FINAL PRESENTATION

SHORT-TERM EXCHANGE STUDENT

Genetic Algorithm (GA) and GA's application on forecasting the air quality – Determine the parameters to predict atmospheric ozone concentration.

The main contents

I. Introduction

- Name: Dinh Thu Hang (Vietnam)
- Affiliation: GSGES (Apr 2014 ~ Sep 2014)
- Supervisors at GSGES: Prof.Yoshizumi KAJII
- Supervisor at Hanoi University of Science and Technology (HUST): Associate.Prof.Nghiem Trung Dung

- Master thesis: A study to apply the genetic algorithm in the forecast of air quality
- *Study topic at GSGES*: **Genetic Algorithm (GA) and GA's application on forecasting the air quality – Determine the parameters to predict atmospheric ozone concentration.**

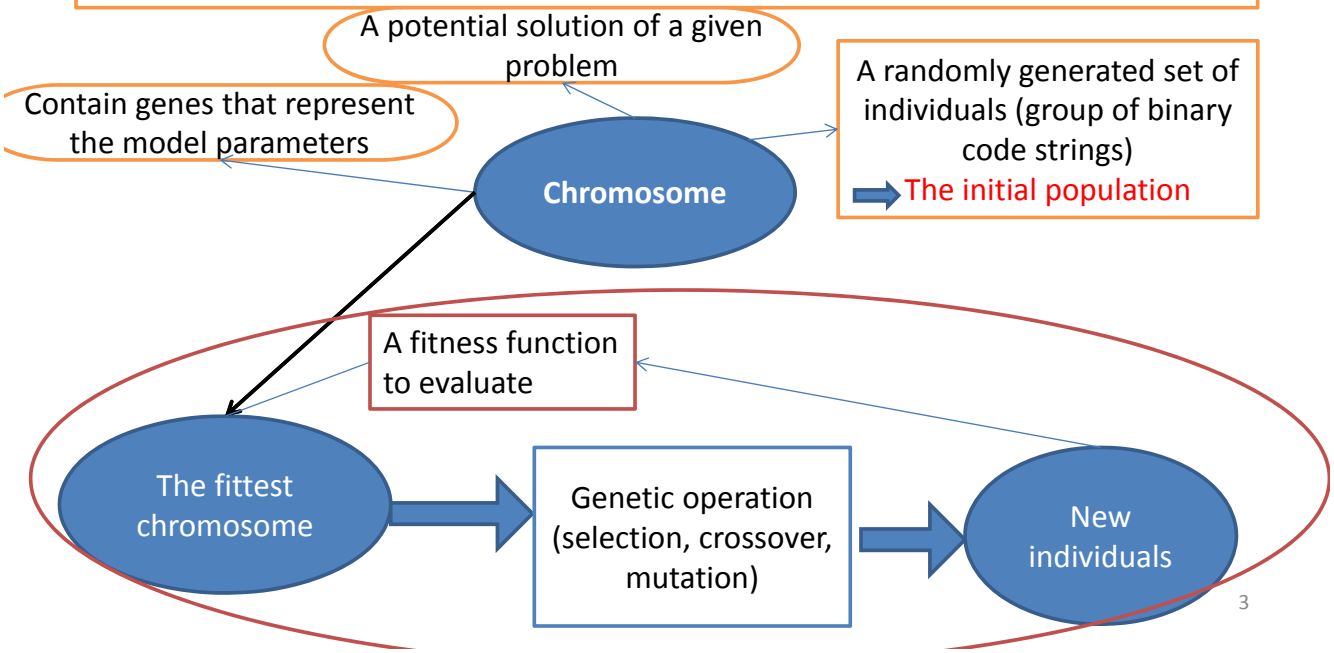
Kyoto, 19th Sep, 2014

II. Study outcome

Literature review of Genetic Algorithms(GAs)

1. **GAs** are search and optimization techniques introduced by Holland (1975), based on Darwin **principles** of evolution and natural genetics:

- *The existence of a population limited by a maximum number of individuals*
- *The natural creation of new individuals with similar properties of the existing ones*
- *The natural selection of the fittest individuals*



Literature review of Genetic Algorithms(GA)

2.The steps of GA

Initialization

1

Many binary-coded strings b*i (i=1,..p)* are randomly generated to form an initial population or set of initial solutions which will be optimized by iteration Generally**, p(population size) =30-160**

Selection

2

Individual solutions are selected to breed a new generation through a fitness-based process, where fitter solutions (as measured by the fitness function ***f***) are typically more likely to be selected.

