Introduction to Genetic Algorithm

Implus Tech

Osbert

Previously on Implus Tech Song…

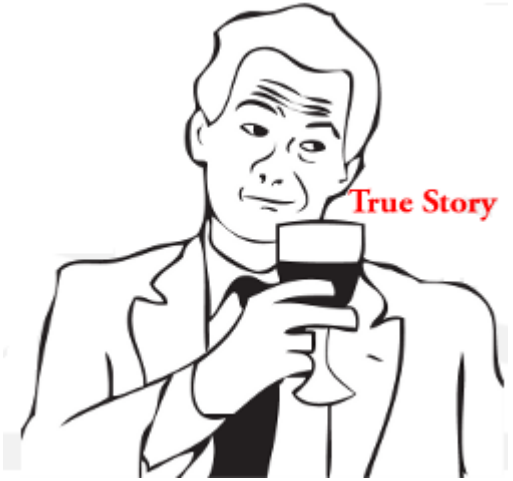
- Machine Learning by Yoga
  - Linear Regression
  - Partial Derivative
  - Gradient Descent

What is **Genetic Algorithm**?

- The **genetic algorithm** is a method for solving both constrained and unconstrained optimization problems that is based on natural selection, the process that drives biological evolution.

What is **Genetic Algorithm**?

- **Genetic Algorithm** is an algorithm that you want to know a good but not necessary the best result of a problem but are ~~having zero idea how to get that – or maybe just you don't want to admit you suck at algorithms so you pretend to be~~ too lazy to implement one, so you give that elixir a try.



For Example(s)

Example 1: Divide the Loot

- Robbers of ***m*** try to divide their loot of bank notes of ***n***. They agree that each of them can get Q_1, Q_2, …Q_m bank notes respectively. But because the face value of the bank notes are different, they also want the average face value of the bank notes that fall into each robber's pocket to be as close as possible. How to find a fair allocation solution?
- What if we know there are only ***k*** different face values?

Everyone Loves Mathematical Representation!

- Let $q_{1,i} + q_{2,i} + \cdots + q_{n,i} = Q_i$ where $Q_i \in \mathbb{N}$ is constant $\forall 1 \leq i \leq m$
- Let $q_{j,1} + q_{j,2} + \cdots + q_{j,m} = Q'_j$ where $Q'_j \in \mathbb{N}$ is constant $\forall 1 \leq j \leq n$
- Let $fv_1, fv_2, \ldots fv_n \in \mathbb{R}^+$ are constants
- Let $\sum_{i=1}^{m} Q_i = \sum_{j=1}^{n} Q'_j$
- Find

