Evolutionary Optimization

Genetic Network Programming

1. Basic Concept

- **Proposed by K. Hirasawa in 2000**

- **GNP is an extension of GA and GP**

Genetic information is expressed by string information such as (0,1)

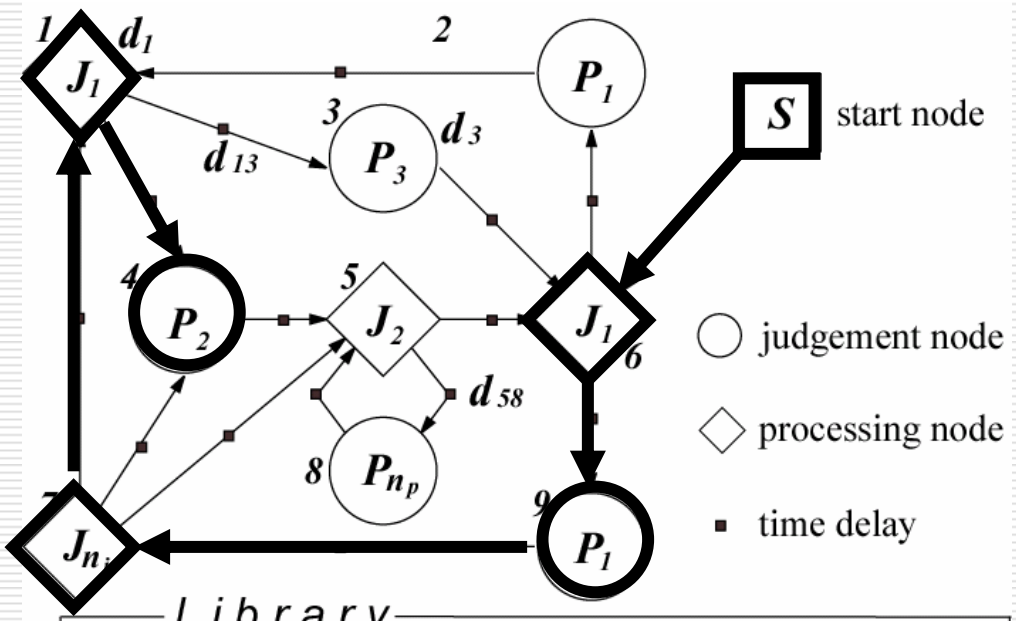
Each gene has a tree structure

- **In GNP, "Processing Nodes" and "Judgment Nodes" are connected each other like network (Directed Graph)**

- **In GNP, each processing/judgment is influenced by the past processing/judgments (Assurance of Non-Markovian Process)**

