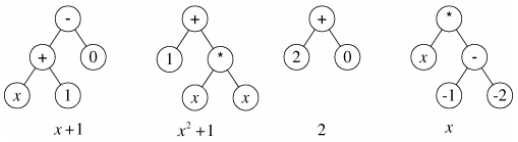
Uvod u genetsko programiranje

Što je genetsko programiranje? (GP)

- Evolucijski algoritam
  - Oponaša prirodu
- Skup rješenja
  - svako rješenje je jedan računalni program koji (bolje ili lošije) rješava zadani problem
  - simulacija evolucije: bolja rješenja preživljavaju, loša izumiru

Prikaz jedinke - programa

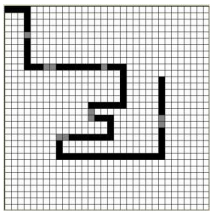
- Prikaz uz pomoć stabla



- niz naredbi:
  - funkcije (čvorovi stabla)
  - akcije ili varijable (listovi stabla)

Primjer primjene GP-a

- Mrav se kreće po stazi i skuplja hranu (2D polje)
- Pretpostavka: mrav 'vidi' samo polje neposredno ispred sebe
- Rješenje: program koji 'upravlja' mravom!
- Kvaiteta – količina pronađene hrane (u zadanom broju koraka)



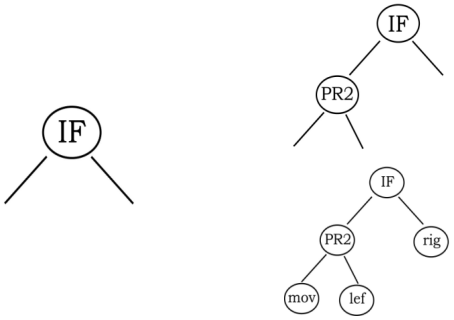
Struktura jedinke

- Funkcije:
  - IF (2 podstabla): ako je ispred mrava hrana, izvodi se lijevo, inače desno podstablo
  - PR2, PR3 (2 ili 3 podstabla): izvode se sva podstabla s lijeva na desno – simulacija niza naredbi
- Akcije:
  - *rig*: okreni se 90 stupnjeva desno
  - *lef*: 90 stupnjeva lijevo
  - *mov*: pomak naprijed

Kvaliteta programa - jedinke

- Ocjena – količina pronađene hrane
- Optimalna jedinka nalazi svu hranu

Generiranje inicijalne populacije



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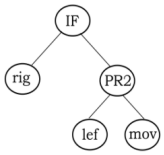

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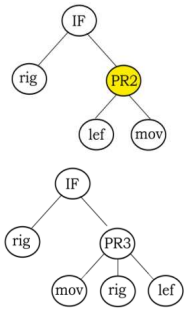


- Slučajno odabran čvor zamjenjuje se slučajnim podstablom

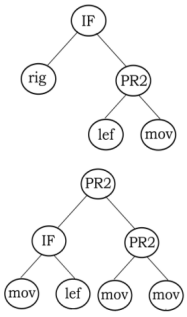
Selekcija

- Ispitivanje kvalitete rješenja
- Najbolje jedinke prelaze u novu generaciju (preživljavaju)

Križanje

- Dva rješenja (roditelji) kombiniraju svojstva i tvore novo rješenje (dijete)

Križanje



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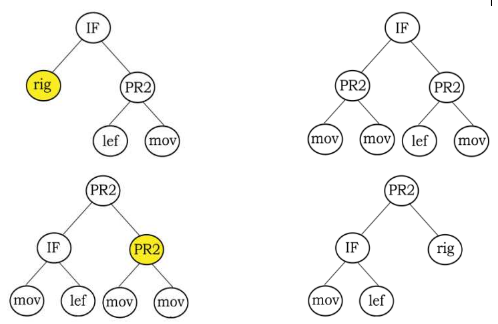

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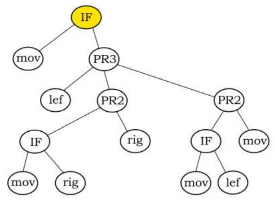

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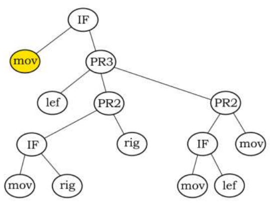