Crossover

3

For individual solutions used to breed next generation, GA performs crossover with probability Pc. A single crossover point is selected and then data on that point in selected individuals is swapped to generate new individual solutions

Pc=0,25-0,75

Mutation

4

Some bits of selected individual solutions are mutated with probability Pm, by mutation, some chromosome bits will turn "1" into "0" and some will turn "0" into "1"

Pm=0,01-0,2

(2)-(4) is repeated until fitness value of the best individual solution fall under the given threshold or successive iterations no longer produce better results

The advantages of GA

- Optimization with continuous or discrete variables
- Derivative function is not necessary
- Dealing with a large number of variables
- Optimization with extremely complex cost surfaces
- Providing a list of optimal solutions (not just a single solution)
- GA was selected due to the different type of parameters to optimize and the complexity of the constraints (ensure that all regression parameters are statistically significant)

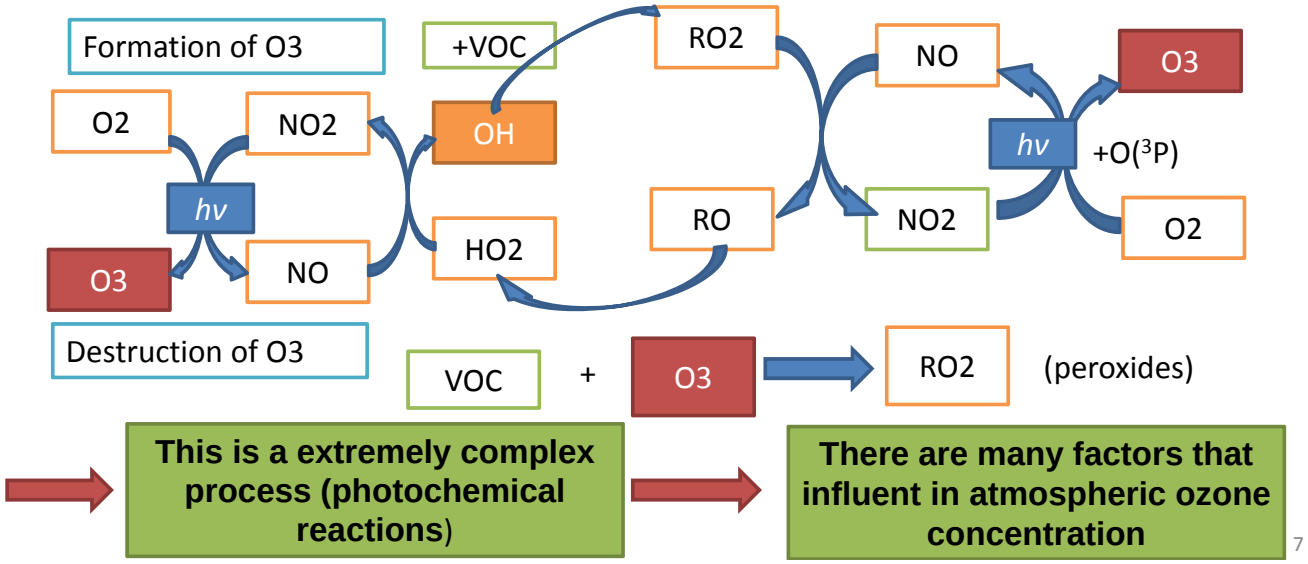
Application of GA in previous research

1. To optimize the data division, the weights or the structure of the artificial neural networks (GA-ANN) for surface ozone concentration forecasting
   - *ANN model are characterized by: a set of processing neurons (designated by nodes); a pattern of connectivity among neurons; an activation function for each neuron and a learning rule*

