Fuzzy fitness assignment in an Interactive Genetic Algorithm for a cartoon face search

Authors:

Kenichi Nishio, Masayuki Murakami

Eiji Mizutani, Nakaji Honda

Presented by: **Ehsan Nazerfard**

nazerfard@eecs.wsu.edu

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Outline

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About the paper

- **Authors**:

  - **Kenichi Nishio**, Sony Corp., Kitashinagawa, Shinagawa, Tokyo, Japan

  - **Masayuki Murakami**, Dept. of Communications and Systems, Univ. of Electro Communications, Chofugaoka, Chofu, Tokyo, Japan

  - **Eiji Mizutani**, Kansai Paint Co., Ltd., Fushimimachi, Chuo, Osaka, Japan

  - **Nakaji Honda**, Depat. of Communications and Systems, Chofugaoka, Chofu, Tokyo, Japan

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- **Editors**:

  - **Elie Sanchez**

  - **Takanori Shibata**

  - **Lotfi A. Zadeh**

What is an IGA?

- IGA stands for Interactive Genetic Algorithm

- An IGA is a GA whose fitness is determined with human intervention.

  - ➢ Searching for a target according to user's subjective factors

- Applications

  - ➢ Criminal suspect search
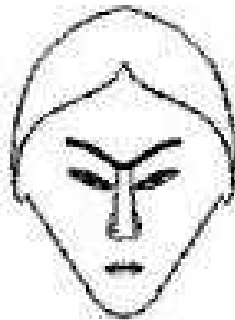
  - ✓ Cartoon face search

  - ➢ …

Cartoon face space

- Each face has 12 parameters corresponding to facial components (eyes, hair, mouth, …)

- Each component has 3 bits of variable range

- A face F can be assigned to a point in the 12 dimensional face-space:

  - $F = (f_0, f_1, f_2, …, f_{11})$ $(f_{min} <= f_i <= f_{max})$

- Origin of the space:

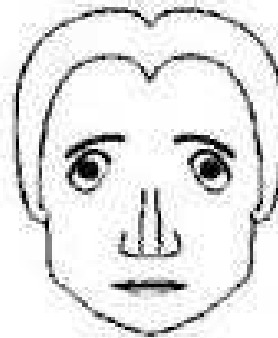 - $O = (o_0, o_1, o_2, …, o_{11})$ $(o_i = [f_{min}+f_{max}]/2)$

Cartoon face space (cont.)

- Extreme faces, i.e. F_{min} and F_{max}
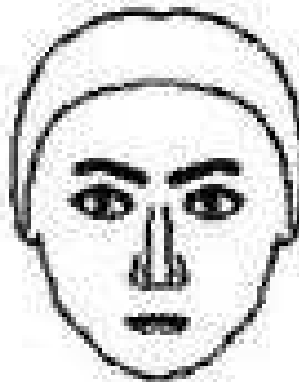

chromosome: 00000...0   chromosome: 111111...1

- Average face, i.e. O (the origin of the space)

Facial difference: Distance

- Any two faces, A and B, can be connected by a straight line; the length of the line is the Euclidean distance:

$$\overline{AB} = |A - B| = \sqrt{\sum (a_i - b_i)^2}$$

- It is used to rank "similarity" between faces.