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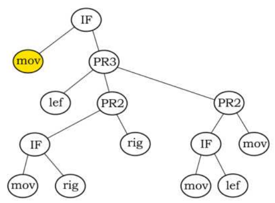

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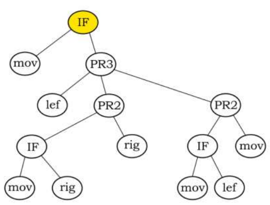

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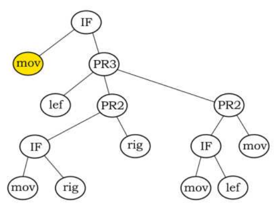

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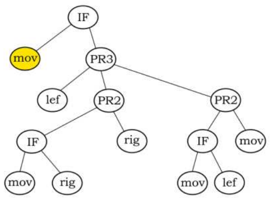

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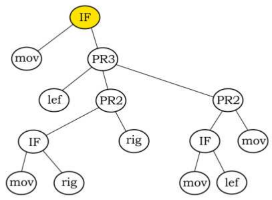

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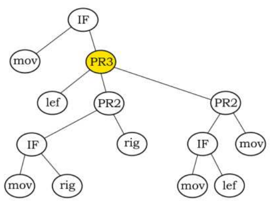

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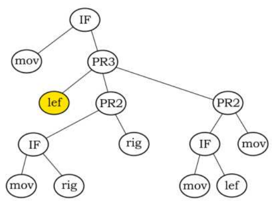

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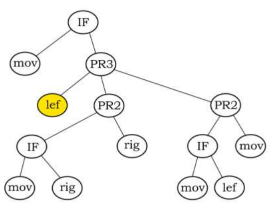

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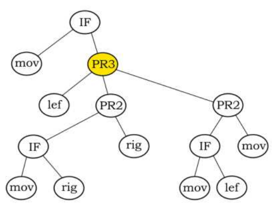

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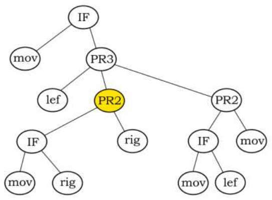

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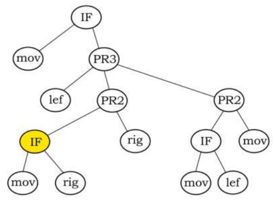

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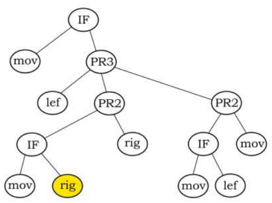

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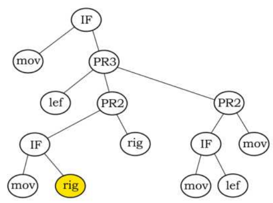

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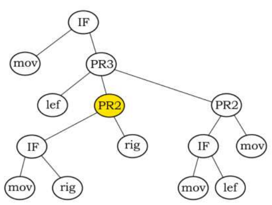

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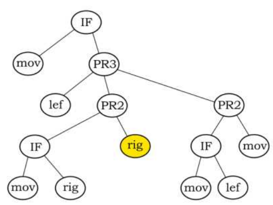

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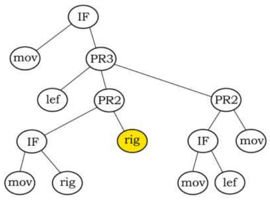

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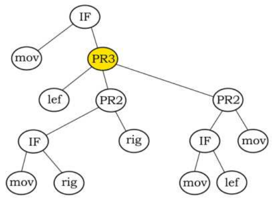

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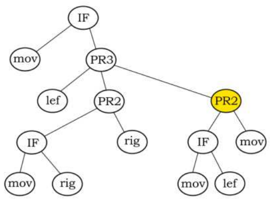

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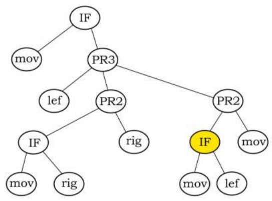

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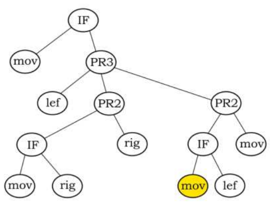

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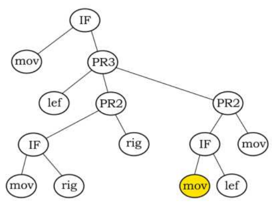

