# Investigating Face Space

**Steve DiPaola**
Stanford University
steve@dipaola.org

## Introduction

Imagine an n-dimensional space describing every conceivable humanoid face, where each dimension represents a different facial characteristic. Within this continuous space, it would be possible to traverse a path from any face to any other face, morphing through locally similar faces along that path.

We will describe and demonstrate a development system we have created to explore what it means to "surf" through face space. We will present our investigation of the relationships between facial types and how this understanding can be used to create new communication and expression systems.

## The System

While a multi-dimensional space is a convenient way to generate a universe of faces, it has a slippery relationship to the ways we perceive facial similarity and sort faces into different categories. We currently measure facial similarity by values of low level facial parameters, such as chin width, eye radius, etc., based on our knowledge of creating facial animation systems for the graphics and avatar industries [1, 2], however perceived similarity operates on a different metric. The correlation between facial parameter values and perceived race, age, gender, or cultural stereotype is even less straightforward. It is this experimentation with classifications and their facial relationships, as well as how a viewer reacts to them, which have provided the motivation to create this development environment.



The system uses a genetic algorithm technique known as aesthetic selection [3] to search through face space, using approximately 25 parameters to specify the genotype. An earlier version of this system [4] was developed as a freely downloadable web tool, which allows users to create families of 3d heads for use in the popular simulation game "The Sims" by Maxis. In this version a menu of random faces is generated from random points in face space. By selecting one of the faces, the user is able to surf through the local region centered around the selected face and can increase or decrease the local region of similarly looking faces by the use of a mutation rate slider and other controls. In this way, novice users can "find" or breed a face or family of related faces that appeal to them for use in the game.

A large web based community is currently using this system to make thousands of faces. In addition, these users have the ability to publish and trade faces on the web and even breed their creations with those of other users. Every head or family of heads becomes a local starting point or region in face space. What we have found is that a user will have a strong emotional response to certain faces they encounter (which appears to have cultural underpinnings) and that this emotional attachment continues as they surf that locally related face space. By expanding this system into a full development tool, we hope to better understand these cultural relationships for both specific faces as well as their relationship to other faces in face space. Specifically, we are interested in the following areas:

- The system allows us to traverse morphing face paths through face space, with the ability to affect the trajectory of path (straight, curved) and the key points (faces) to target along the way. Music can be described as paths through tonal space with significant cultural biases described by certain paths or key points (i.e. notes, intervals, scales) determine whether certain motifs sound appealing. Can we similarly write a composition in face space? Imagine a representation of two intertwining paths through face space that use their relationships, both harmonic and discordant, to create a composition.
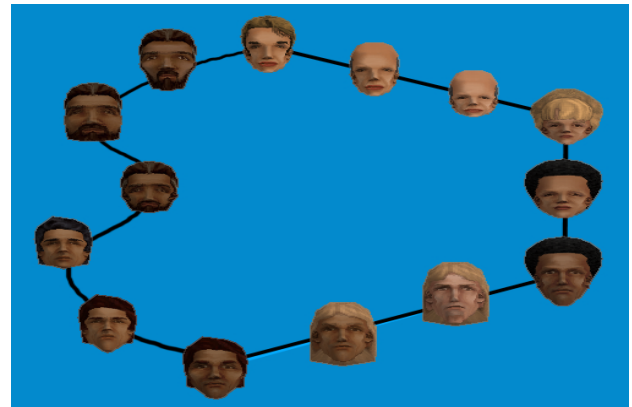


- We have so far concentrated on facial types, but we can expand the current development system to work with facial emotions as well. Can we create a syntax or language using face symbology that can be recognized rapidly, and span national and cultural boundaries?

It is well known that we humans have specific neuro-programming for recognizing and interpreting faces. It is hoped that we can use the face space development system to better understand the conscious and intuitive meaning of faces and the universal language they appear to represent *(facial meaning and inter-relationships)* for use in the arts, cultural theory and communication.

**References**
1  DiPaola, *Extending the Range of Facial Types*, Journal of Visualization and Computer Animation,  1991
2  Parke & Waters, Computer Facial Animation, 1996
3  Sims, Artificial Evolution for Computer Graphics, In SIGGRAPH, 1991
4  Facelift download - http://thesims.ea.com/us/