
AAIC

Harnessing the Power of Evolution

— James Keal —

Adelaide Artificial Intelligence Club

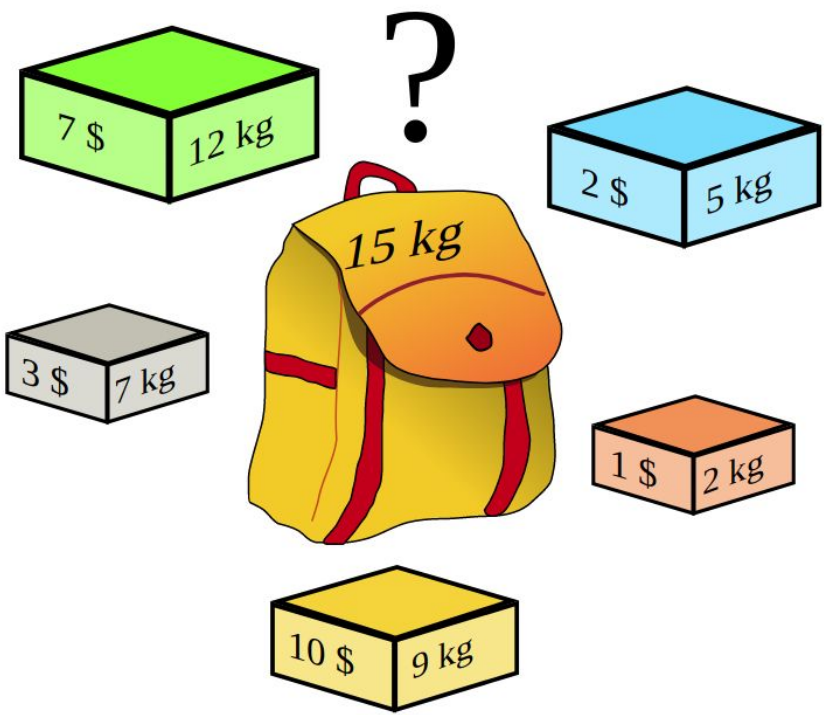
Optimisation

What is it?

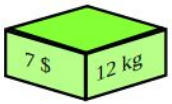
Optimisation

Making something the best it can be.

What kind of problems?



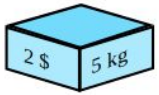
1.11 $/kg



0.58 $/kg

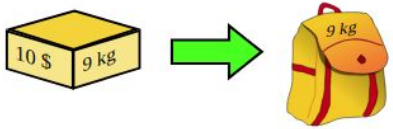
0.5 $/kg

0.43 $/kg

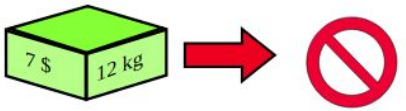


0.4 $/kg

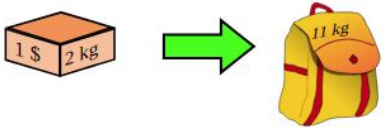
(1)



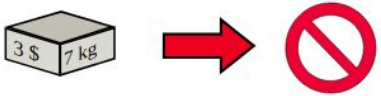
(2)



(3)



(4)



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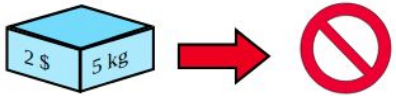
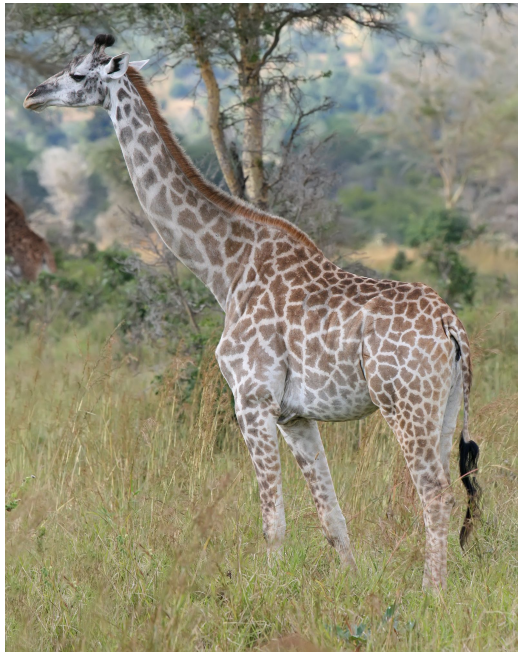


What kind of problems?