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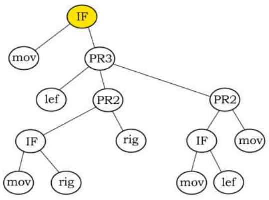

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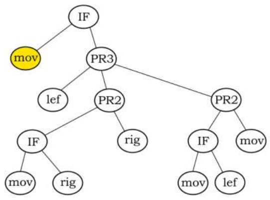

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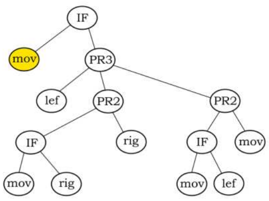

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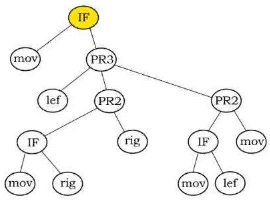

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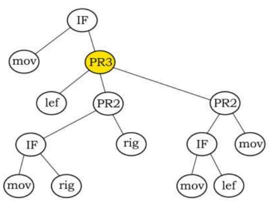

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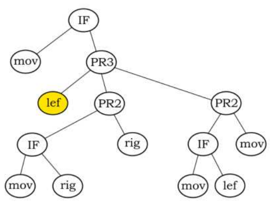

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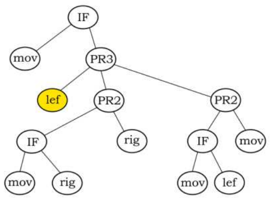

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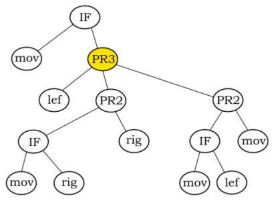

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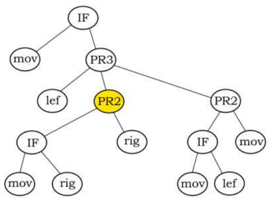

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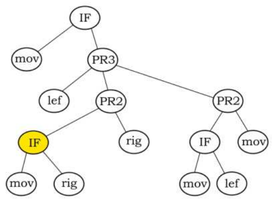

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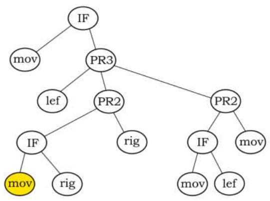

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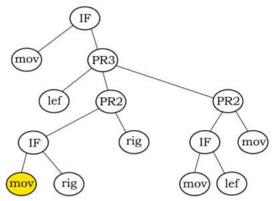

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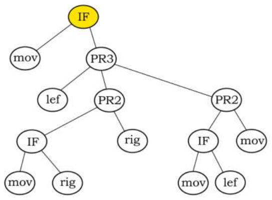

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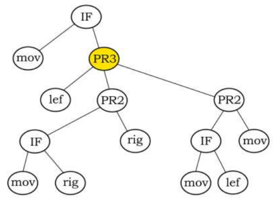

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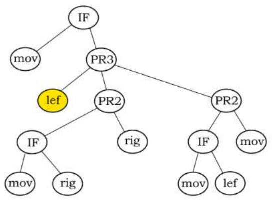

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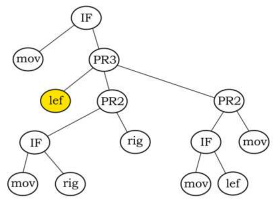

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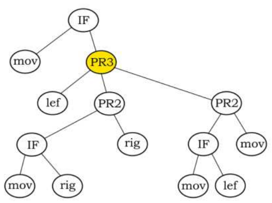

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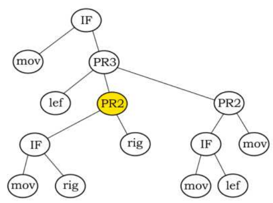

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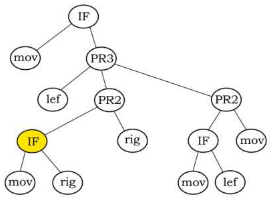

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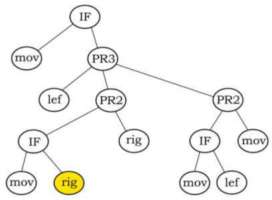

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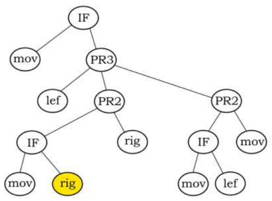

