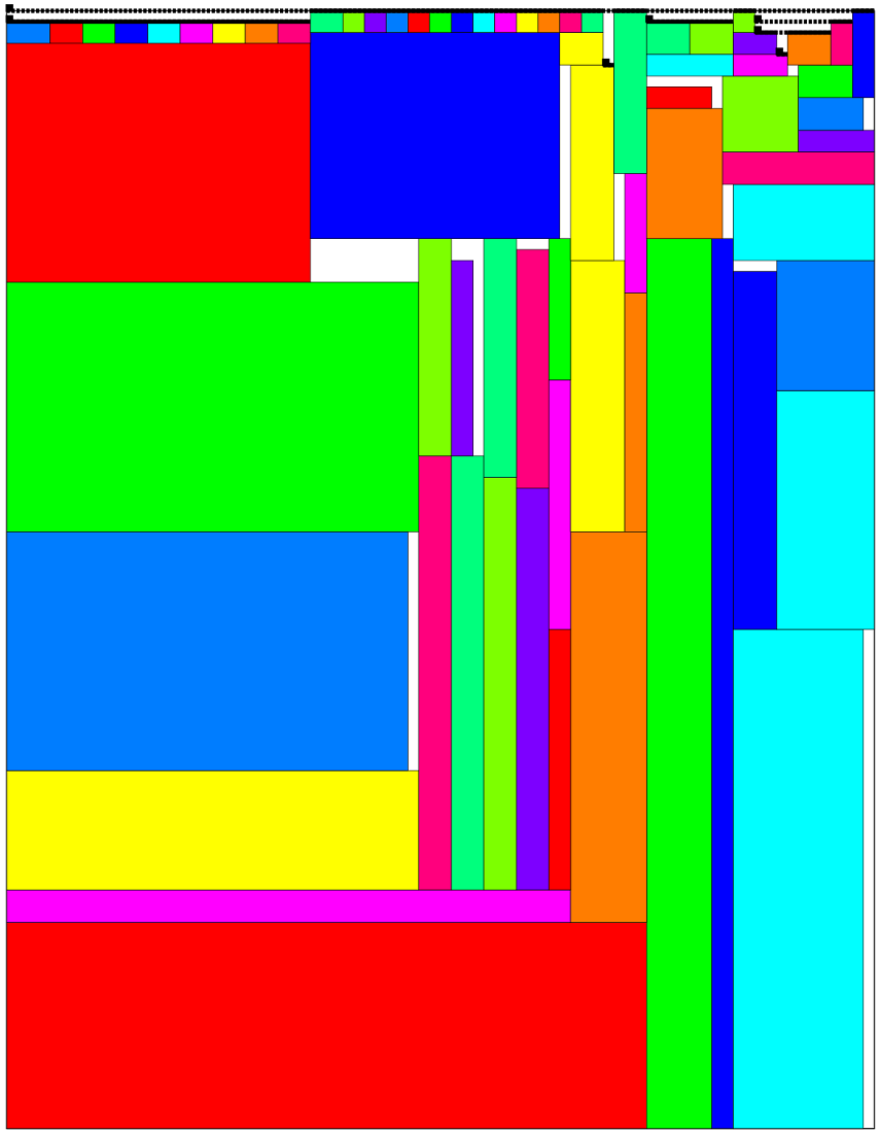
Outline

- Why the result qualifies as human competitive
- Why the judges should consider it as the "best" in relation to the other entries

2D Packing

- 2D packing problem
- Minimise the height
- Solution found by an evolved heuristic. Not found 'directly' by GP



Justification for "human-competitive"

- 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.
- 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.

- Competitive with →
- Better than →

Burke; G. Kendall & G Whitwell. *A New Placement Heuristic for the Orthogonal Stock-Cutting Problem*. Operations Research, Volume 55, Number 4, Pages 655-671, **2004**.
E. Hopper & B. C. H. Turton. *An Empirical investigation of meta-heuristic and heuristic algorithms for a 2D packing problem*. European Journal of Operational Research, Volume 128, Number 1, Pages 34-57, **2001**.