- Problems for which many possible solutions exist
- Problems for which solutions are easy to evaluate and compare...
- … but solutions are difficult or impossible to check if optimal

What kind of problems?



Genetic Algorithms

- A solution search algorithm inspired by natural selection
- Part of a much larger field known as “evolutionary computation”
- Developed by John Holland, University of Michigan, 1970

Genetic Algorithms

1. Encode solutions as *genomes* (strings)
2. Define the *fitness* function
3. Randomly generate a *population* of *individuals*
4. *Repeat:*
    a. *Select* individuals from the population based on fitness
    b. *Mate* selected individuals to produce a new population
    c. *Mutate* some individuals to introduce diversity

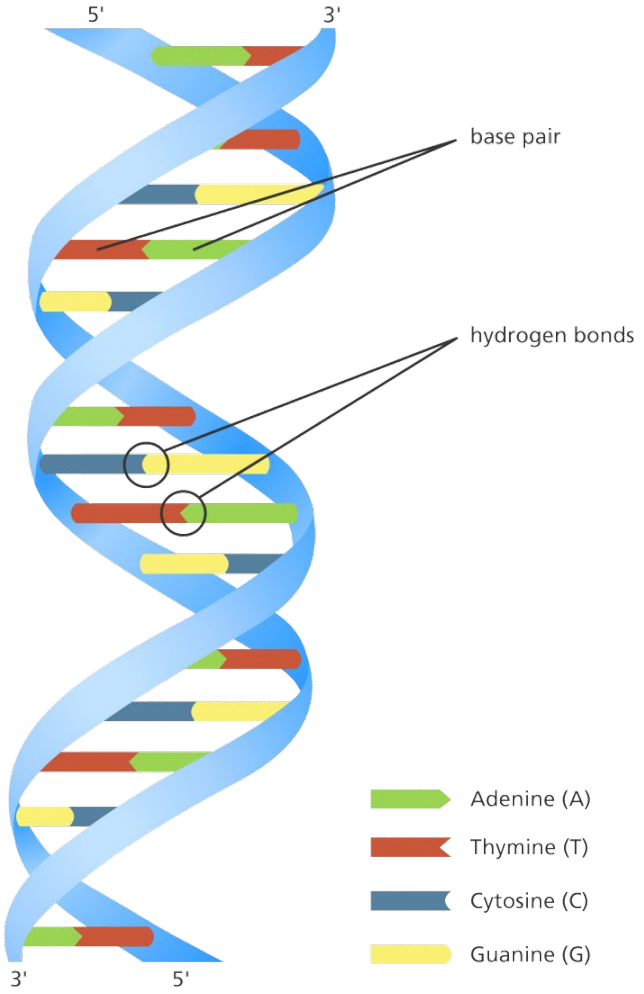
GAs

1. Encode solutions as genomes (strings)

$$X = [A,G,A,A,G,T,C,T]$$

2. Define the fitness function

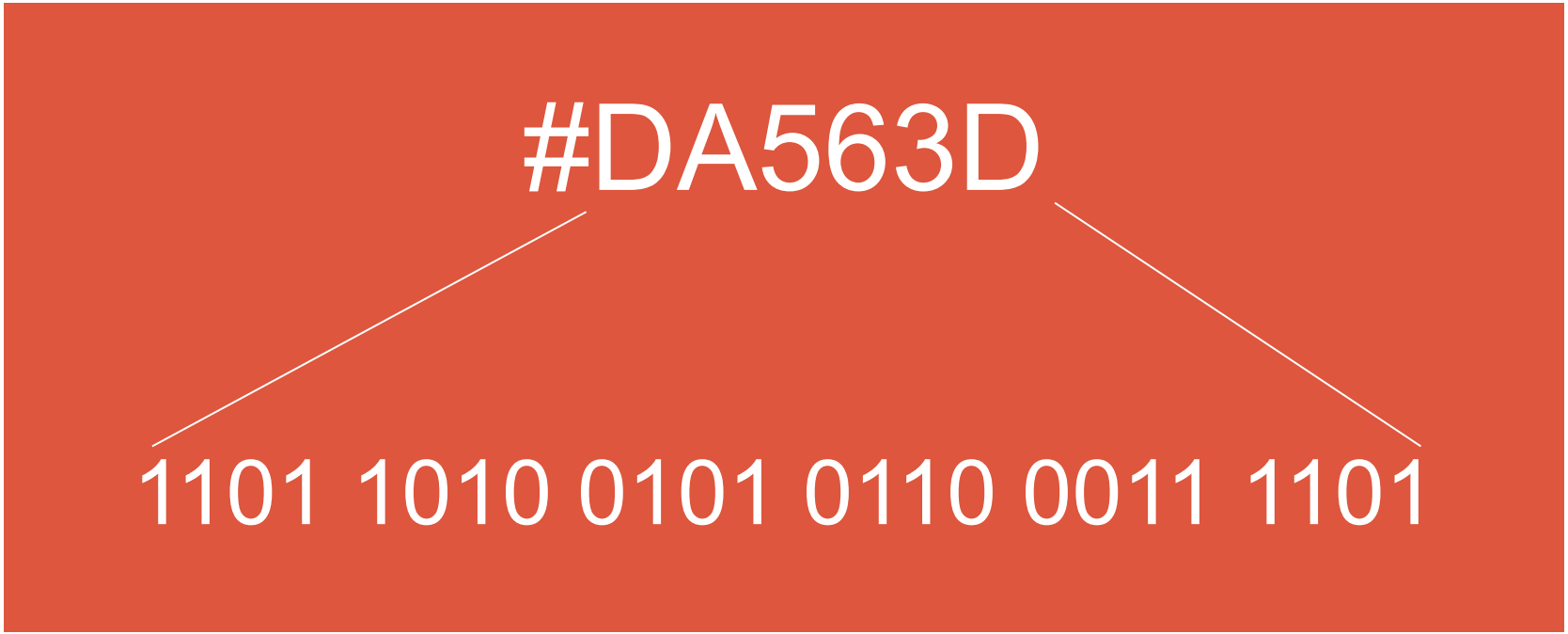
$$f(X) = 5$$



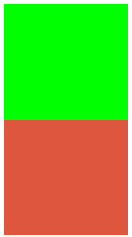
Example: Colours

#DA563D

Example: Colours



Example: Colours

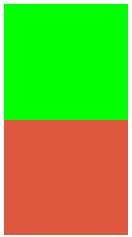


T = 0000 0000 1111 1111 0000 0000