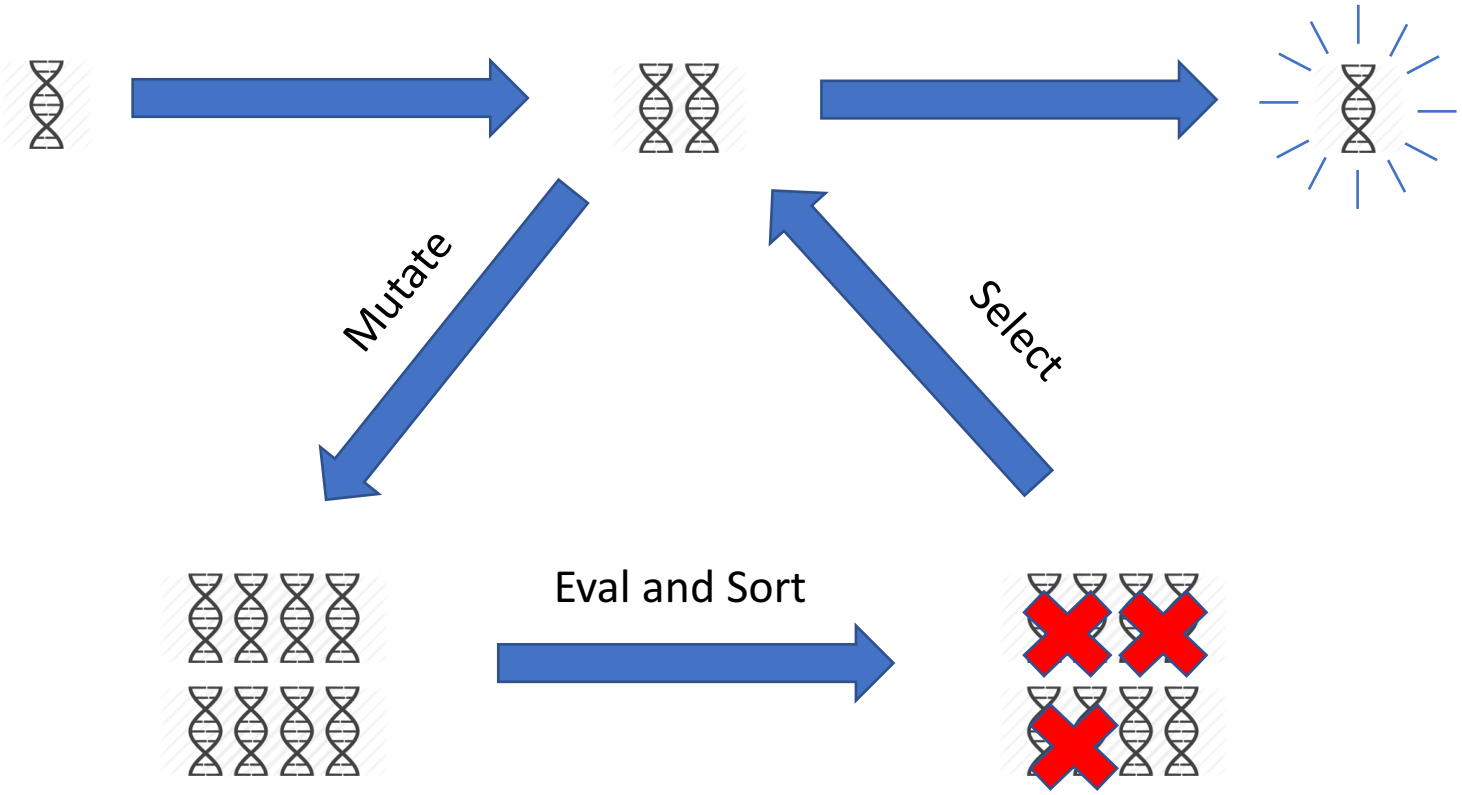
$$\underset{q_{j,i}}{\operatorname{argmin}} \sqrt{\sum_{k=1}^{m} \left(\frac{\sum_{j=1}^{n} q_{j,k} fv_j}{Q_k} - \frac{\sum_{i=1}^{m} \sum_{j=1}^{n} q_{j,i} fv_j}{\sum_{i=1}^{m} \sum_{j=1}^{n} q_{j,i}} \right)^2}$$

