## **Needs-Based AI Model Introduction**

The Needs-Based AI Model is effectively a derivative of the models and implementation used with the classic video game ‘The Sims’; as the author of this model helped with the development of the game and ‘cousin’ expansions of its associated model for other titles since. Although we will mostly be referencing the ‘Physical Needs’ component thereof, we must note that it’s only a piece of a far more powerful model/system which further implements action selection, action performance, realizing complex ‘action chains’, and some degree of goal planning. We also refer to a presentation given on this model alongside the greater AI implementation of ‘The Sims’ of which discusses some of the social dynamics/relations mechanisms. We also need to discuss it because physical needs to affect human emotions and vice versa. If we have implemented the simulation of physical needs into our NPCs and desire a realistic and accurate realization of their personality and emotions: needs-based AI is essential!

## **Needs and Types thereof**

OSC and CiF utilize and discuss some of the psychological models which inspired their work, of which the ‘Big 5 Personality Traits’ and OCC are well-known. Another well-known model that some may comment has been left out of our discussion so far is ‘Maslow’s Hierarchy of Needs’ – but now it gets its turn. The Maslow model is a “theory of human behavior based on increasingly important psychological needs” from which ‘The Sims’ modeled its “biological and emotional drivers” for NPC agents. Needs-Based AI is thus a model by which action selection (typically immediate i.e. short term) is based on fulfilling a set of needs whose units represent the 'motivation' of satisfying each such need (towards some homeostasis 'balance' between the needs WLOG). Needs are represented as an array of numeric values of range [0, 100] which decay over time; and increase/decrease based on actions and events. They have the semantics of “lower is worse and more urgent”, so that hunger=30 means “I’m pretty hungry,” while hunger=90 means “I’m satiated.” Need values should decay over time, to simulate unattended needs getting increasingly worse and more urgent. Performing an appropriate action then refills the need, raising it back to a higher value (this is a connection from actions to need satisfaction, ergo likewise resolution of impact of needs on mood, emotions, etc.) For example, we simulate the agent getting hungry if they don’t eat, by decaying the hunger value over time. Performing the “eat” action would then refill it, causing it to become less urgent (for a while). Thus to recap the main semantic meaning:

* Lower-> 'more urgent' s.t. [hunger:10]-> "very hungry" (e.g. long time since eating meal)
* Higher-> 'less urgent' s.t. [hunger:90]-> "not hungry" (e.g. event occurs of eating a meal)

That is: Need values will decay (over time in all cases), and action performed / event occurred -> values for affected need(s) increase ergo urgency decreases, for as long as the agent is active.

There are 8 types of needs separated into 2 groups: physical and mental. Physical needs include hunger (remedied by eating food), hygiene (remedied by cleaning oneself and one’s environment), bladder (self-evident), and comfort (remedied by sitting or laying down). Mental needs include energy (remedied via a Sleep Cycle which itself is a VERY interesting and realistic simulation but sadly out of direct scope of this paper), social (remedied by interaction with other NPCs/PCs), fun (remedied by entertainment / recreation, and environment a.k.a. room (remedied by architecture/aesthetic). Regarding environment: the details are left vague but we believe this simulates things like becoming depressed if one lives indoors all day without any exposure to sunlight, lives in a derelict ruin versus a luxury apartment, etc. Regarding ‘energy’: we are compelled to express a contention for which we also offer a resolution thereof. To address this in reverse order: we believe that ‘energy’ could be partitioned into 'physical' and 'mental' such that each certainly affects the other; while each would be affected by only their corresponding needs. That is, low hunger would affect the decay of 'physical energy' which would then affect 'mental energy' such that low hunger affects mental energy - but only by proxy of affecting its respective energy need. To provide intuition to this idea: being tired after a 5 mile jog does not necessarily imply a corresponding fatigue for solving math problems; nor does completing a math exam imply a corresponding fatigue for the 5 mile jog. While each task certainly affects the energy available for other - we do this only through one energy need affecting the other. That is, taking the exam reduces mental energy, which then reduces physical energy for jogging - and vice versa. And we see examples of this 'multidimensional by way of grouping' relationship within the Sims 1 model for things like sleep cycles.

## **Implementation within AI system**

We conclude our synopsis of the Needs-Based AI model with some implementation notes, noting the obvious in that these notes are sparse. This is largely due to the fact that as with Dialogue Agents, only some components of this model apply within scope of this project. For a full realization of Fëa and all of its components: a substantially greater discussion of implementation for this model would be needed. That said, we first node that the means by which needs values are turned into a ‘mood score’ again utilizes principles in behavioral mathematics. Specifically: the sum of all physical and mental need values is taken such that each is weighted by respective hyperparameters which tune their influence upon the computed mood score not unlike a simple classifier network. Going from the Will Wright pseudocode as we implemented in a basic demonstration of the ‘Sims-style Needs Model’ back in 2019: the resulting subtotal score is then factored against a fraction (technically – is divided by a whole number) such that this number is also effectively a hyperparameter (in Wright’s case – 17) from which a final mood value is produced. The next question is what the greater Fëa system does with this mood value; for which we have an idea. One option is to have individual needs values both explicitly affect their corresponding emotions and personality types (i.e. low social need value and extrovert means joy decreases); while also using the mood value as a standalone emotional component which speaks for the character’s “mood given needs” whereas the OSC value produces “mood given emotions”. We could then either take a weighted average of both, or experiment with a number of such calculations WLOG.

Two final points involve the topics removed from scope of this report; but of which remain applicable due to their prospective impact on emotions given needs if/when a full realization is modelled/realized. The first regards the impact of needs on actions and behaviors thereof. We observe that ‘The Sims’ model uses simple utility calculus on the rewards of all possible actions s.t. the action chosen is defined as the “random [choice] among the top 4 that cause the most happiness [i.e. utility]”. In response to this, we instead suggest a reactive intensity/priority model could be modeled implemented analogous to how OSC calculates emotions, wherein more intense higher priorities (i.e. really hungry and hunger is high priority need, need to piss really bad but enjoying television show) are chosen consequent, without going into any more detail. Finally, we make a small remark about the impact of Personality attitudes on Objects (standalone and WRT advertisement concept): in that this could allow for realizations such as “being unhappy because living in dirty house” but happiness would increase if house was cleaner, etc.