X = 1101 1010 0101 0110 0011 1101

$$f(X) = \sum_i x_i \odot t_i$$

Example: Colours



T = 0000 0000 1111 1111 0000 0000

X = 1101 1010 0101 0110 0011 1101

$f(X) = 10$

GAs

4. Randomly generate a population of individuals

GAs

4. Repeat:
    a. Select individuals from the population based on fitness

GAs

4. Repeat:
    a. Select individuals from the population based on fitness

- Randomly choose *n* and keep the best, *k* times
- Shuffle and pair then keep the best of each, twice
- Spin a wheel with slice size proportional to fitness

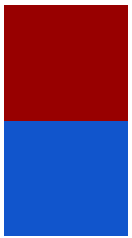
GAs

4. Repeat:
    a. Select individuals from the population based on fitness

- Randomly choose *3* and keep the best, *k* times

GAs

4. Repeat:
   b. Mate selected individuals to produce a new population



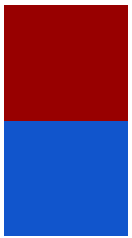
X = 1001 1000 0000 0000 0000 0000

Y = 0001 0001 0101 0101 1100 1100

With some probability P_c

GAs

4. Repeat:
    b. Mate selected individuals to produce a new population



X = 1001 1000 0000 0000 0000 0000

Y = 0001 0001 0101 0101 1100 1100

GAs

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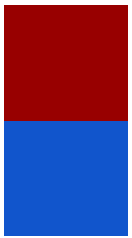