Facial difference: Angle

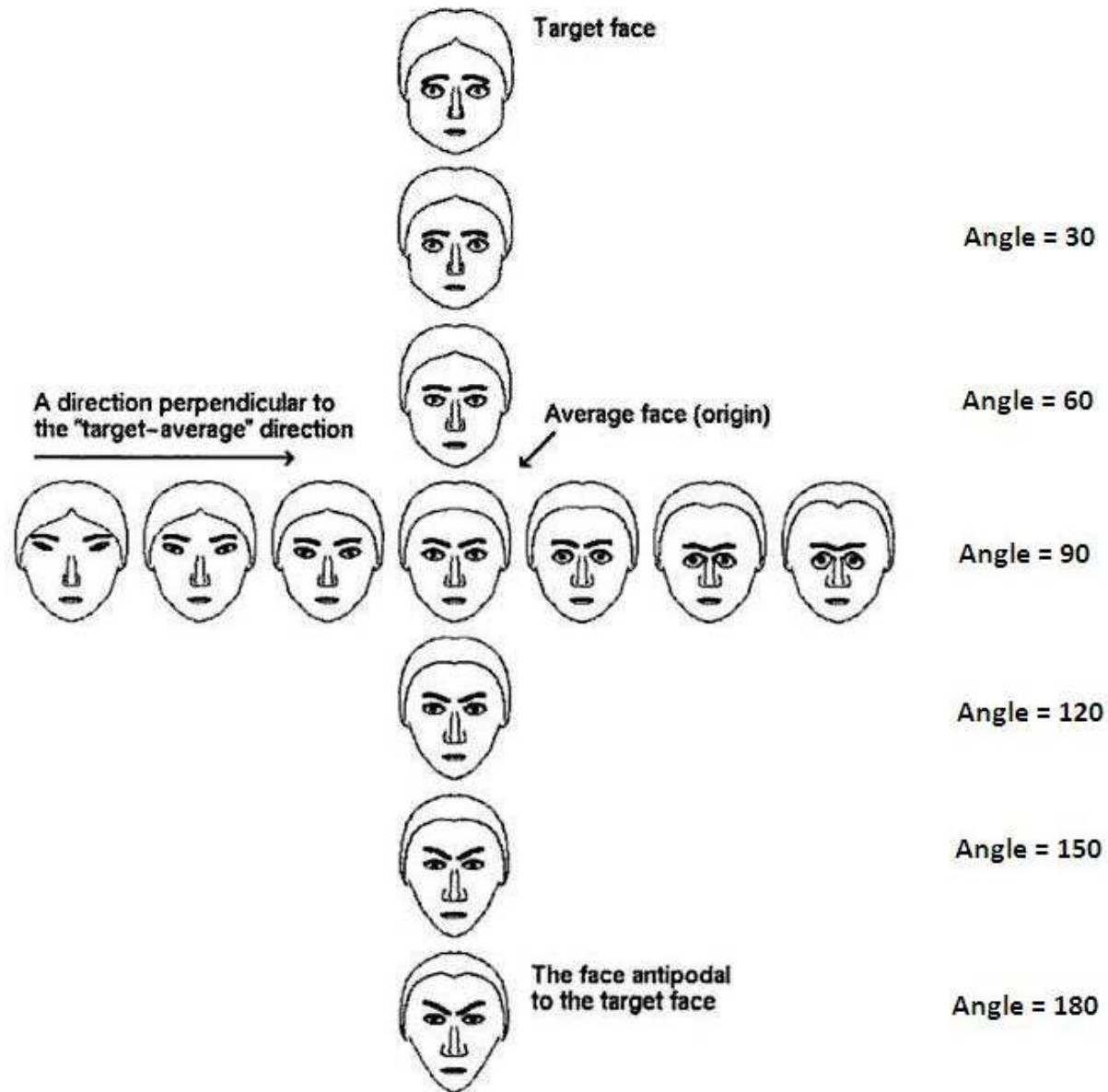- To stipulate more facial differences, we use the angle between two faces:

$$\overline{A\widehat{O}B} = \cos^{-1} \frac{(A-O).(B-O)}{\overline{AO}\ \overline{BO}}$$

- In addition to distance, angle is also used to rank "similarity" between faces.

Example: Angle between faces

Target face

Angle = 30

Angle = 60

A direction perpendicular to the "target–average" direction

Average face (origin)

Angle = 90

Angle = 120

Angle = 150

The face antipodal to the target face

Angle = 180

Fitness assignment

- Experiments show that it is tiresome for the user to rate all the faces.

- Therefore, the user needs to identify just the closest face (winner face) to the target face.

$$fitness = \begin{cases} 1.0 & the\ face\ selected\ by\ the\ user \\ ? & the\ other\ faces \end{cases}$$

Fuzzy fitness assignment

- Fuzzy fitness assignment strategy is used to rate the other faces:

- Sample fuzzy rule:

If (*Distance* is *small*) and (*Angle* is *small*) and (*Gen.* is *any*) Then (*Fitness* is *large*)

Sample fuzzy rule set

- The bar symbol "-" is a symbol that matches any of linguistic labels.

| Input			Output
Distance	Angle	Generation	Fitness
small	small	–	large
small	medium	small	medium-large
small	medium	medium	medium
small	medium	large	medium-small
small	large	small	medium
small	large	medium	medium-small
small	large	large	small
large	large	small	medium-small
large	large	medium	small
large	large	large	small

