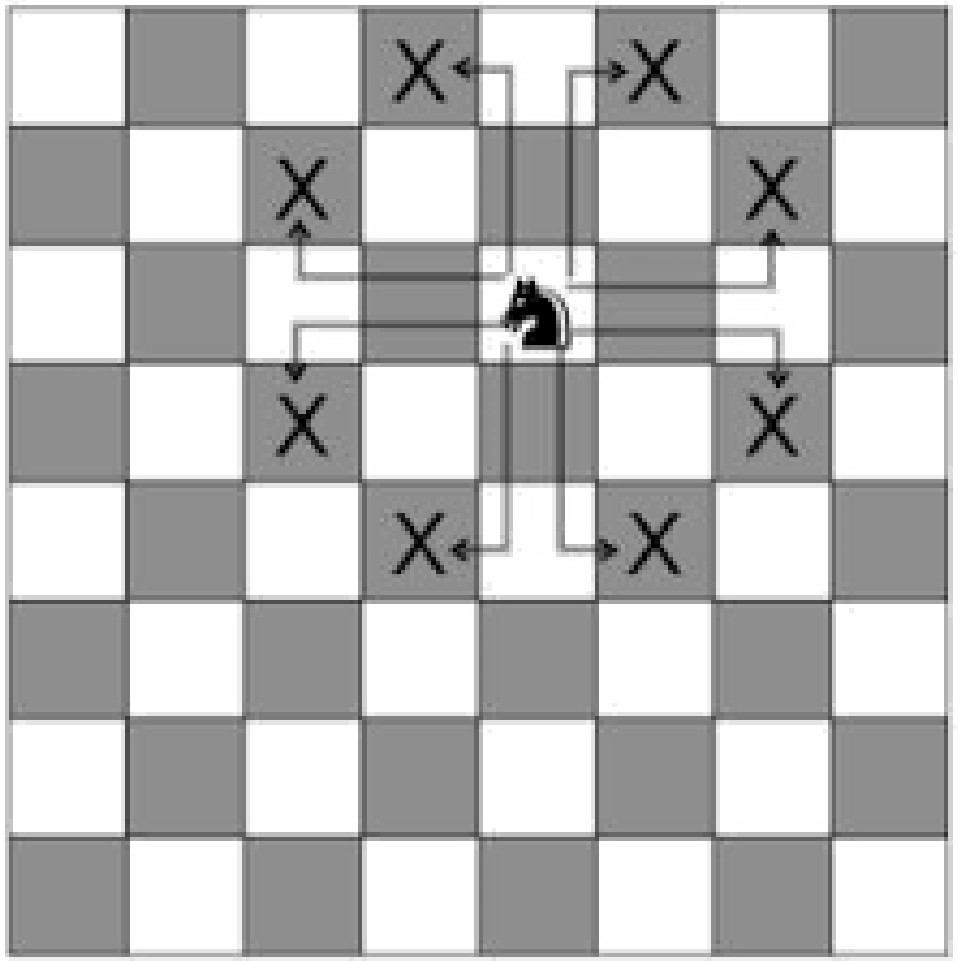
K-Knight Problem

K-Knight Problem



- *Knight movements*:
  - [2, 1]
  - [2,−1]
  - [−2,1]
  - [−2,−1]
  - [1,2]
  - [1,−2]
  - [−1,2]
  - [−1,−2]

K-Knight Problem

- Showing a configuration of *K* knight on a N*N board such that no two knights attack each other.
- Constraints :
  - $\forall_{i,j}\, S_i \neq S_j \;\; (no\ two\ knights\ are\ the\ same)$
  - $\forall_{i,j}\, k_i \notin \{k_j + x | x \in Knight\ moves\} (no\ two\ knights\ attack\ each\ other)$