2. Basic Structure

Basic Structure of GNP



Judgment result

Processing Node

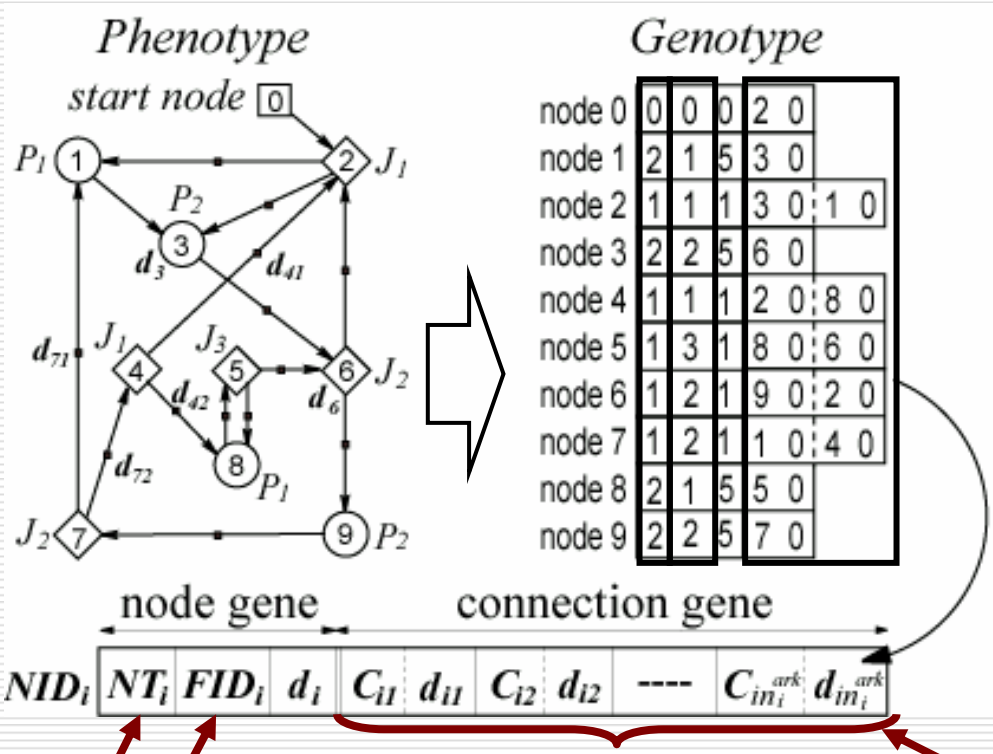
Describe the action of GNP

Judgment Node

Judge the information from the environments

Each node is defined by designers

3. Phenotype and Genotype



Phenotype

Network structure expression

Genotype

Gene structure expression

Bit-strings describing connections from node *i*

Bit-string describing the function of node *i*

Bit-string describing the kind of node i

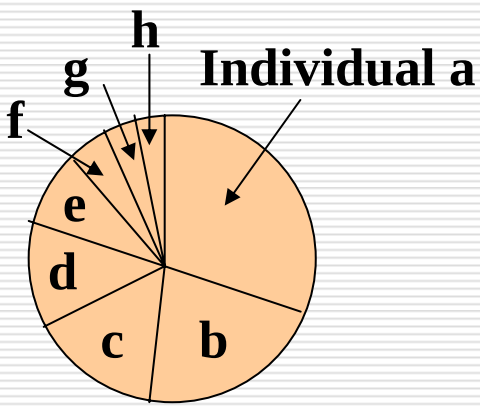
4. Genetic Operator

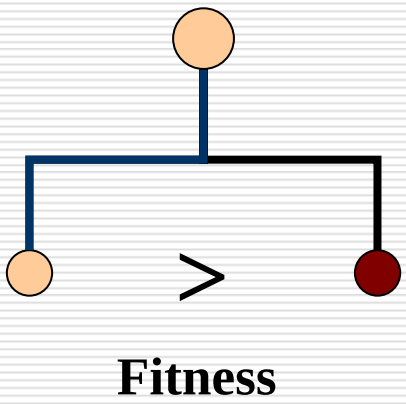
Genetic operators of GNP are almost the same as the ones of GAs such as **selection, crossover and mutation**

1. Selection

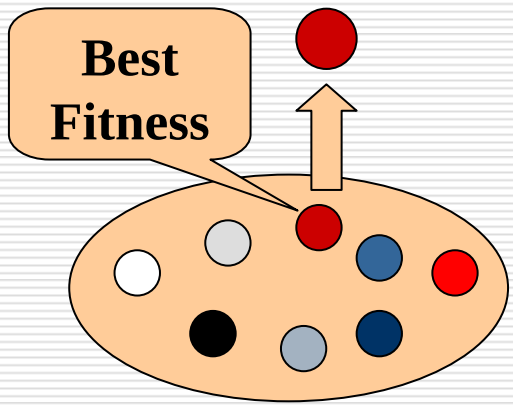
Select the individuals according to their fitness