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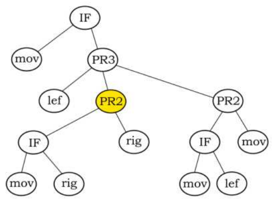

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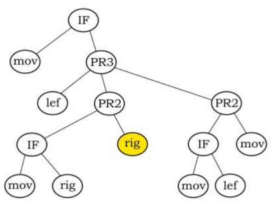

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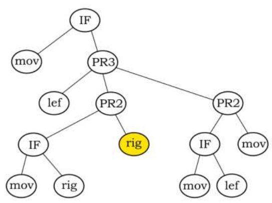

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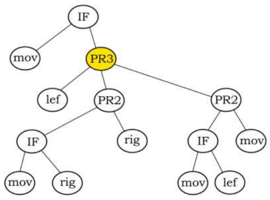

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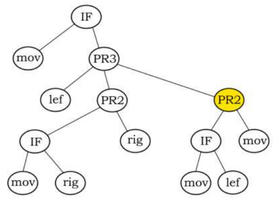

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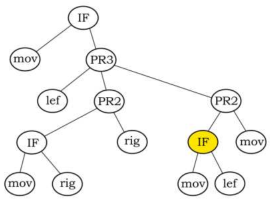

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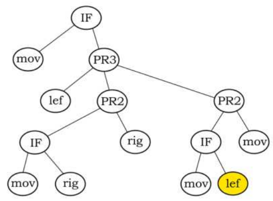

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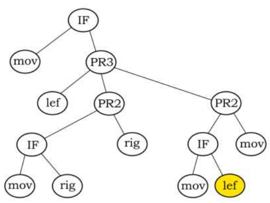

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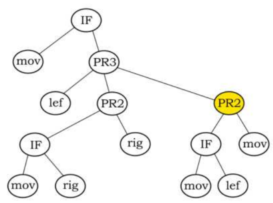

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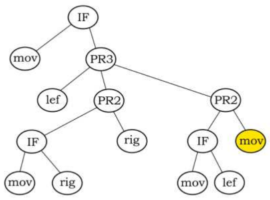

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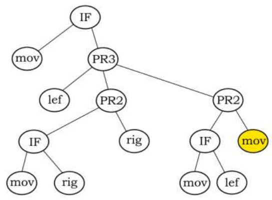

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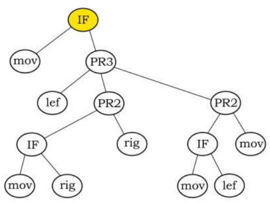

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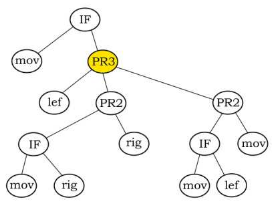

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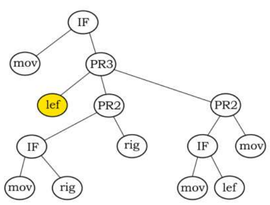

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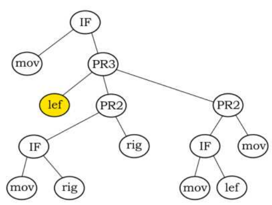

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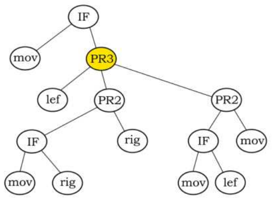

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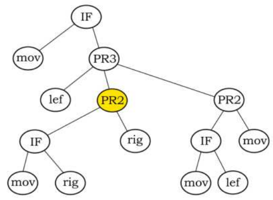

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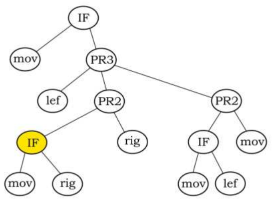

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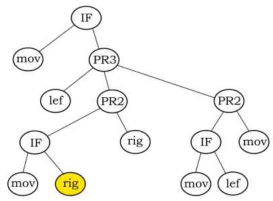

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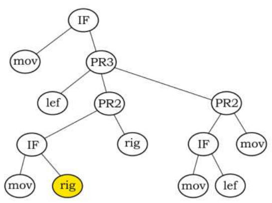

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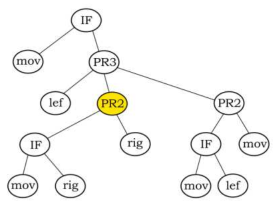