K-Knight Problem

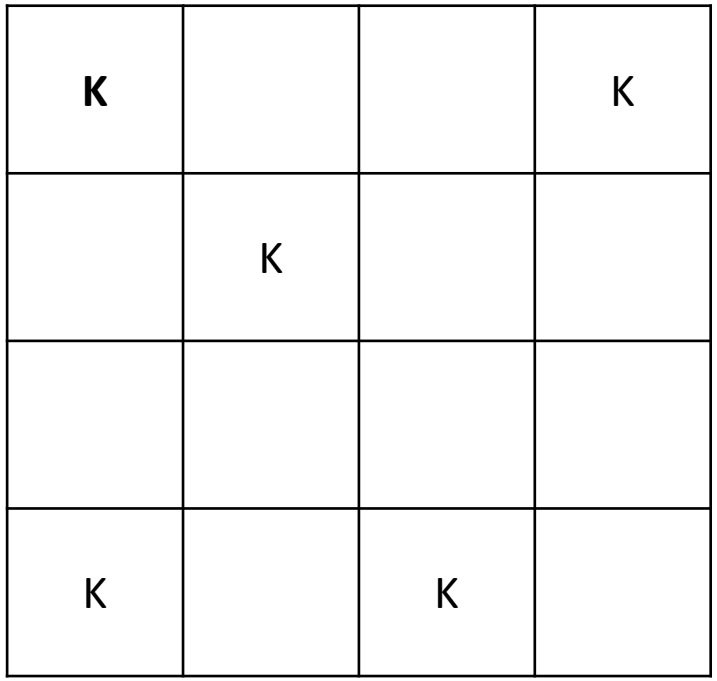
- Each square of the board is given a number based on position
  - $index = row * n + column$
- Each population is a ***sorted*** list that shows position of a knight.

	0	1	2	3
0	0	1	2	3
1	4	5	6	7
2	8	9	10	11
3	12	13	14	15

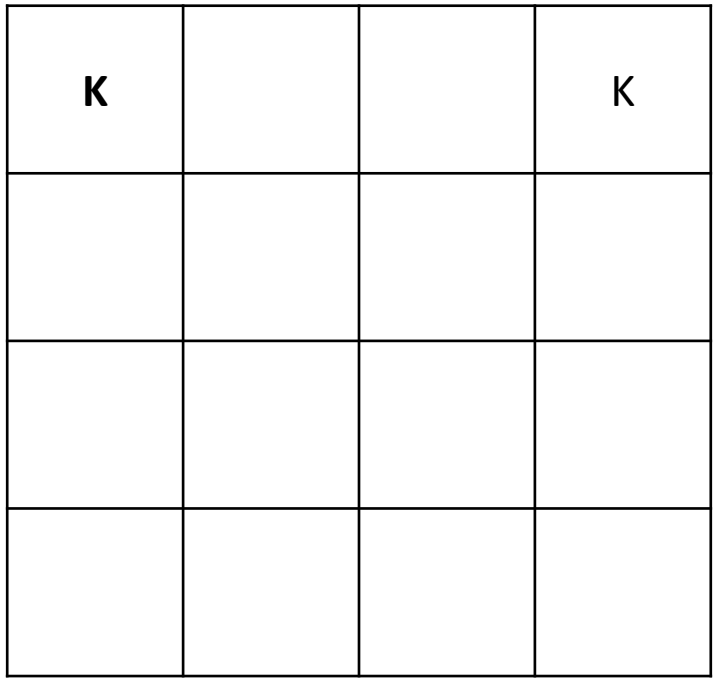
K-Knight Problem

- Examples:

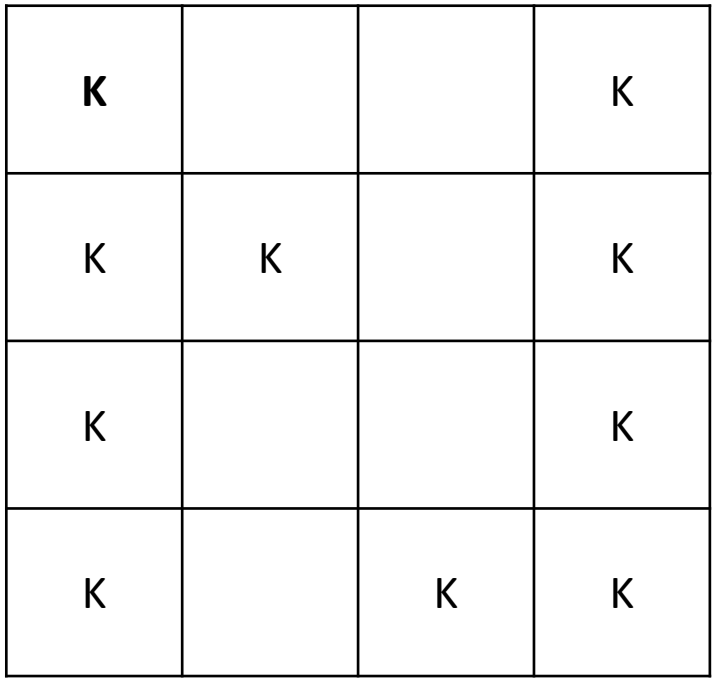
<0,3,5,12,14>



<0,3>



<0,3,4,5,7,8,11,12,14,15>

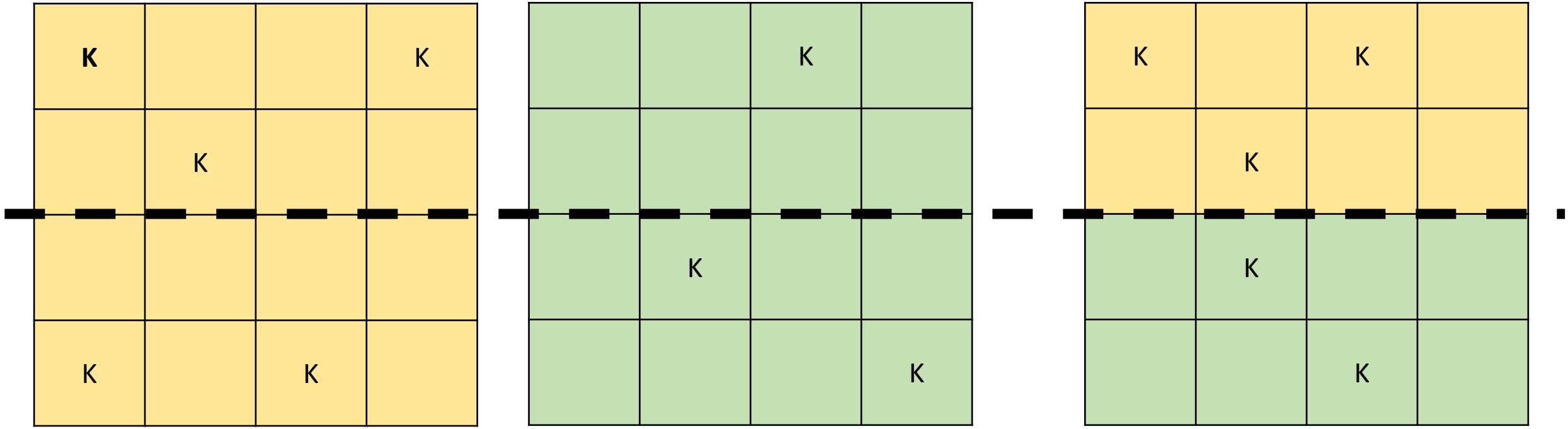


K-Knight Problem

- Fitness:
  - Low number of Conflicts, high number of knights
  - We only count pair of conflicts – each conflict once
  - $f(x) = \begin{cases} k + k_{max}, & conflict = 0 \\ \frac{k}{conflict}, & otherwise \end{cases}$

Crossover

- Single point crossover, on the row



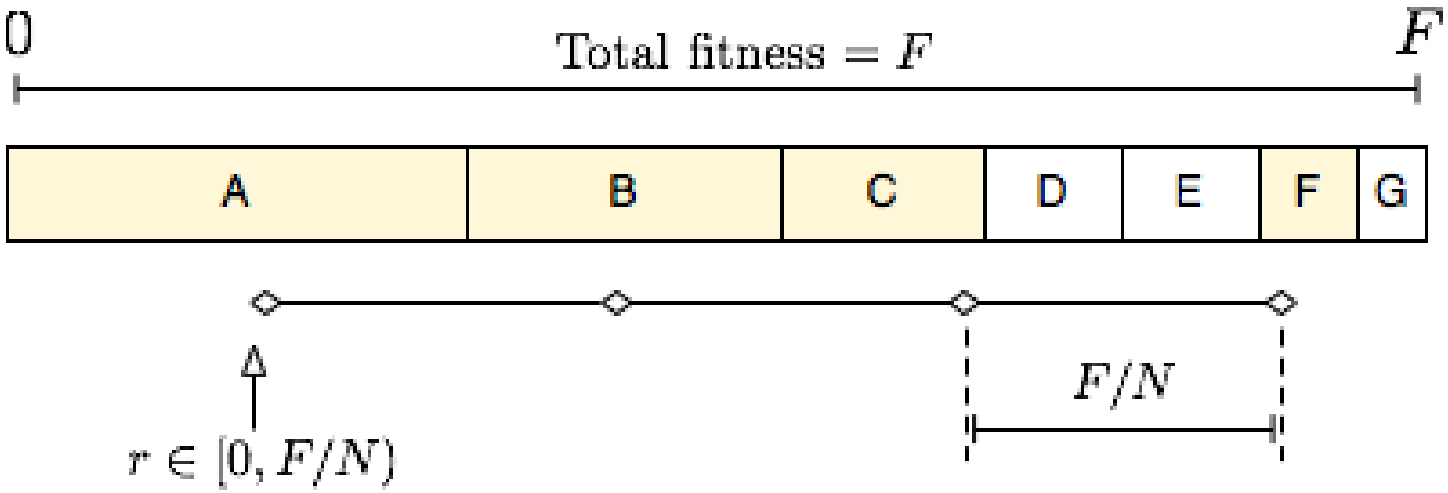
Crossover

- Give each square a number
- $Crossover\ Point = row\ * n + (n\ - 1)$
- Look in each sequence for a lower number and select index before or after that.
- Example:
  - *<1, 3, 5, 8, 13, 14> , row = 2*
  - *-> crossover point = 11*
  - *Index = 5*
  - *<1, 3, 4, 8> <13, 14>*

