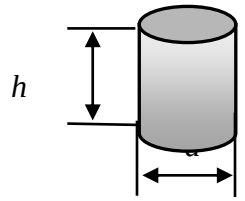
ECE 449 In-class exercise #19 **Fall 2019**

Simple GA application: Design of a cylindrical can
(adopted from "An Introduction to Genetic Algorithms" by K. Deb)

Parameters: diameter *d* and height *h*



Objectives/constraints: minimum volume 300ml, minimize cost of can material
This corresponds to the following NLP problem:

$$\text{Minimize} \qquad f(d,h) = c\left(\frac{\pi d^2}{2} + \pi dh\right)$$

$$\text{Subject to} \qquad g(d,h) = \frac{\pi d^2 h}{4} \geq 300$$

$$\text{Variable bounds} \qquad d_{\min} \leq d \leq d_{\max}$$

$$h_{\min} \leq h \leq h_{\max}$$

Representation:
Parameter values (*d* and *h*) must be represented. Assume binary representation, 5 bits per parameter, i.e. overall length of the string l=10. The following string represents a can of diameter 8 cm and height 10 cm

$$\underbrace{01000}_{d}\ \underbrace{01010}_{h}$$

i.e. (*d*, *h*)=(8, 10) cm is represented by chromosome **0100001010**

This corresponds to $d_{\min} = h_{\min} = 0$ and $d_{\max} = h_{\max} = 31$. This can be generalized using scaling function

$$x_i = x_i^{min} + \frac{x_i^{\max} - x_i^{\min}}{2^{l_i} - 1} \text{value}(s_i)$$

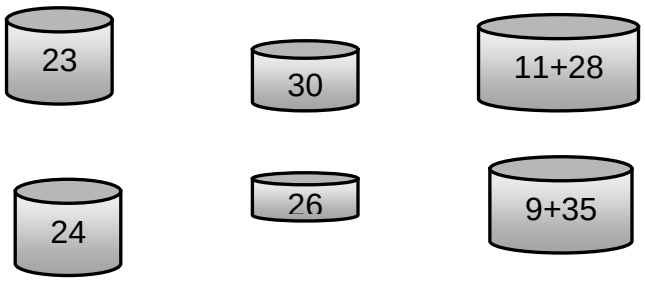
Fitness assignment:

Fitness is assigned to each solution using the fitness function $F(s)$, in our case $f(d,h)$:

$$F(s) = 0.0654\ (\pi \cdot 8^2/2 + \pi \cdot 8 \cdot 10) = 23$$

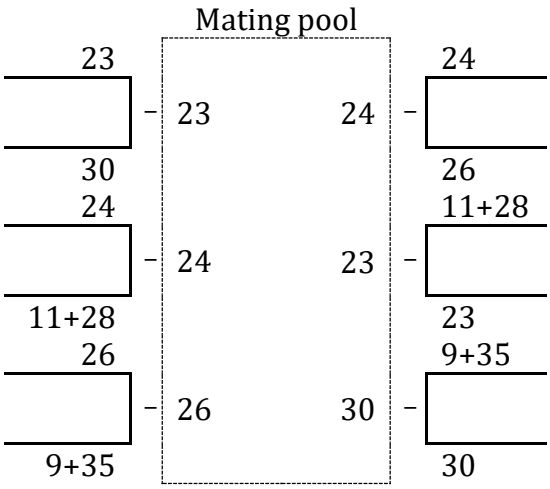
[0.0654 is an arbitrarily chosen unit cost of material used to make the can]

Initial population: Let's assume the following population has been randomly generated



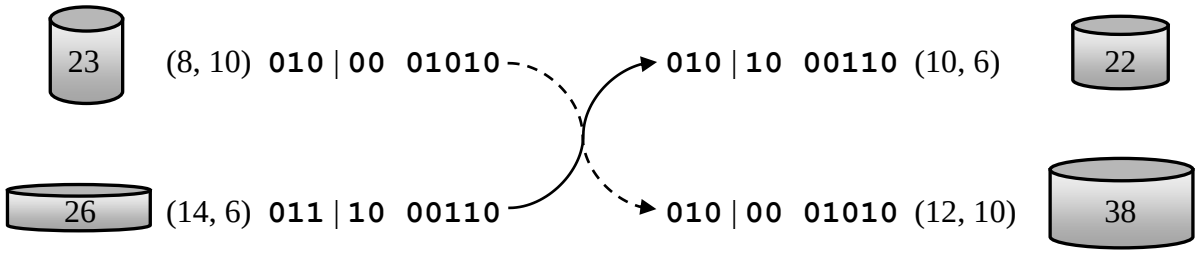
Note: Terms with '+' include penalties for cans that do not satisfy constraints - here $g(d,h)$.

Selection: Let's use tournament selection



Individual	# population	# m. pool
23	1	2
24	1	2
26	1	1
30	1	1
11+28	1	0
9+35	1	0

Crossover: example of combining two individuals (from the mating pool)



Mutation: example of mutation of single individual