- Such that $q_{j,i} \in \mathbb{N}, \forall 1 \leq i \leq m, 1 \leq j \leq n$

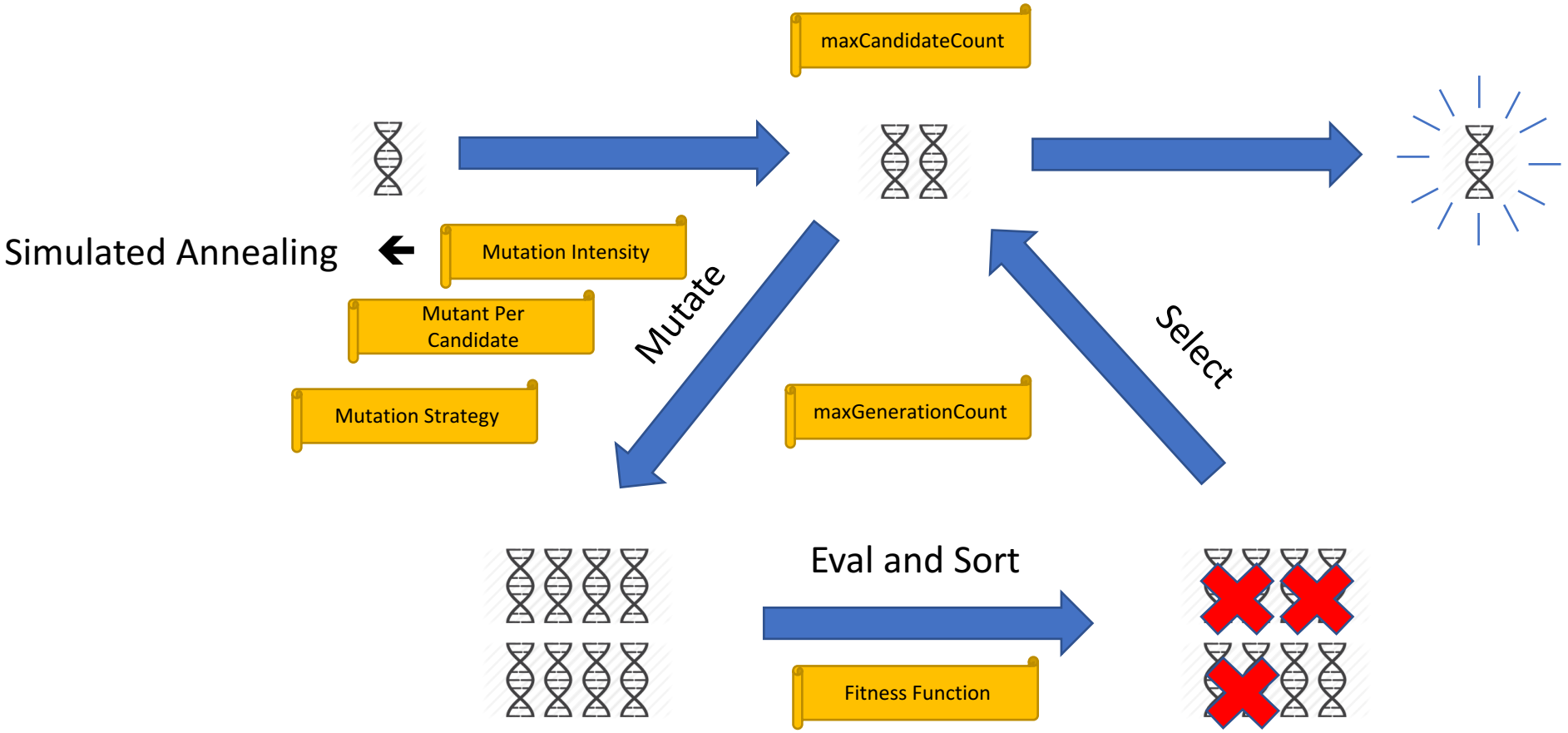
For the Sake of Time…

- This is **Linear Regression** without the restriction of integer (i.e. life will be so much easier for the robbers if the face value of a broken bank note is proportional to its area)
- Unfortunately with the restriction of integer, this problem is at least **Integer Programming** level, which is **NP-hard**
- There might be tricks to play around, especially with the ***k*** face values, but I am too lazy to think about it (wink wink)

Introduction to Genetic Algorithm (For Real)



Introduction to Genetic Algorithm (For Real)