2. To define threshold regression models (TR-GA) to predict the next day hourly average ozone concentration
   - *The threshold regression assumes that the behavior of the dependent variable changes when it enters in a different regime, the change from one regime to another depends on a specific value (threshold value) of an explanatory variable (threshold variable)*

Determine the parameters to predict atmospheric ozone concentration

1. Atmospheric ozone sources:
- Photochemical reactions involving its precursors (volatile organic compounds and nitrogen oxides) with natural or anthropogenic origin (gasoline vapor, fossil fuel power plant, refineries, other industries) under the action of suitable ambient meteorological conditions
- Tropospheric/stratospheric exchange that causes the transport of stratospheric air, rich in ozone, into the troposphere
- Horizontal transport due to the wind that transports ozone produced in other regions



This is a extremely complex process (photochemical reactions)

There are many factors that influent in atmospheric ozone concentration

Determine the parameters to predict atmospheric ozone concentration

Parameters
(input variables of model)

- NO
- NO2
- VOC
- O3
- CO

Recorded in the previous day

- Temperature (T)
- Relative Humidity (RH)
- Solar Radiation (SR)/UV
- Wind Speed (WS)

Meteorological parameters:
Use predicted data of the predicted day

Use GA to determine which parameters is the most important input variables and which are the threshold value and threshold variables

III. Evaluation

1. The study plan completion

Two parts of the thesis were written (the introduction and literature review)

2. What have I learned in Japan

- Obtain more knowledge about environmental issues, materials for my current study
- Experience a professional training environment to learn and improve research skills
- Experience Japanese culture in city and rural area

3. The next works

- Learn to write code of the model in matlab program
- Run model with data that were collected in Hanoi monitoring station
- Finish the thesis

The experiences in Kyoto

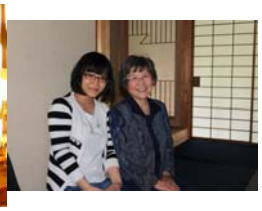
1. Participate in lectures and field trips

- **4 lectures (Apr ~ Jul):**
  - ✓ Environmental Ethics and Environmental Education
  - ✓ Integrated Watershed and Coastal Management
  - ✓ Environmental Leadership A
  - ✓ Management of Global Resources and Ecosystems

- **The field trips: Wakayama trip**

To learn about Japanese agriculture

2. Experiences



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References

1. J.C.M.Pires, B.Goncalves, F.G.Azevedo, A.P.Carneiro, N.Rego, A.J.B.Assembleia, J.F.B.Lima, P.A.Silva, C.Alves, F.G.Martins (2012) Optimization of artificial neural network models through genetic algorithms for surface ozone concentration forecasting. Springer-Verlag2012
2. Harri Niska, Teri Hiltunen, Ari Karppinen, Juhani Ruuskanen, Mikko kolehmainen, Evolving the neural network model for forecasting air pollution time series, Engineering Applications of Artificial Intelligence 17 (2004) 159-167
3. Hong Zhao, Jie Zhang, Kai Wang, Zhi peng Bai, Aixie Liu, A GA-ANN Model for Air Quality Predicting, 2010, IEEE.
4. Barbara J. Finlayson-Pitts, James N. Pitts, Jr. Chemistry of the Upper and Lower Atmosphere, Academic Press (2000)
5. J.C.M.Pires, F.G.Martins, M.C.M.Alvim-Ferraz and M.C.Pereira, Genetic algorithm based technique for defining threshold regression models, International Environmental Modelling and Software Society (iEMSs) 2008
6. A. Osyczka and S. Kundu, A new method to solve generalized multicriteria optimization problems using the simple genetic algorithm, Structural Optimization 10, 94-99, Springer-Verlag 1995.