- **Roulette Selection**
- **Tournament Selection**
- **Elite Selection**





Fitness



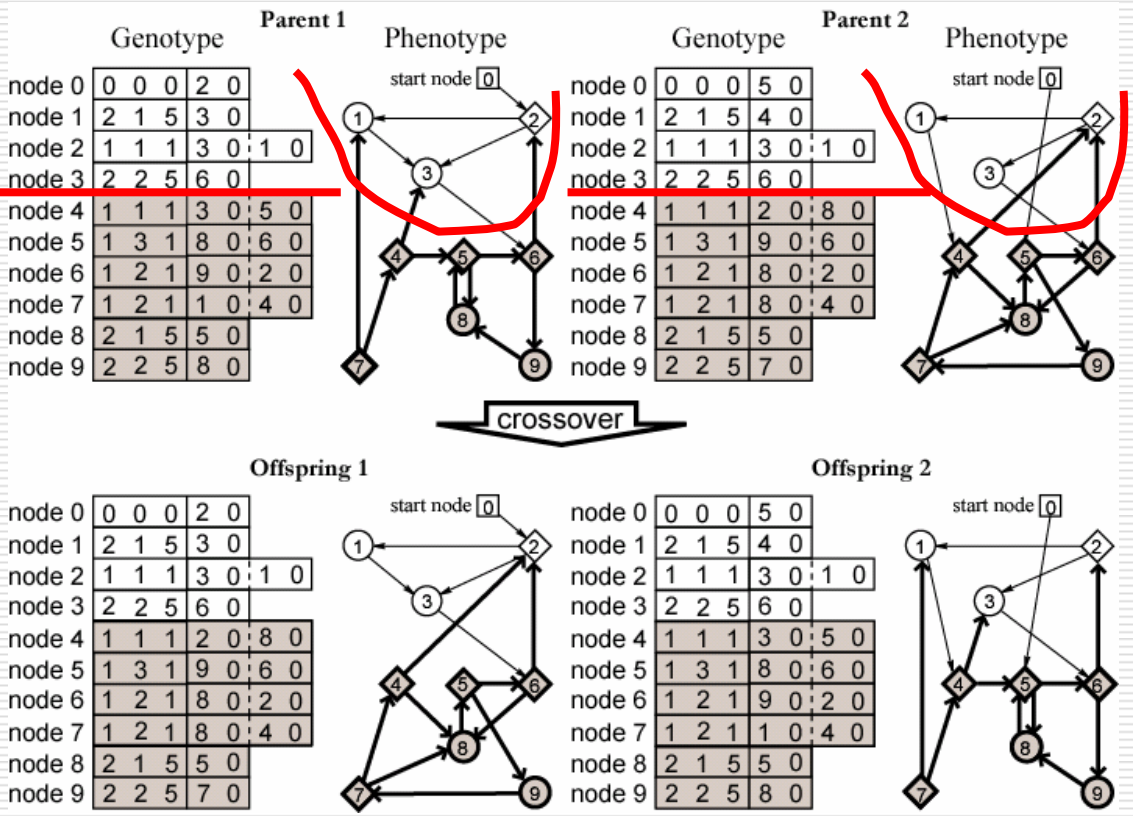
4. Genetic Operator

2. Crossover

Exchange the sub-networks of the parents using crossover probability

One Point Crossover — **Network is reformed by one point**

Crossover Point

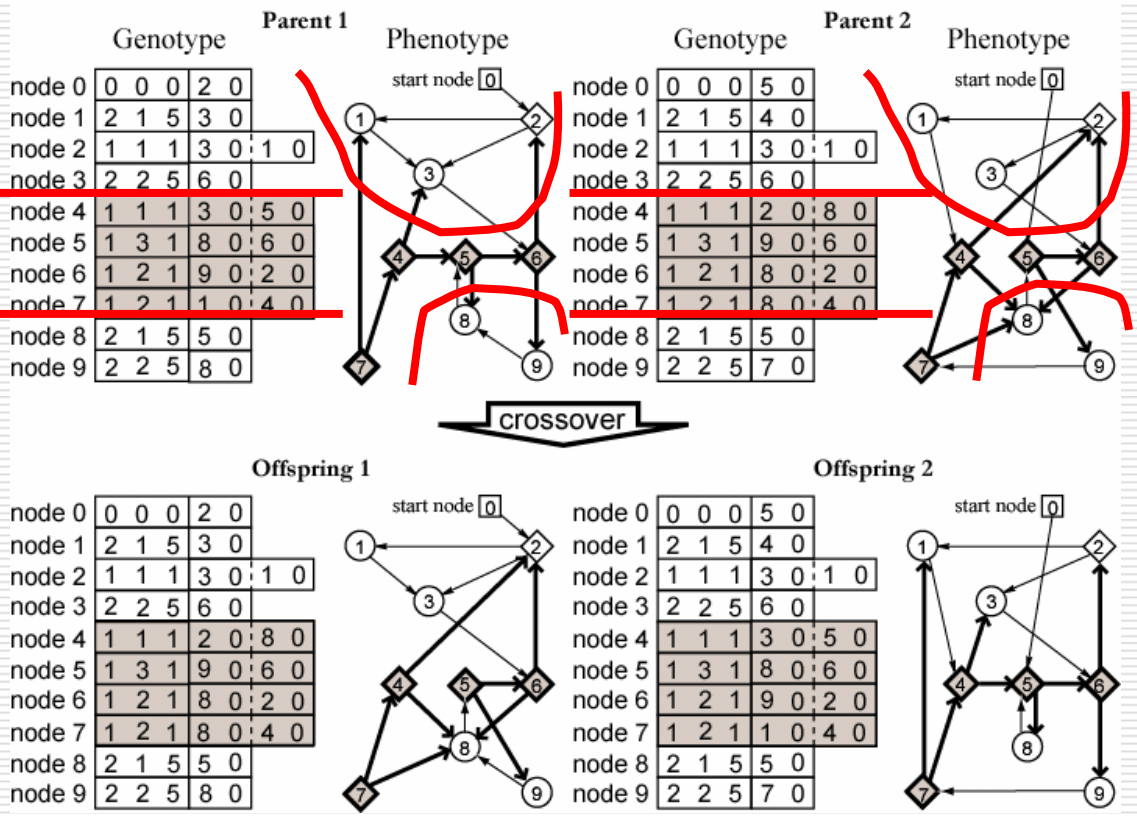


4. Genetic Operator