X = 1001 1000 0000 0001 1100 1100

Y = 0001 0001 0101 0100 0000 0000

GAs

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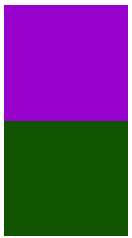
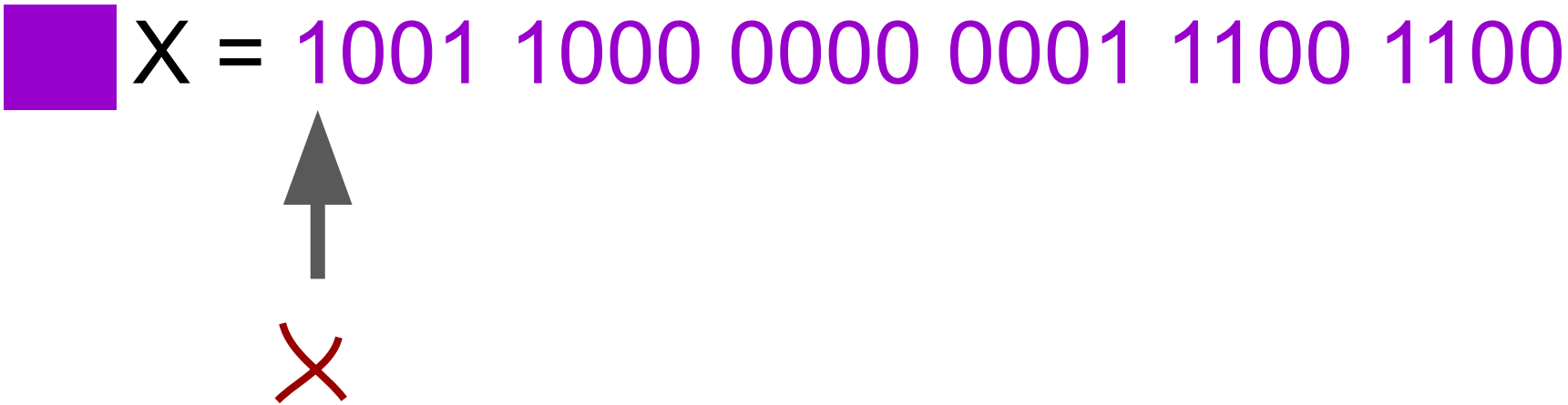


X = 1001 1000 0000 0001 1100 1100

Y = 0001 0001 0101 0100 0000 0000

GAs

4. Repeat:
    c. Mutate some individuals to introduce diversity



GAs

4. Repeat:
    c. Mutate some individuals to introduce diversity

X = 1001 1000 0000 0001 1100 1100

GAs

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X = 1001 1000 0000 0001 1100 1100

