From Caveman to Gentleman

A CiF-based Social Interaction Model applied to Conan Exiles

Luís Morais
lmcorreiamorais@tecnico.ulisboa.pt

João Dias
joao.dias@gaips.inesc-id.pt

Pedro A. Santos
pedro.santos@tecnico.ulisboa.pt

ABSTRACT

Even though modern video games present rich storytelling and high graphical fidelity, they are still lacking in rich non-scripted NPC social interactions. In this work we present an extension of the Comme il Faut (CiF) and CiF-CK social interaction models, where we added emotions and a emotion appraisal process based on the OCC model of emotion and also added a belief system that models the social network values that the NPCs expect for the other NPCs' relationships. A version of the new model, which we named Comme il Faut - Exiles (CiF-Ex), was implemented in the AAA game Conan Exiles using their modding tools and tested. The results were noteworthy: the users enjoyed more the game and tended to spend more time near CiF-Ex enabled NPCs. The majority of the users preferred CiF-Ex NPCs, even without voice acting versus the vanilla NPCs with voice acting. CiF-Ex NPCs were perceived as more believable and less predictable. This paper has been accepted to be present in the conference Foundations of Digital Games 2019, San Luis Obispo, California, USA.

CCS CONCEPTS

• **Computing methodologies → Intelligent agents**; *Multi-agent systems*; Planning for deterministic actions.

KEYWORDS

Social Model, Social Interaction, Artificial Intelligence, Non-player Character, Video game

ACM Reference Format:
Luís Morais, João Dias, and Pedro A. Santos. 2019. From Caveman to Gentleman: A CiF-based Social Interaction Model applied to Conan Exiles. In *Proceedings of Foundation of Digital Games (FDG'19).* ACM, New York, NY, USA, 11 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 INTRODUCTION

Artificial intelligence is slowly making its way into our lives. Recent advancements in AI have allowed technologies like Apple's Siri[1], Microsoft's Cortana[2] or Google's Assistant[3] (all mobile assistants with a degree of personality and sociability) to get into the pocket of the mainstream person. This suggests that the general public is open to interact with and integrate social artificial intelligence in their daily lives.

In parallel, the video games industry has seen a growing concern in representing the world as we know it in order to give the users a more engaging experience. This attentiveness to realism manifests in different forms - we can observe the constant improvement over the years in graphic fidelity; analyze the enthusiasm that Virtual Reality caused with the appearance of the Oculus Rift[4] and consequent race to release VR headsets between companies like HTC with the HTC Vive[5] and Sony with Playstation VR[6]; and consider the trend in current video games to grant rich stories with distinct characters. In short, greater realism and interactivity are two targets to pursuit.

In this context, AI can be seen as an augmentation to the gameplay experience. Despite the abundant number of AI controlled characters in AAA games nowadays, Human-AI social interaction in video games is usually very simple, devoid of characterization and consequences, which creates a contrast between the individuality that those characters display in cutscenes and the actual gameplay. A notable exception was the experimental video game Façade [16] that provided a fresh approach to interaction with social NPCs, but whose technology never was used in a commercial game.

Social interactions that cause real consequences in the game world are hard to model. As the player is given more freedom of social choice and more detail is added to the characters, the space of possible social consequence grows rapidly. If the developer chooses to represent the player's choices with a traditional branching tree, they would have to account for all the possible combinations of player actions, meaning that the amount of content that needs to be created would grow accordingly. Consequently the studios would have to allocate more resources. In short, better social behaviour increases significantly the authoring burden. To combat this tendency, new, non-conventional models that dynamically adjust the social panorama have to be applied.

A family of architectures for social AI, CiF [11], has had success with its implementation in Prom Week [7] and with a more recent extension of the architecture, CiF-CK [8], which was integrated on *The Elder Scrolls V: Skyrim* [2] as a mod (fan-made alterations to video games that add or modify mechanics). One of the characteristics that distinguishes this system from others is that it has been associated and implemented in video games, while others are normally used in demos, designed to showcase the architecture itself.