2. Crossover

- **Several Points Crossover** **Network is reformed by several points**

Crossover Point

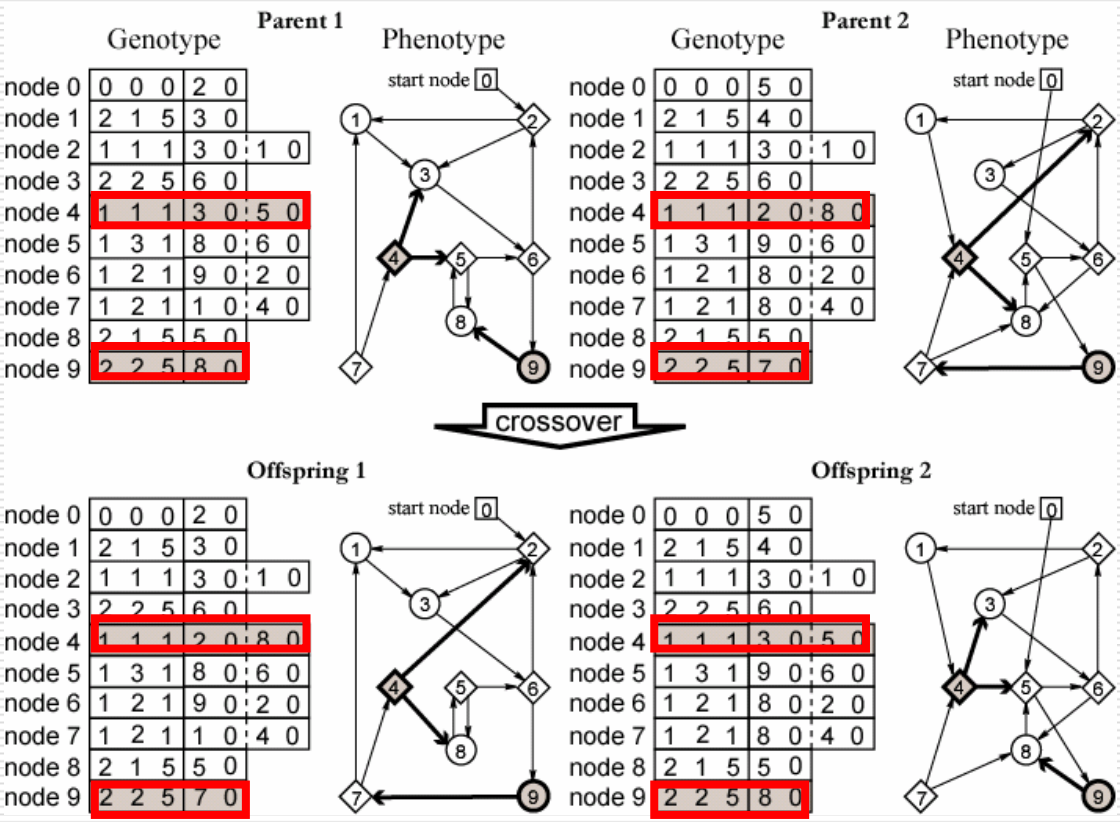


4. Genetic Operator

2. Crossover

- **Uniform Crossover**

Randomly selected nodes are exchanged between the parents



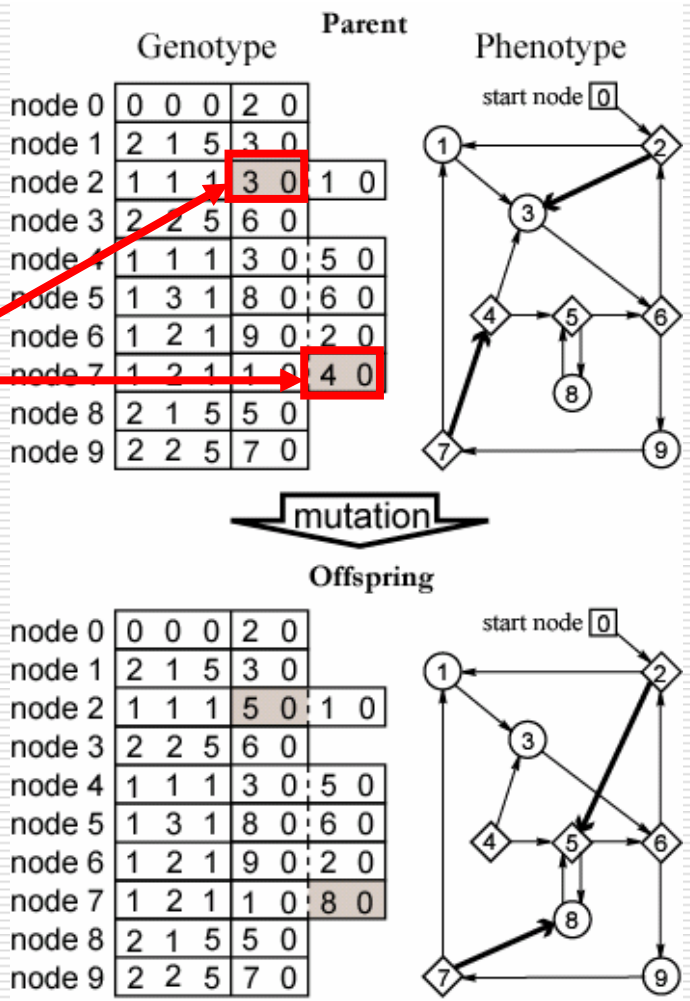
4. Genetic Operator

3. Mutation

Change node genes and its connection genes using mutation probability