	0	1	2	3
0	**0**	**1**	**2**	**3**
1	**4**	**5**	**6**	**7**
2	**8**	**9**	**10**	**11**
3	**12**	**13**	**14**	**15**

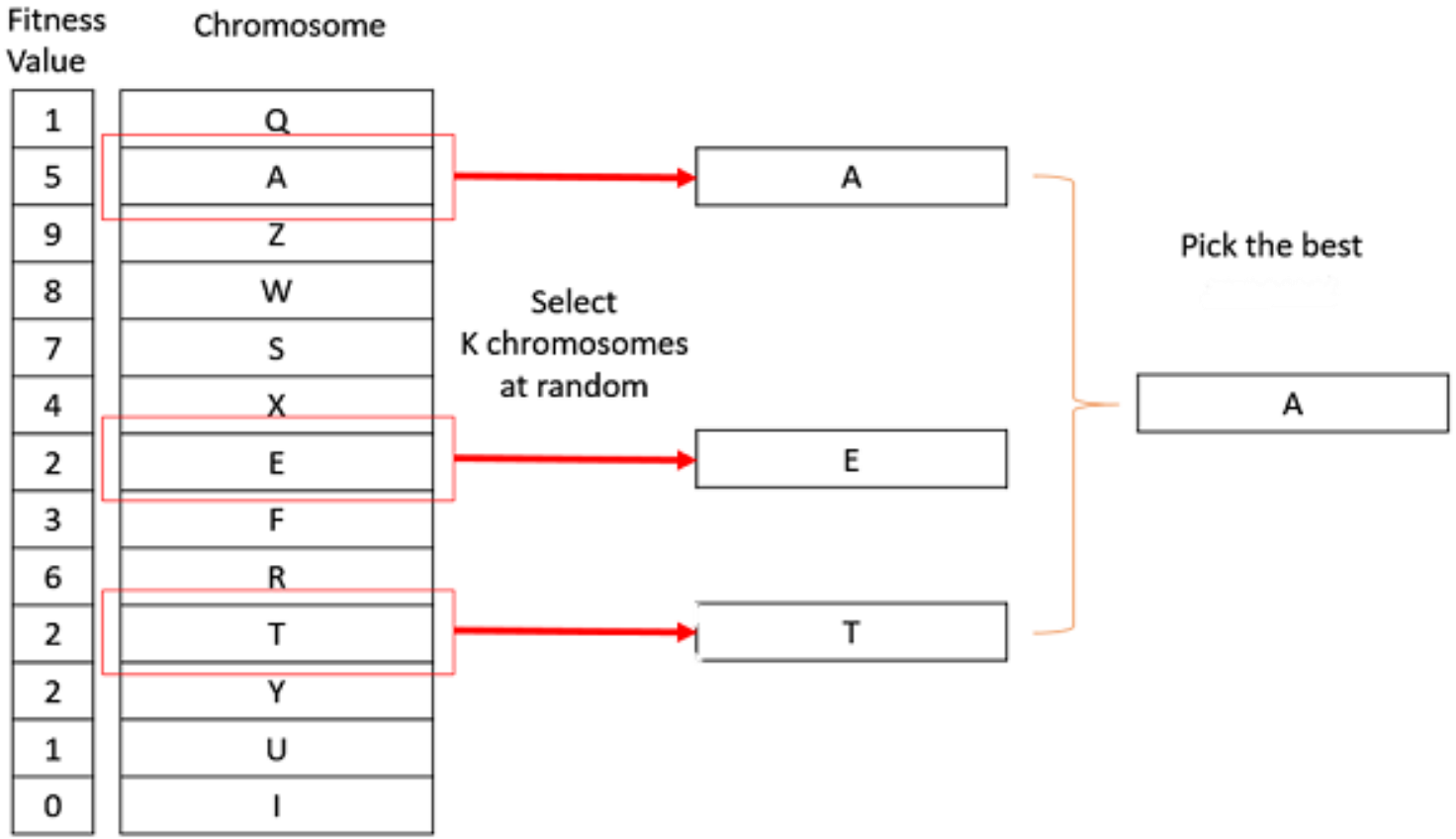
Parent Selection

- Stochastic Universal Sampling (sus)
  - Create a scale based on the fitness of each individual (creating the wheel)
  - Partition the scale by the number of selection we want to perform
    - $Pointer\ Scale = F/N$
    - $r\ (random\ start) = [0, Pointer\ Scale)$



