Quantum genetic terrain algorithm (Q – GTA): a Technique to study evolution of earth using quantum genetic algorithm

By:

Pranjal Sharma – Department of IT

Ankit Agarwal – Department of ECE

Bhawna Chaudhary – Department of IT

Genetic Algorithm (GA)?

- Genetic is a search heuristic that is inspired by Charles Darwin's theory of natural evolution.
- It reflects the process of natural selection on the basis of survival of the fittest
- Thus producing a offspring of the next generation
- It basically is an evolutionary optimization algorithm
- It includes 5 processes named population initialization, fitness calculation, mutation, crossover and termination condition.

Isotopic fractionation

- It describes the processes that affect the relative abundances of isotopes, used in isotopic geochemistry.
- It is defined as relative partitioning of the heavier and lighter isotopes between two coexisting phases in a natural systems.
- There is a temperature dependency of isotopic ratio which embarks that with change in ratio changes temperature.

Modelling earths evolution

- As per D. Paul the isotopes are present at multi reservoirs incorporating Sm-Nd.- Rb-Sr isotopic decay systematics.
- There is a lot of transition among these reservoirs.
- Not only this these isotopes moves from one channel to another eg mantle to lithosphere , mantle to atmosphere etc.
- Thus studying the evolution of earth on the basis of isotopic ratio changes deriving the temperature changes of the earths different channels.

Introduction Q- GTA

- Quantum genetic terrain algorithm is basically a moulded version of the GA.
- It does not refer to implementing in quantum or classical version here. But depicts a generic implementation.
- It consist of same 5 keys of GA moulded as per our use.
- It implements the combines use of isotopic evolution and genetic evolution in the algorithm called Q-GTA.