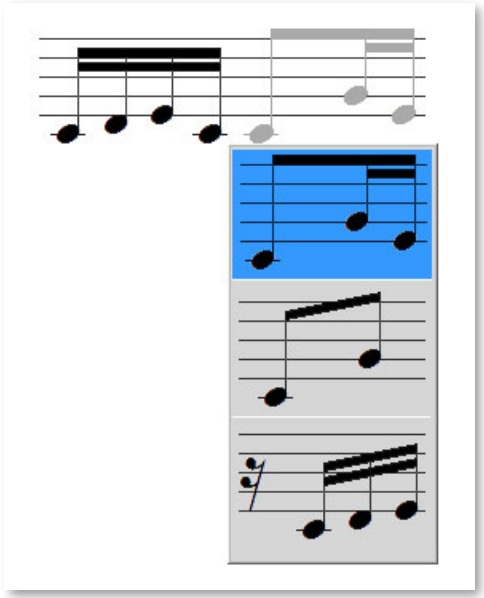
Example 2: Compose Like Ba~~s~~ch

Ad =>

Encode Music with Chunk and Linkage

Chunk

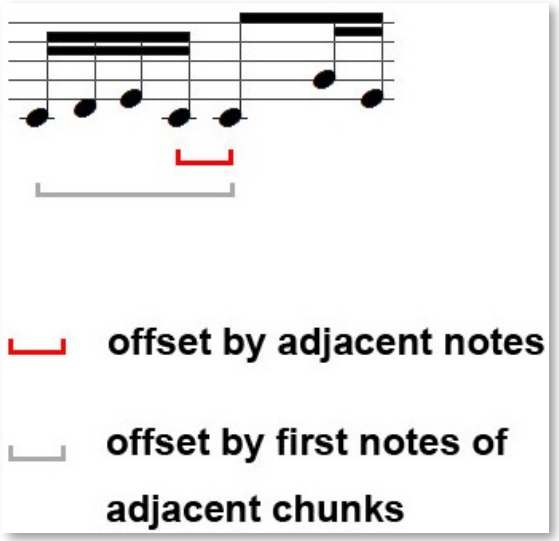
(four 16th notes)



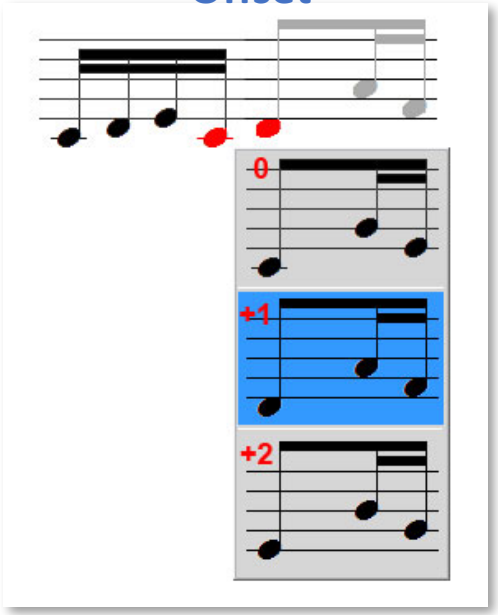
64 most common chunks
from Bach's fugues