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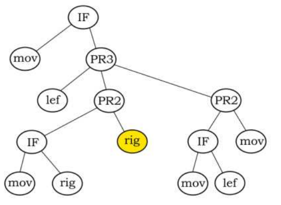

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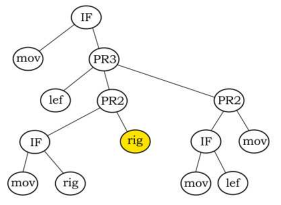

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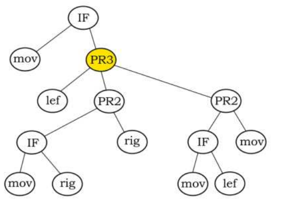

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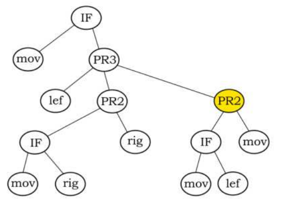

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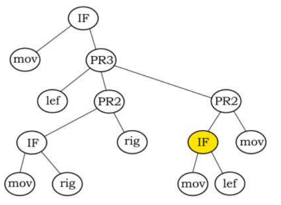

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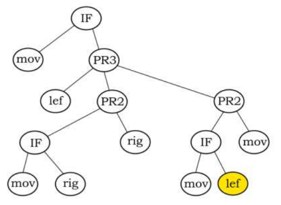

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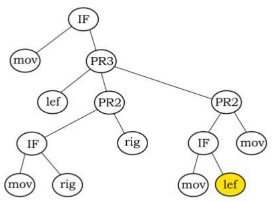

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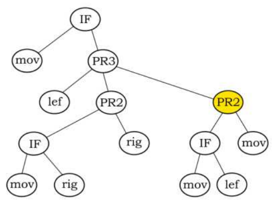

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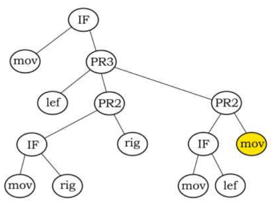

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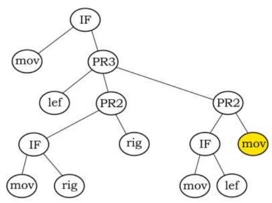

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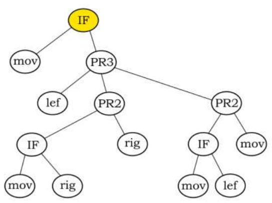

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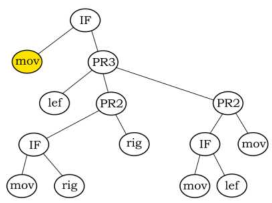

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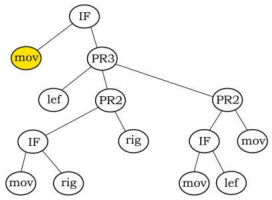

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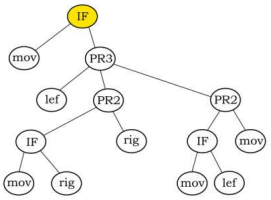

- Kraj 'života' jedinke:
  - definirani maksimalni broj ponavljanja algoritma ili broj koraka (akcija)...
  - ... ili pronađena sva hrana
- Implementacija nekih primjera:
  - http://msdn.microsoft.com/msdnmag/issues/04/08/GeneticAlgorithms/default.aspx
  - http://www.lalena.com/ai/

Neki primjeri primjene GP...

- automatizirano oblikovanje: analogni sklopovi, kontrolni krugovi, antene, neuronske mreže...
- algoritmi raspoređivanja (računalni programi, proozvodni procesi, radna snaga,...)
- algoritmi za obradu multimedijalnih podataka (npr. evaluacija VoIP protokola)
- računalna sigurnost: *intrusion detection*
- *database query algorithms*
- predikcija financijskih podataka
- evolucija OOP komponenata
- igranje igara (šah)
- pronalaženje prim brojeva

Umjesto zaključka

- GP:
  - za 36 različitih problema pronađeno rješenje jednako ili bolje od najboljeg ljudskog rješenja (*human competitive*)
  - 21 problem za koji je GP pronašao prethodno patentirano rješenje
  - barem 2 nova rješenja koja se mogu patentirati
- http://www.genetic-programming.org/
- http://www.zemris.fer.hr/~golub/ga/ga.html