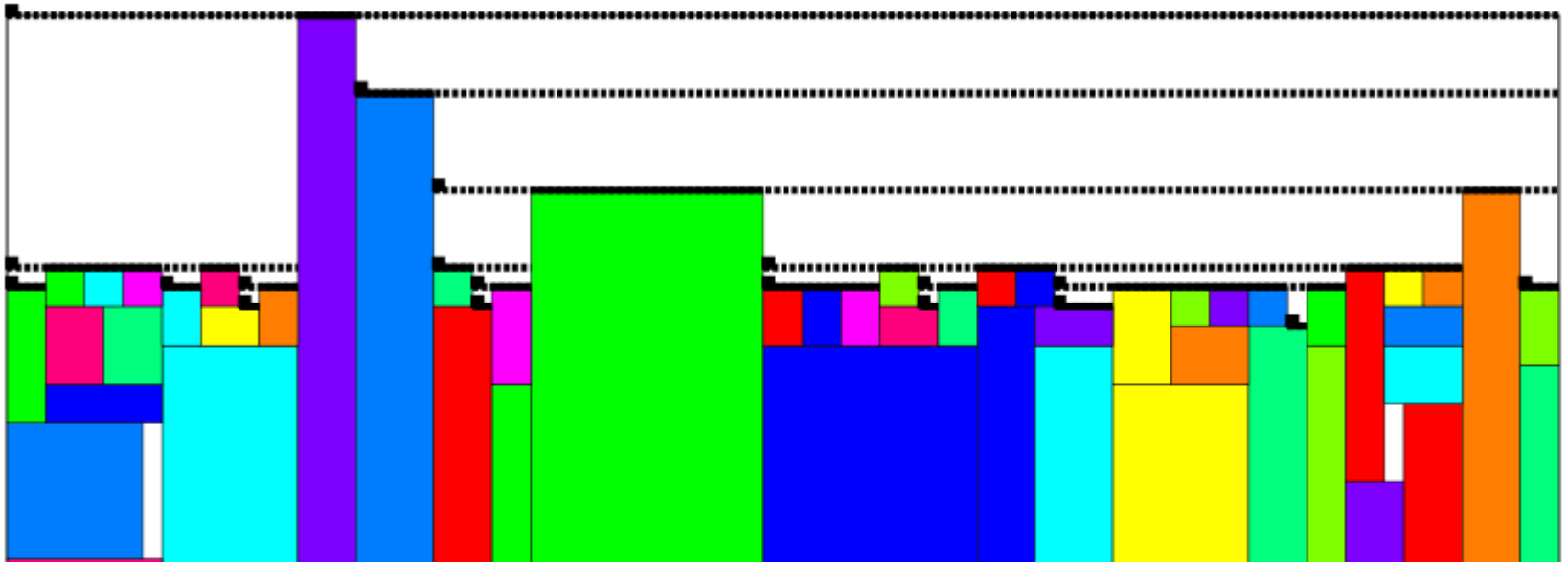
Justification for "human-competitive"

- 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.

- References at the end show a succession of increasingly better solutions.
- "Best-Fit" is the most recent.
- Our evolved heuristic is (at least) competitive with Best-Fit.

Justification for "human-competitive"

- Best-Fit has a post-processing stage, which deals with "towers".
- In contrast, our evolution process designs methods which deal with the problem before it becomes a problem. Superior to Best-Fit's constructive stage.
- Humans have not designed this ability into their heuristics, yet GP does.



Why should it be considered the best?

- 1) Beats the most recent heuristic, not just an older heuristic.
- 2) Evolves specialised heuristics.
- 3) Evolves solution methods, not just solutions.

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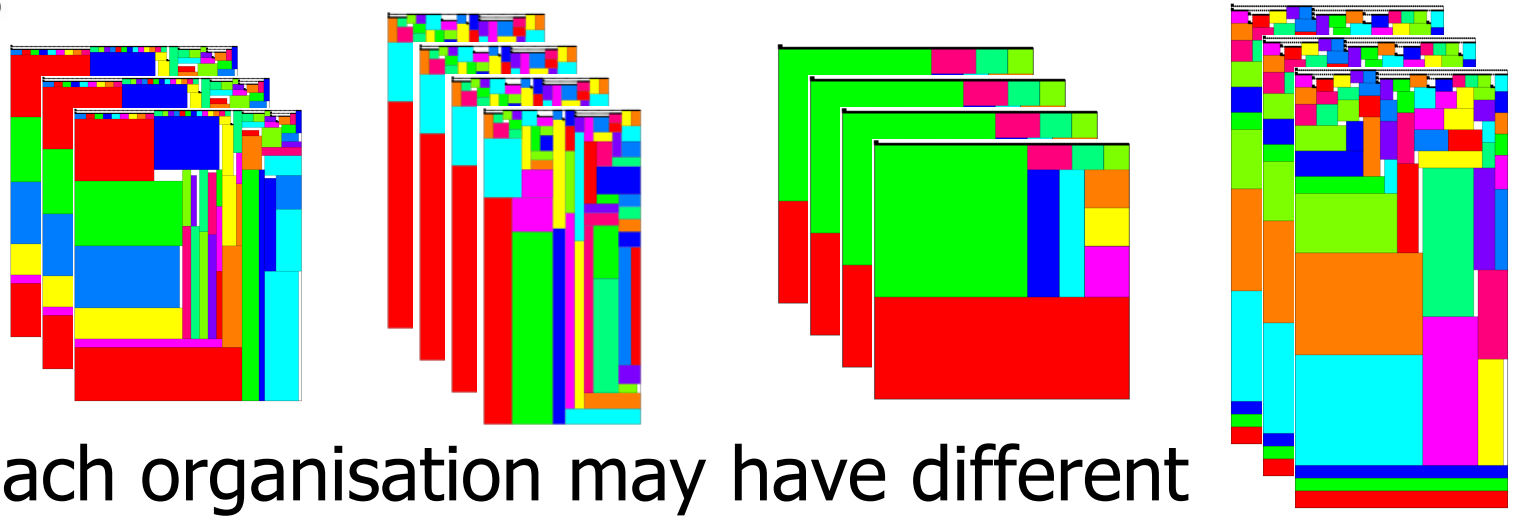