Linkage

Type

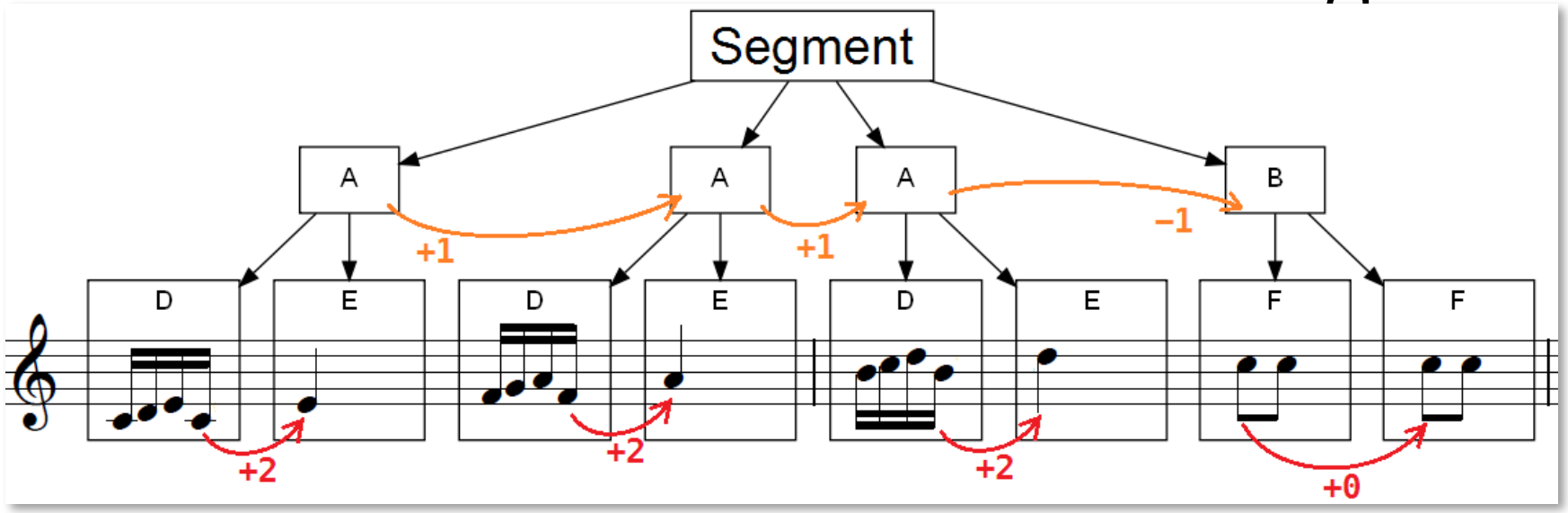


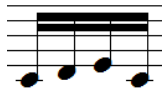
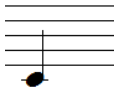
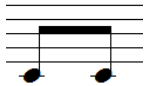
Offset