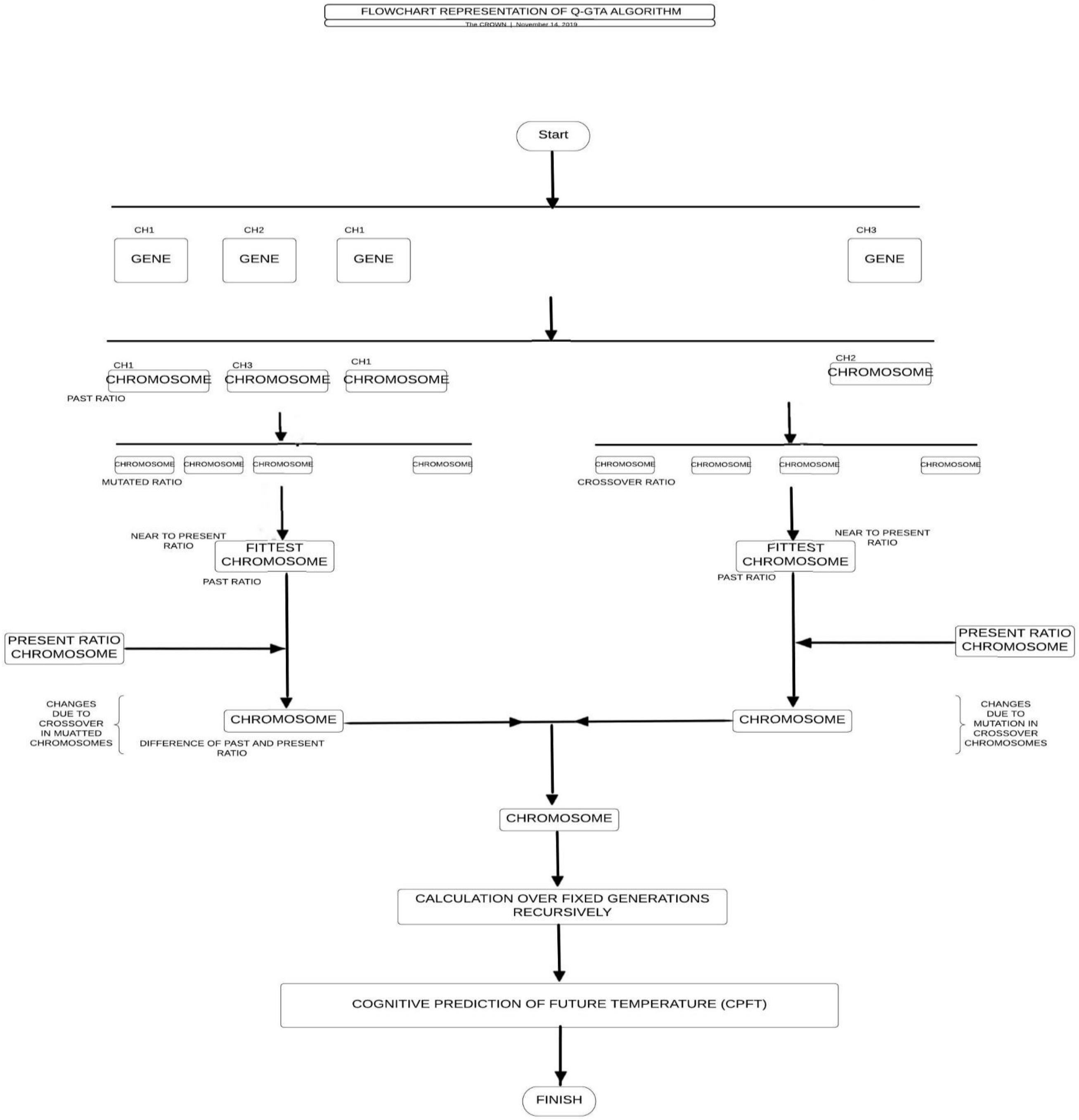
Key points of Q-GTA

- Population initialization
  - Genome
  - Chromosome
  - Parent Selection
- Fitness Function
- Mutation
- Crossover
- Termination condition

Algorithm

- BEGIN
- Generation ← 0
- Initialize pool genes as past ratio
- Procedure chromosome formation (gene, channel, chromosome)
  - If ‘i’ less than ‘n’ then
  - End if
  - If gene[i].Random() ← channel == gene[j].Random← channel then
  - Chromosome ← gene
  - End if
  - End procedure
- If temp changes then
  - Mutation ← Δ chromosome Ratio
  - C_F [fittest mutated chromosome] ← chromosome – Δ chromosome
  - End if
- If movement of isotopes then
  - Crossover ←Δ chromosome Ratio
  - M_F [fittest crossover chromosome] ← chromosome – Δ chromosome
  - End if
- Steps D.b and E.b forms fittest chromosomes
- Increment generation and go to step b till Generation not equals Present Generation
- CPFT (Cognitive Prediction of Future Temperature)
- END

Flowchart



FLOWCHART REPRESENTATION OF Q-GTA ALGORITHM
The CROWN | November 14, 2019
Start
CH1
GENE
CH2
GENE
CH1
GENE
CH3
GENE
CH1
CHROMOSOME
CH3
CHROMOSOME
CH1
CHROMOSOME
CH2
CHROMOSOME
PAST RATIO
CHROMOSOME
CHROMOSOME
CHROMOSOME
CHROMOSOME
MUTATED RATIO
CHROMOSOME
CHROMOSOME
CHROMOSOME
CHROMOSOME
CROSSOVER RATIO
NEAR TO PRESENT RATIO
FITTEST CHROMOSOME
PAST RATIO
NEAR TO PRESENT RATIO
FITTEST CHROMOSOME
PAST RATIO
PRESENT RATIO CHROMOSOME
PRESENT RATIO CHROMOSOME
CHANGES DUE TO CROSSOVER IN MUATTED CHROMOSOMES
CHROMOSOME
DIFFERENCE OF PAST AND PRESENT RATIO
CHROMOSOME
CHANGES DUE TO MUTATION IN CROSSOVER CHROMOSOMES
CHROMOSOME
CALCULATION OVER FIXED GENERATIONS RECURSIVELY
COGNITIVE PREDICTION OF FUTURE TEMPERATURE (CPFT)
FINISH

Result

FOR MUTATION

Step 1:

0.1195	0.7063	0.7066	A1	B1	C1	D1	E1	Gen 1

Step 2:

0.1184	0.7128	0.7098	A2	B2	C2	D2	E2	Gen 2

Step 3:

0.0011	-0.0065	-0.0032	A1–A2	B1-B2	C1-C2	D1-D2	E1-E2	Anchor value

Step 4:

0.1173	0.7193	0.7130	2A2-A1	2B2-B1	2C2-C1	2D2-D1	2E2-E1	Expected mutation

Step 5:

0.1179	0.7136	0.7091	A3	B3	C3	D3	E3	Gen 3

Step 6:

0.5	0.7924	0.5469	A4	B4	C4	D4	E4	Fitness value

Step 7: Calculate fitness value for overall chromosome fi/sigma(fi)

Step 8: We will take a reference value and compare it if true then we will select that chromosome for next iteration.

Step 9: Repeat these steps for n+1 generation. Where n is the present generation and n+1 is the future generation.

*Gen 1 – starting generation

*Gen 2 – second generation from start

*Anchor value – here we simply use difference as anchor value. Anchor value is a value that calculates the difference among two generation. We can use different functions to calculate anchor value.

*Expected mutation – it is simply the next expected value by subtracting the anchor value from next generation value.

*Fitness value – here we calculated simple percentage error. Fitness function can be changed to calculate more accurate value.

Conclusion

- The 5 pillars of Q-GTA are modelled with a old set of rules but new definitions.
- The basic idea of ability of GA to control and make decision are still protagonist.
- Prognoses of the isotopic ratios.
- The size of generation should be sufficiently large.
- The number of generation should also be high to predict better.
- Unavailability of proper data to analyse the crossover part of algorithm.

Future work

- Use of D/H ratios to study planetary evolution.
- Development of CPMT model
- Cognitive approach of fitness function
- Prediction of natural trends and calamities based on temperature changes

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THANKS