Fuzzy membership functions

- Fuzzy membership functions set up for three inputs (distance, angle and generation), and singleton output functions.
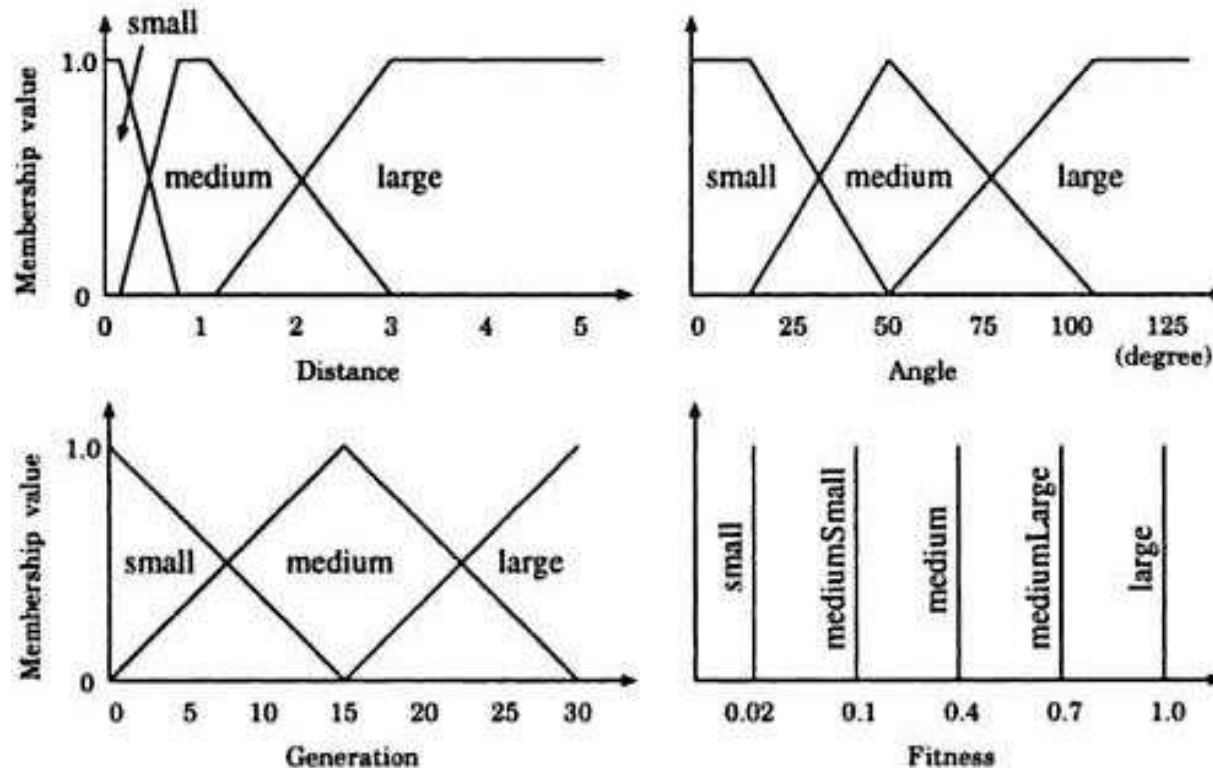
Fuzzy membership functions