offset can be
–2, –1, 0, +1, +2

Encode Music with Chunk and Linkage



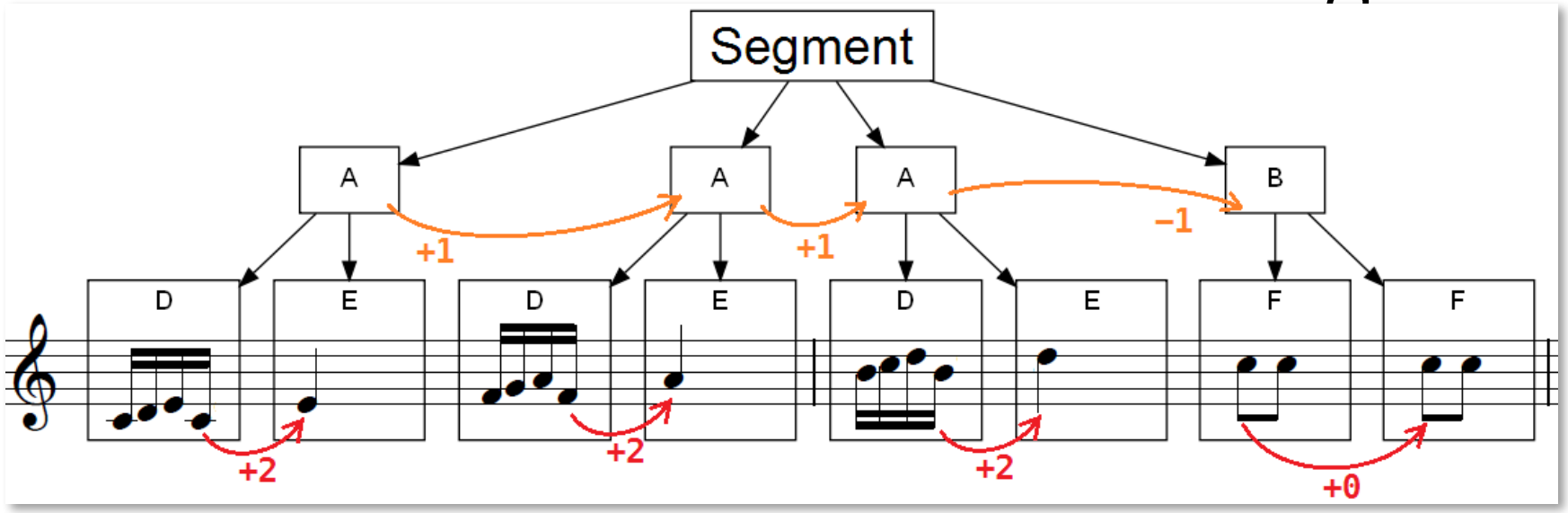
D:  **E:**  **F:** 

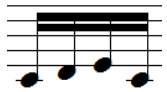
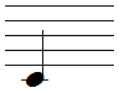
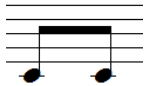
D = ((k (1 1)) (k (1 1)) (k (1 -2)) (k))

E = ((k) (r) (r) (r))

F = ((k (1 0)) (r) (k) (r))

Encode Music with Chunk and Linkage



D:  **E:**  **F:** 

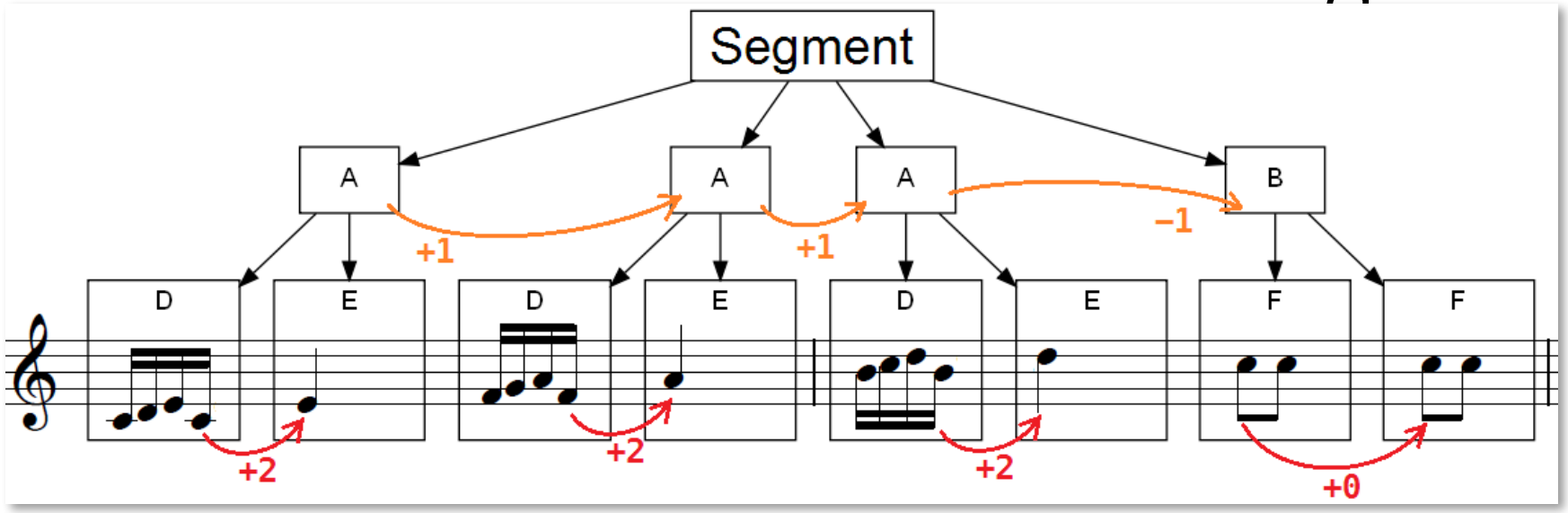
A = D + E

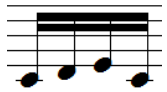
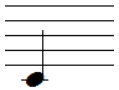
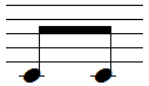
= (*G+* (*Gml* D +2) E)

