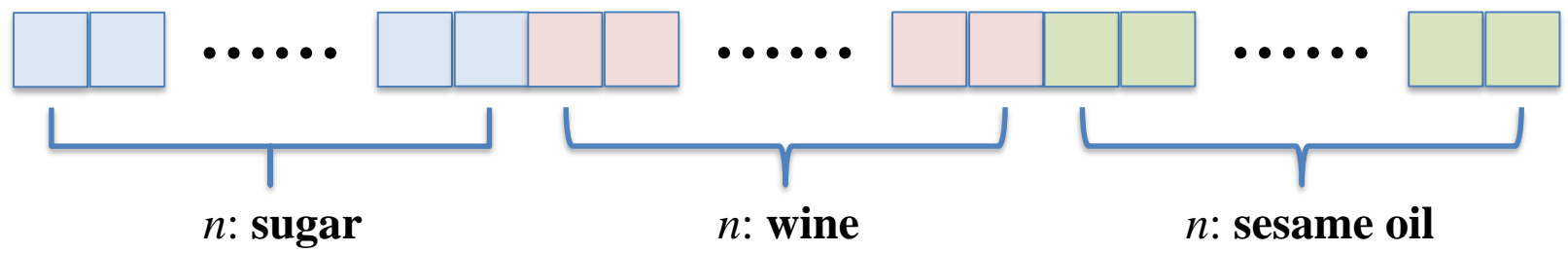**Q1:** Main features of Genetic Algorithms

- Coding – typically binary
- Reproduction
    - ✧ Selection of parents in the current generation
    - ✧ Crossover
    - ✧ Mutation
    - ✧ Fitness evaluation
    - ✧ Selection of off-springs for new generation
- Termination

Q2: (i) Assume that the maximum value is N. Pick n such that $N \leq 2^n - 1$.

n: **sugar** n: **wine** n: **sesame oil**

(ii) Assume the maximum values for colors, sizes, shapes and objects are C, SI, SH, O. Pick l, m, n, p, where

$$C \leq 2^l - 1, \; SI \leq 2^m - 1, \; SH \leq 2^n - 1 \text{ and } O \leq 2^p - 1.$$

l: **red** m: **small** n: **round** p: **apple**
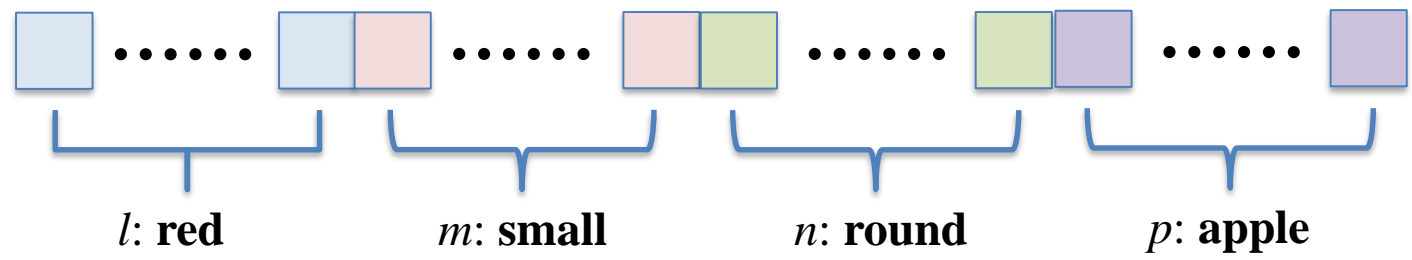
Q3: $f(x) = (a + b) - (c + d) + (e + f) - (g + h)$

(a)

       a b c d e f g h

x1 = 6 5 4 1 3 5 3 2   f(x1) = (6+5)-(4+1)+(3+5)-(3+2) = 9

x2 = 8 7 1 2 6 6 0 1   f(x2) = (8+7)-(1+2)+(6+6)-(0+1) = 23

x3 = 2 3 9 2 1 2 8 5   f(x3) = (2+3)-(9+2)+(1+2)-(8+5) = -16

x4 = 4 1 8 5 2 0 9 4   f(x4) = (4+1)-(8+5)+(2+0)-(9+4) = -19

    x2 , x1 , x3 , x4
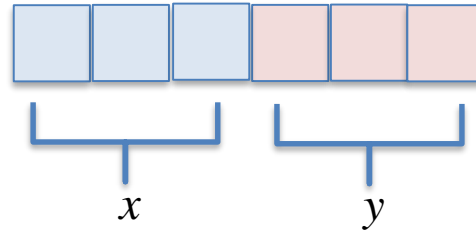
(b)

    a b c d e f g h   **a b c d e f g h**

x1 = 6 5 4 1 3 5 3 2   x1' = 6 5 4 1 6 6 0 1   f(x1') = 17

x2 = 8 7 1 2 6 6 0 1   x2' = 8 7 1 2 3 5 3 2   f(x2') = 15

x3 = 2 3 9 2 1 2 8 5   x3' = 2 5 4 1 3 5 8 5   f(x3') = -3

x1 = 6 5 4 1 3 5 3 2   x1' = 6 3 9 2 1 2 3 2   f(x1') = -4

Q4: $z = x^2 - 2y + 3$, where $0 \leq x, y \leq 7$

Chromosome

For instance: 011 110

x=3 y=6

x y

We can set $f(x,y) = \dfrac{1}{z+M} = \dfrac{1}{x^2 - 2y + 3 + M}$

where $M + z > 0$, for instance, we can pick M very big.