- Each organisation may have different characteristics of problem. Each would ideally require a different heuristic.
- Maybe their problem changes each week, and would ideally need a new heuristic each week.
- With a system based on automatic heuristic generation, this requires

  no extra human effort.

2) Evolves specialised heuristics

- We show that GP can automatically specialise a heuristic to deal with particular problem characteristics.
- Or it can evolve a general heuristic.
- Automatic specialisation is important because it is **time consuming and expensive to do manually**.

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- For example, this is a solution, not a solution method
- The evolved individual cannot go on to create new antennas for different situations

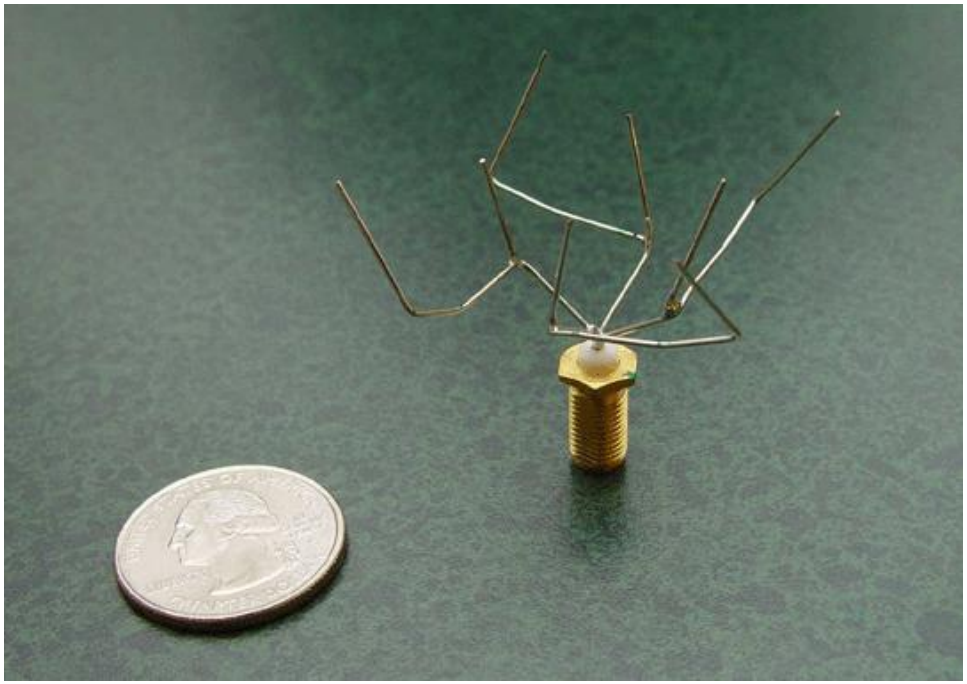
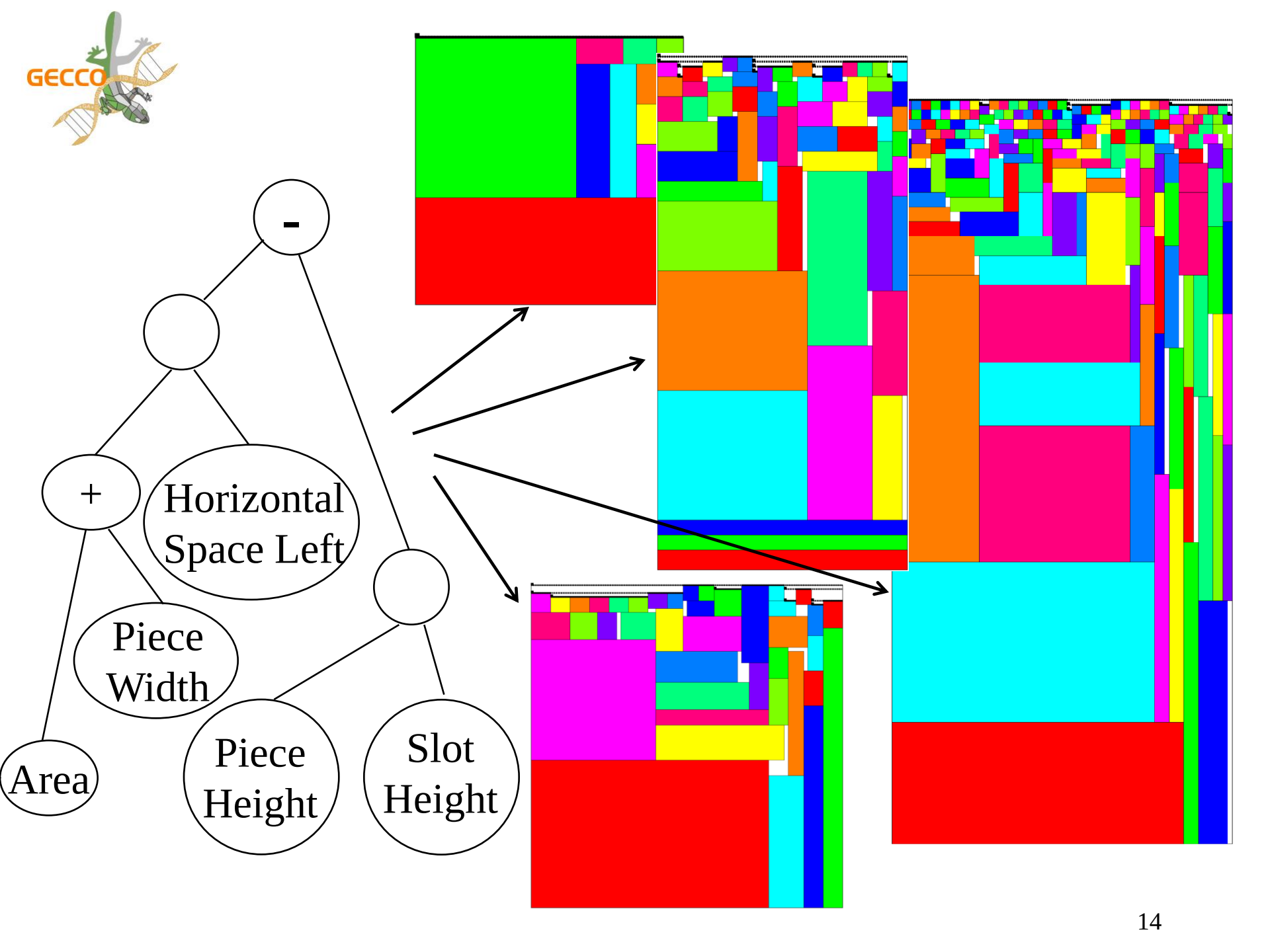


Image source: http://www.genetic-programming.com/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Slot
Height

3) Evolves solution methods, not just solutions

- The evolved individual is **reusable** after it has been evolved
- May not be true of all entries
- The solutions we produce are human competitive
- But importantly, we show that GP can design human competitive **solution constructors**

Summary

- The evolved individuals in this work are heuristic methods in their own right,

  which are shown to be as good as the very best heuristic methods designed by humans.

Thank you for listening

Questions?

References

- References show a succession of solutions to this long standing problem
- Brenda S. Baker; Edward G. Coffman & Ronald L. Rivest. ***Orthogonal Packings in Two Dimensions.***. SIAM J. Comput., Volume 9, Number 4, Pages 846-855, 1980.
- D. Sleator. ***A 2.5 Times Optimal Algorithm for Packing in Two Dimensions.*** Information Processing Letters, Volume 10, Number 1, Pages 37-40, 1980.
- E. Hopper & B. C. H. Turton. ***An Empirical investigation of meta-heuristic and heuristic algorithms for a 2D packing problem***. European Journal of Operational Research, Volume 128, Number 1, Pages 34-57, 2001.
- E. Burke; G. Kendall & G Whitwell. ***A New Placement Heuristic for the Orthogonal Stock-Cutting Problem***. Operations Research, Volume 55, Number 4, Pages 655-671, 2004.