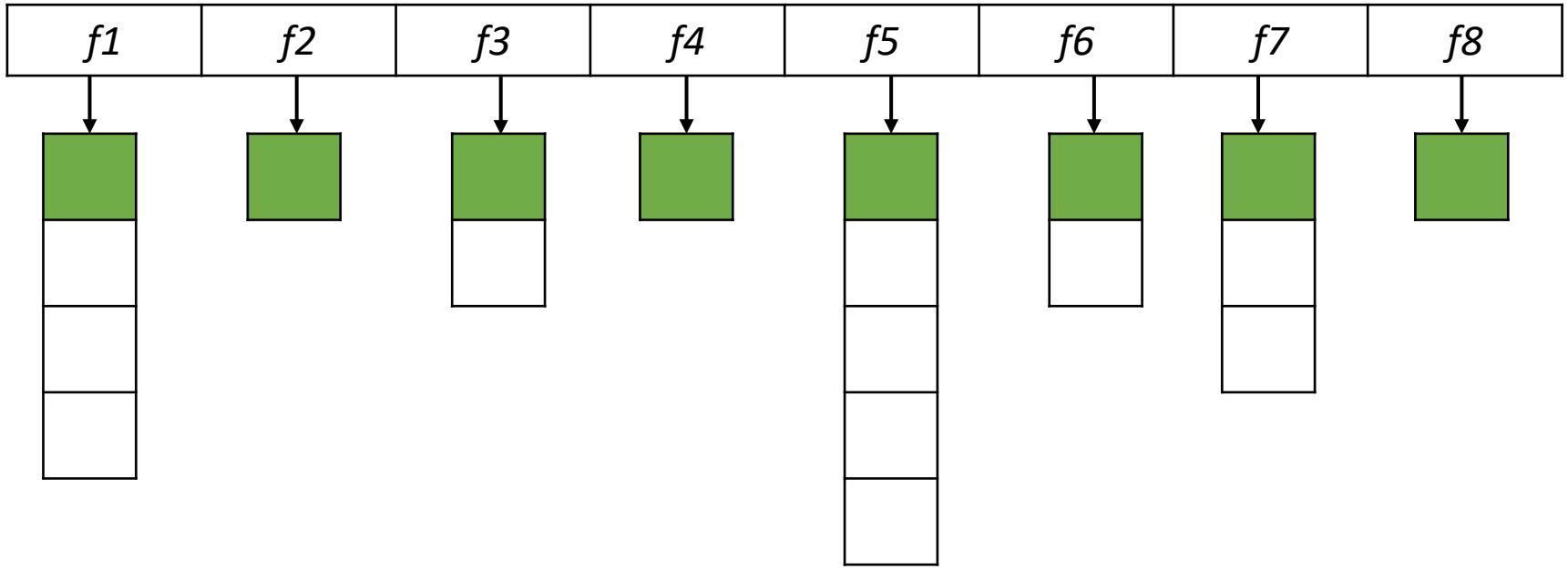
Survival Selection

- Tournament Selection



Reverse Selection

- Divide the population based on fitness
- Have at least one example from each subgroup
- Randomly select the other members



Termination Conditions

- Found the answer
  - *A board with max number of knights in it*
- Evolution steps has ended

- Domination
  - *Tried using reverse selection did not get good answer!*
    - *Number of fitness*
    - *Percent*
- Low improvement

Max Number of Knights

- Max number is $\left\lfloor \frac{n*n}{2} \right\rfloor$
  - Give each row and column a number. $R = \{0, \dots, n-1\}, C = \{0, \dots, n-1\}$
  - Square : $s = \{i, j\}$; $i \in R$, $j \in C$
  - Each Square has a Color $\begin{cases} Black: & i\%2 == j\%2 \\ White: & i\%2 \; ! = j\%2 \end{cases}$
  - Based on the knights movements we can show that knights don't threaten a square with the same color.
  - So coloration of blacks shows that

Max Number of Knights

- We can’t have more than $\left\lfloor \frac{n*n}{2} \right\rfloor$