B = F * 2

= (*G (*Gmf* F +0) 2)**

Encode Music with Chunk and Linkage



D:  E:  F: 

Segment = A * 3 + B

= (*G+* (*Gml*

(*Gdx* (*G (*Gml* A +1) 3))**

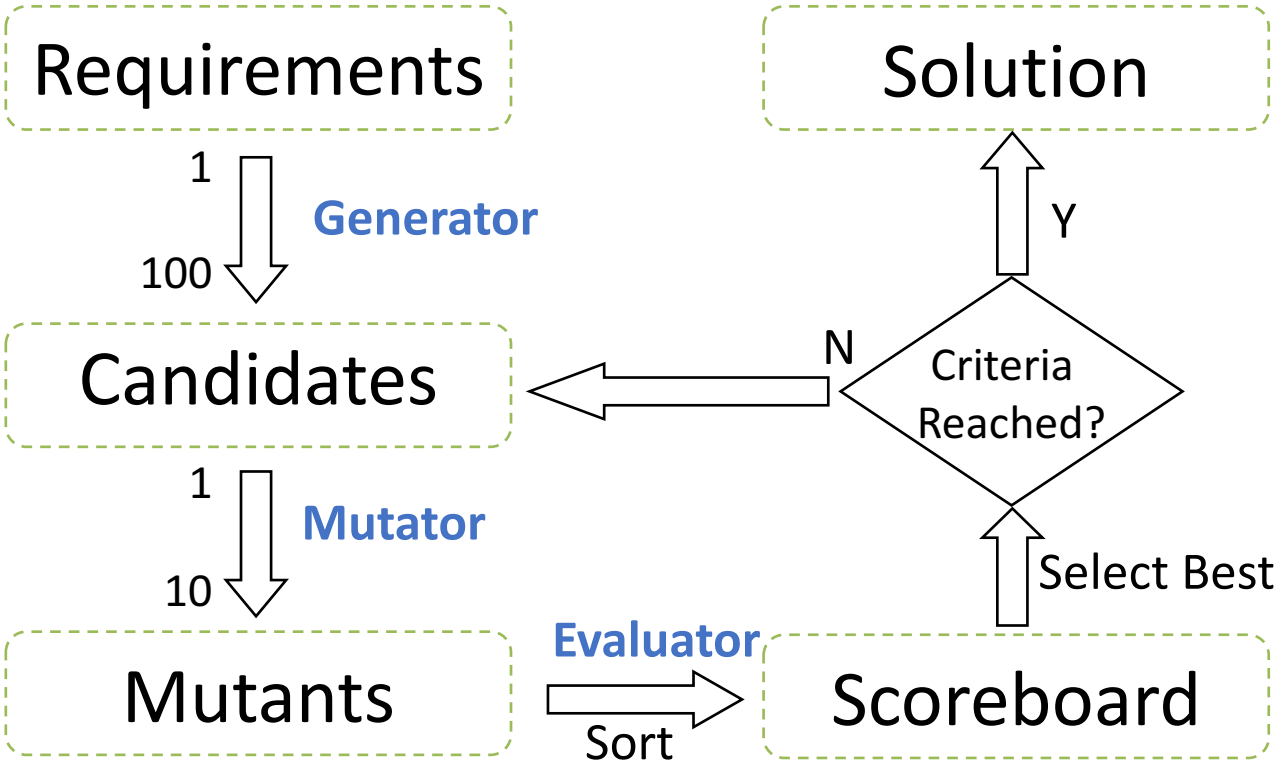
−1)

B)

Why Genetic Algorithm?

- Search space too large
  - 3.7×10^{14} possibilities for each segment
- Rules too complicated
- Does not require optimal solution
- Time insensitive: offline application

Look Familiar?



Thank You!

- Q & A