- Fuzzy membership functions set up for three inputs (distance, angle and generation), and singleton output functions.
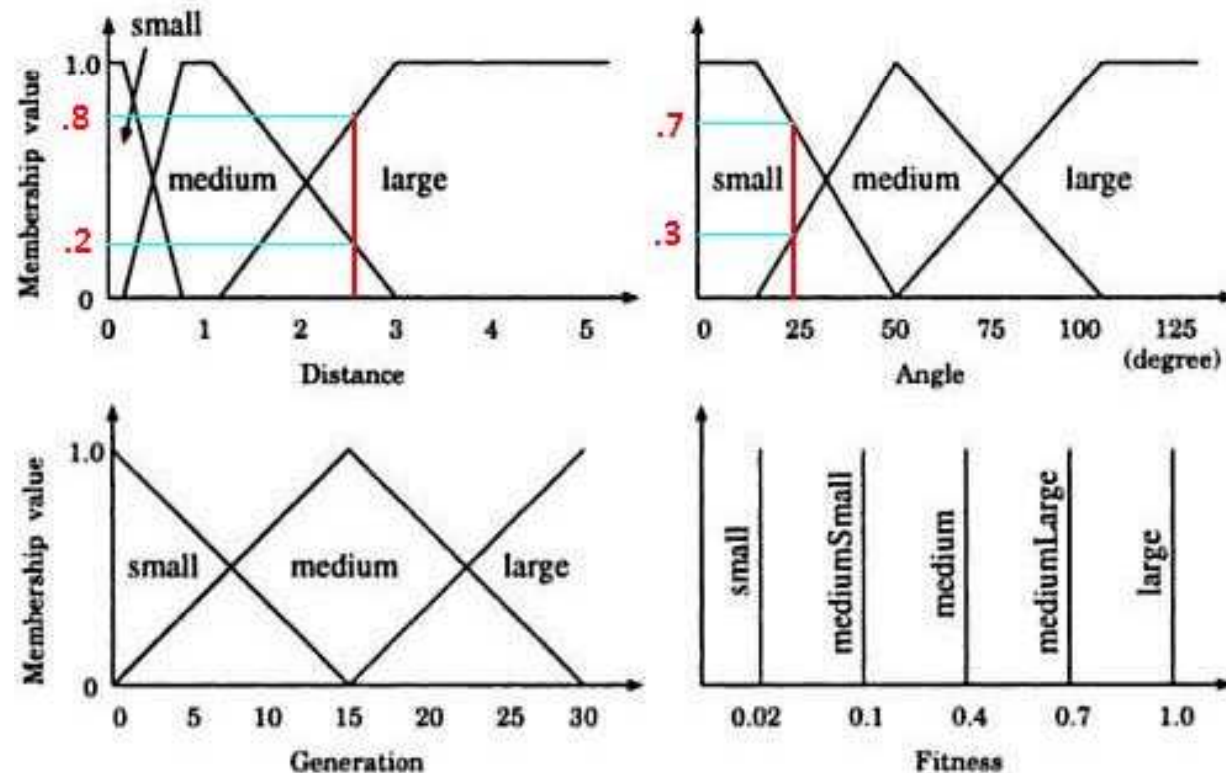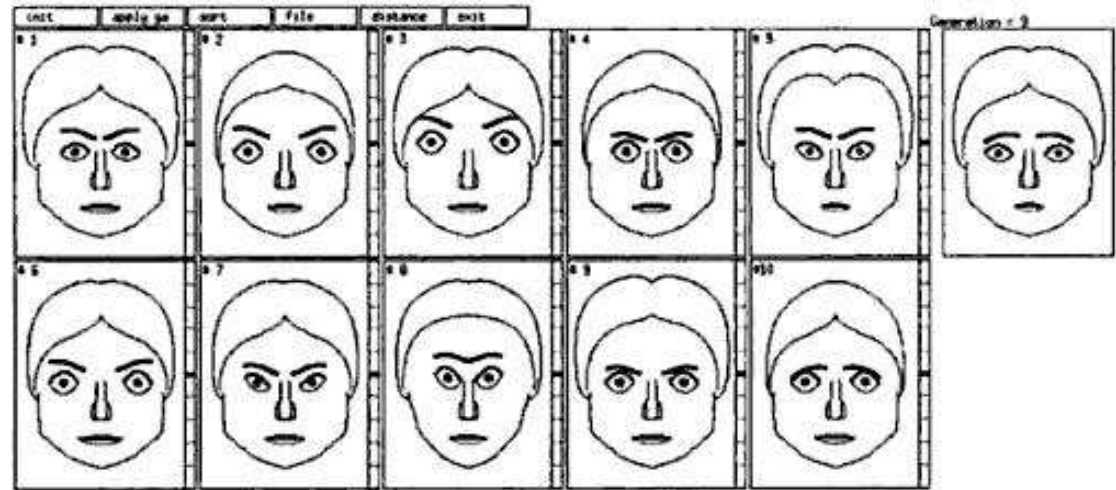
GA parameters

- The Genetic Algorithm parameters used in experiments:

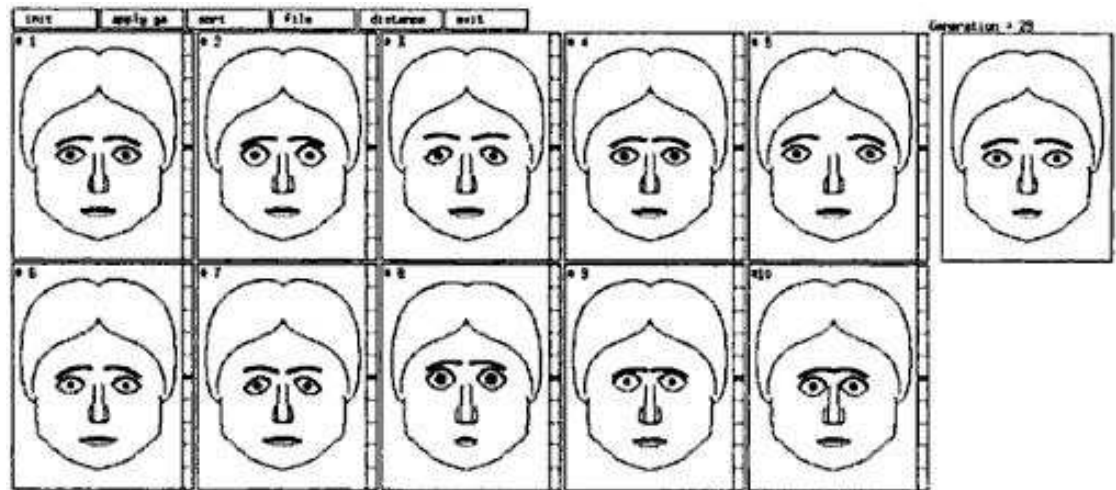| GA parameters	
Population number	10
Chromosome length	36
Crossover method	Simplex[10]
Simplex crossover rate	0.9
Mutation rate	0.05
Number of elites to survive	1

Sample results

- 10th generation

- 30th generation

Summary