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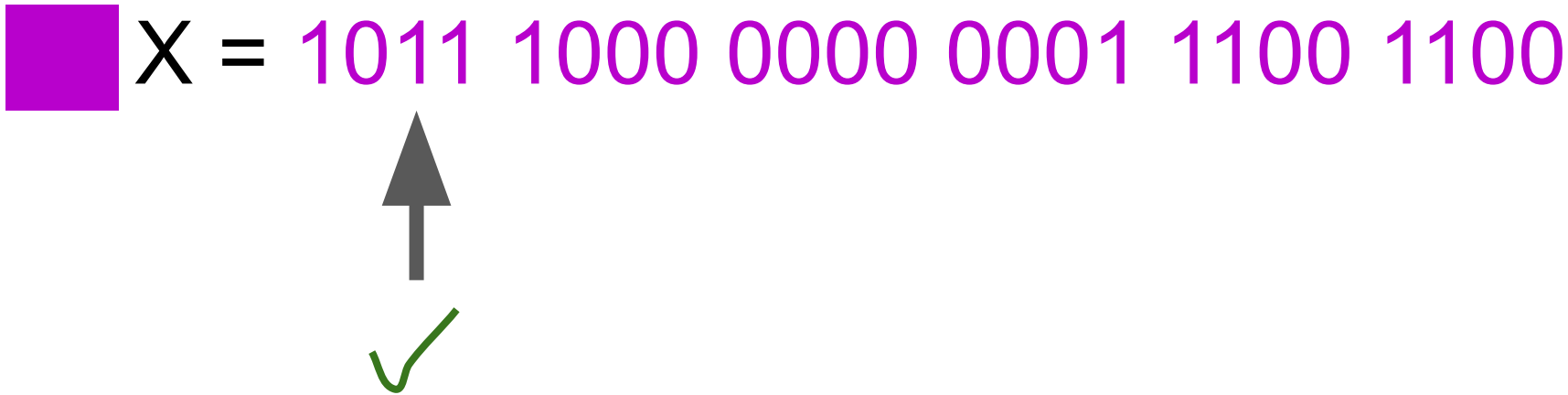
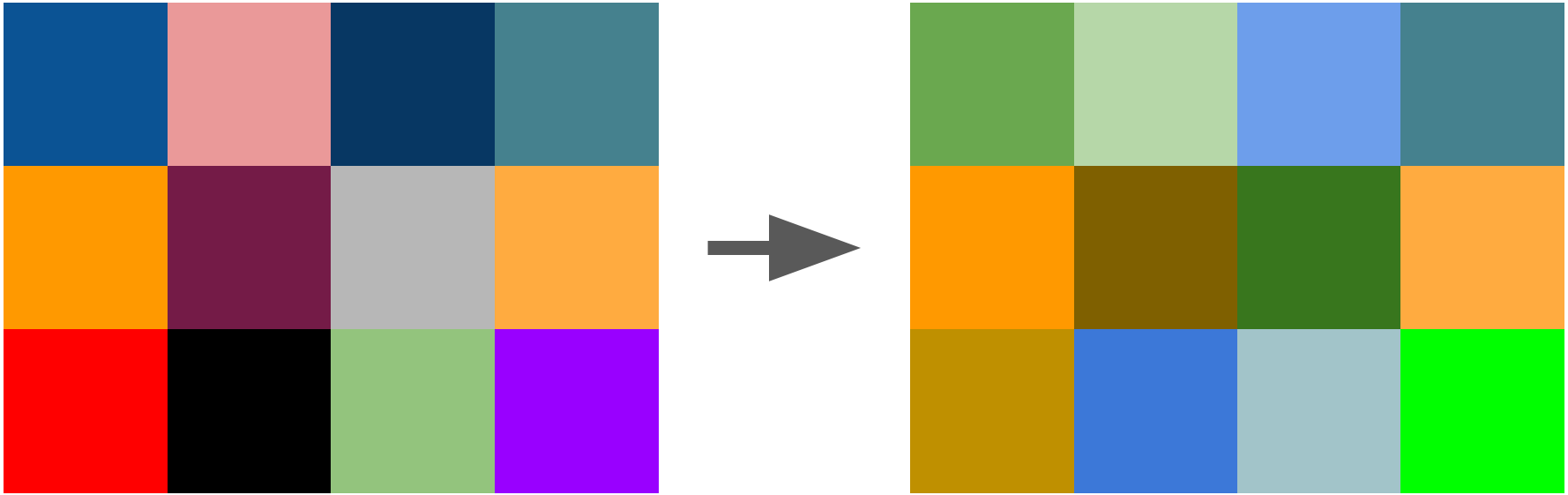
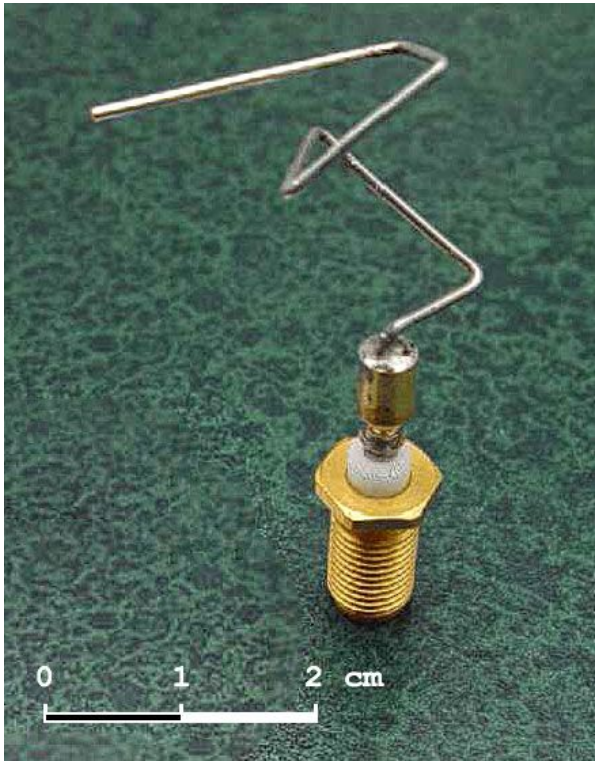


GAs





The 2007 NASA ST5 spacecraft antenna.

GAs

“Flexible Muscle-Based Locomotion for Bipedal Creatures”—Thomas Geijtenbeek

DEMONSTRATION

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