Generation of Emotional Behavior for Non-Player Characters
-- Development of *EmoBot* for Quake II --

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Introduction to *EmoBot*

Recent technology advances in computer game industries demand a development of high-level artificial intelligence. This trend motivates the International Game Developers' Association to develop a special interest group (SIG) in artificial intelligence (IGDA 2003) and the roundtable of 'AI in Computer Games' at the Game Developers Conference (GDC 2003). According to the IGDA SIG, high-level artificial intelligence is defined by the realization of more attractive humanistic features within computer games, such as believable and interesting non-player characters (NPCs) that perform complex reasoning and learning in order to exhibit emotions.

Similarly, the AAAI 2000 Spring Symposium on AI and Interactive Entertainment discussed issues concerning the generation of human-like characteristics for computer games and toys. Reflecting industrial demands and being inspired by contributions from AAAI symposiums, a set of intelligent agents named *EmoBot* was developed to generate emotional behaviors for NPCs (Laird 2000; Wilson 2000). *EmoBot* is embedded within an open-source first-person shooter computer game, ID Software's *Quake II*. The following provides a short overview of the AI engine in *Quake II* (Hooley 2003):

> *Quake II* by ID Software uses a simplistic state-machine approach to its artificial intelligence. … An objective can be interpreted as a "state." Bots start out with their objective as the world, which signifies the bot will follow pre-determined actions such as guarding or patrolling. Once the bot is aware of a player, the bot's objective becomes that player.

EmoBot fabricates emotional behavior with fuzzy logic in the extended logic programming language: *FRIL* -- *F*uzzy *R*elational *I*nference *L*anguage (Baldwin, et. al. 1995). The deployment of fuzzy logic is primarily justified by the fuzziness of personality, and its great success in control applications analogous to *EmoBot* tasks.

Description of Computational Model

EmoBot is realized as a knowledge-based agent that generates emotional behavior as reactions to a momentary perception of game variables (**Figure 1**).

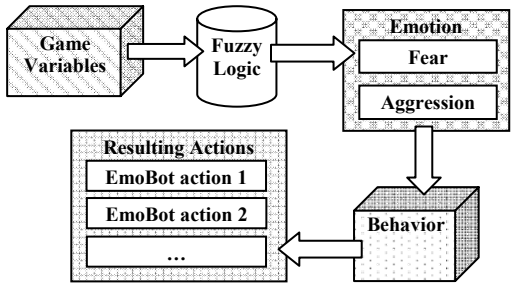

Figure 1—*EmoBot* Overview

Representation of Emotions: EFA Space

States of emotion are represented as values in the three-dimensional Cartesian space, called *EFA* space (where EFA stands for *E*xtroversion, *F*ear and *A*ggression) deployed in the Artificial Emotion Engine™ (Wilson 2000). For simplicity and insignificant relevancy of the extroversion in first-person shooter games such as *Quake II*, *EmoBot* determines its reaction by taking two of the three dimensions into account: Fear and Aggression (FA space). Additionally, variations of mapping game variables onto two dimensions (i.e. representation of a personality) can also be considered as a replacement to the extroversion dimension.

Environment Perception: Game Variables

There are six game variables (specific to *Quake II*) used for momentary perception of the environment by *EmoBot*:

1. NPC health: {bad, fair, good}
2. NPC damage: {low, medium, high}
3. Player health: {bad, fair, good}
4. Player damage: {low, medium, high}
5. Distance: {near, medium, far}
6. Angle: {small, medium, large}

Each variable is partitioned by three fuzzy sets associated

with linguistic labels. Each fuzzy set corresponds to perception agents. An example is provided below (**Figure 2**):

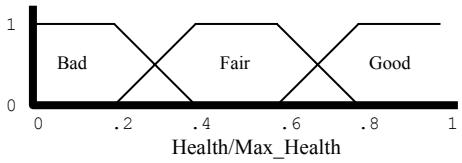

Figure 2—A Fuzzy Partition

Personality: Fuzzy Logic Rules

Fuzzy logic is used to determine a corresponding state of emotion based upon a mapping from perceptions of the environment. Below, the following example mappings are configured by simple fuzzy rules such that underlined linguistic expressions correspond to fuzzy sets and boldfaced logical operators are standard fuzzy logic operators:

IF bot-health IS bad **AND** player-health IS bad
THEN fear IS medium
IF bot-health IS bad **AND** player-health IS fair
THEN fear IS high
IF bot-health IS bad **AND** player-health IS good
THEN fear IS high

Mappings represent personality traits of a NPC, which is analogous to an individual's characteristics (e.g. solders with ample experience may feel less fear in a battle field). Additionally, perceptions represented as fuzzy rules may be uniquely configured to each NPC.

Emotional Behaviors: Partitions in FA Space

Emotional behaviors are determined according to a partition defined on the FA space. Each partition represents a behavioral state corresponding to a set of emotions. Currently, *EmoBot* implements a granularity of six partitions (**Figure 3**):

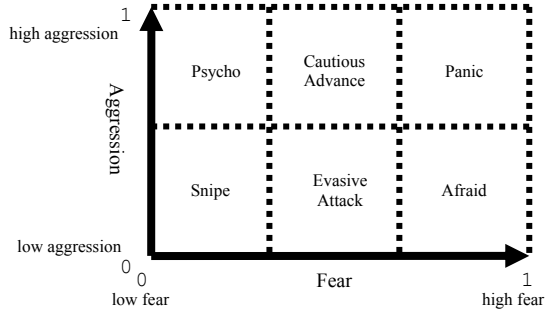

Figure 3—Behavioral States in FA Space

Based upon the NPCs personality and current game states, fuzzy inference yields a specific coordinate within FA space by means of the underlying computational model within FRIL, called Support Logic Programming and Mass Assignment Theory. This is consistent with the standard fuzzy inference as well as probabilistic reasoning. Finally, the coordinate is projected onto the partitioned space to determine the emotional behavior.

Generation of Actions

Action(s) for each emotional behavior was intuitively defined; please see the list below for details:

1. Psycho: Sprint towards player and attack.
2. Snipe: Shoot from a distance.
3. Cautious Advance: Shoot and slowly advance towards player.
4. Evasive attack: Jump from side-to-side and shoot.
5. Panic: Freeze and run in random directions (The NPC cannot do anything because of fear).
6. Afraid: Run in the opposite direction of the player.

Currently, they are statically embedded within *Quake II* game.

Preliminary Project Results

Despite the simplicity of the emotional behavior model (six states, six game variables as inputs), *EmoBot* adds a significant difference to the behaviors of NPCs, as opposed to traditional *Quake II* AI. Furthermore, *EmoBot* illustrates the usefulness of fuzzy logic and demonstrates its positive potentials as a basis for the high-level artificial intelligence in computer games.

Future research may include an adaptive *EmoBot*, where fuzzy partitions of emotional behaviors blend actions.

References

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