- **Mutation of connections**

Connections



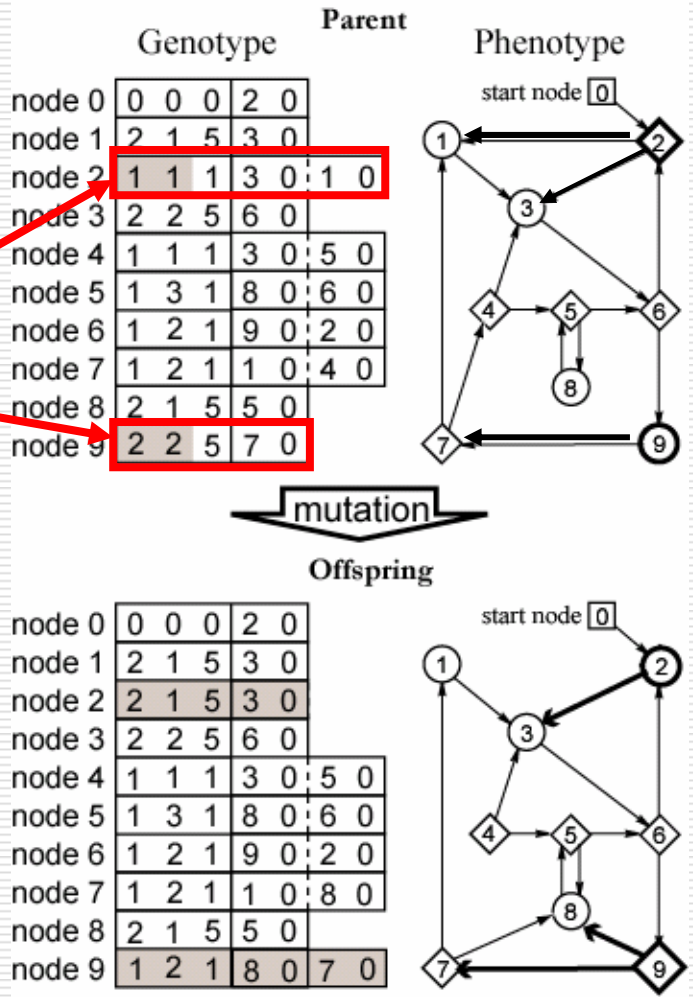
Connections of the branches are changed randomly

4. Genetic Operator

3. Mutation

- **Mutation of the contents of the nodes and their connections**

Nodes and connections



The contents of the nodes and their connections are changed randomly

5. Flow Chart of GNP