Our approach will be to create a social model based on the CiF and CiF-CK architectures that improves the *User Experience* and *NPC Believability*. In particular, the main contributions of our work are:

- *The addition of an emotion layer* based on the OCC model of emotion [12];

[1]https://www.apple.com/ios/siri/
[2]https://www.microsoft.com/en-us/windows/cortana
[3]https://assistant.google.com/

[4]https://www.oculus.com/
[5]https://www.vive.com/eu/
[6]https://www.playstation.com/en-us/explore/playstation-vr/
[7]https://games.soe.ucsc.edu/project/prom-week

FDG'19, August 2019, San Luis Obispo, California USA
2019. ACM ISBN 978-x-xxxx-xxxx-x/YY/MM…$15.00
https://doi.org/10.1145/nnnnnnn.nnnnnnn

- *The extension of CiF-CK's Belief system*;
- *The addition of a third possible outcome* for Social Exchanges;
- *A better integration of the Player and NPCs possible actions*, allowing the Player to respond to all Social Interactions;
- *The validation of the new model* by evaluating its implementation in a AAA video game.

2 RELATED WORK

There are several social models designed by different research groups, each with their objectives, pros and cons. This way, analyzing alternatives and choosing one that not only fits the demands of our work (such as the objectives and the particularities of the implementation platform) but that is also easily extendable is important. We present a brief look on the video game that will serve as base to the implementation, Conan Exiles, and the social models that contributed to the conception of our new model.

2.1 Social Models

A social model improves the NPCs' social behaviour by simulating human characteristics like traits, emotions and desires that are impacted based on the context of their social interactions. NPCs are vital to create a living world - through the simulation of human behaviour they make the world feel even more dynamic and believable.

2.1.1 ***Comme il Faut (CiF).*** The aim of the Comme il Faut [11], social AI system is to provide a model in which the author is able to create representations of social norms and interactions that are reusable and recombinable depending on the context of the communication, while still keeping the burden of authoring social AI behaviour low. The result is an interactive social environment whose characters have distinct personalities, goals and relationships and are able to socially interact between them.

CiF lowers the authoring burden needed to create a rich and interactive social environment to tell a story by allowing the creator to specify the social context of the world in the form of rules. The nature of the rule based representation allows new domain knowledge to be added and used right away. Rather than a more simple action-reaction approach or behaviour tree, the resulting interactions, designated as *Social Exchanges (SEs)*, are spontaneous but coherent with the foundation of the encoded social world and the involved characters.

2.1.2 ***Comme il Faut - Creation Kit (CiF-CK).*** Comme il Faut - Creation Kit [8] is an implementation of CiF that has role-playing games (RPGs) as focus. The term "quest" is very familiar to any RPG: a plot driven mission that has initial conditions, an objective and effects. CiF-CK uses the parallels between the notion of *quest* and CiF's *social exchanges* to create an adapted model than can be generalized for any RPG.

Diverging from the original CiF, in which every character has its personality defined by the system and can be controlled by the user, CiF-CK puts the player on the role of a single character and allows them to role-play and shape that character's story.

A notable addition to the CiF model is the notion of *belief*. A character may believe that one fact is the truth and act accordingly, despite possibly being wrong. The NPCs' desire formation now takes into account not only their goals but also what they believe to be true.

CiF-CK was implemented in the video game *"The Elder Scrolls V: Skyrim"* [2], a role playing game (RPG) developed by Bethesda Game Studios. The resulting work not only accomplished its goals of creating a better gaming experience with interesting and believable characters, but also resulted in a mod that achieved success within the player community and the media[8].

2.1.3 Other Social, Psychological and Emotional Models. There are several other models proposed in the literature.

Ensemble [19] is a CiF architecture iteration presenting social exchange performances, *social practices*: playable social dialogues where the player and the NPC take turns, choosing what to say at each stage. Instead of being fixed, social practices are generated on the go and depend on previous Player dialogue choices.

PsychSim [17] is a tool to define scenarios with individuals and groups, each with their own goals, relationships, beliefs and mental models and watch how they interact and influence each other. Agents in this system have fully specified decision models of other agents. This illustrates how in real life human actions are made taking into account predictions based on mental models that we have of other people, based on *"theory of mind"* [5].

Syntethic Group Dynamics (SGD) [15] is a model that meets the user's expectations by following believable group dynamics between virtual agents, inspired by theories developed in human social psychology sciences. The different types of interactions that may occur in the group alter the dynamics, producing a positive effect on the user's social engagement.

Fearnot Affective Mind Architecture (FAtiMA) [3] is an agent architecture that endows agents with emotions and personality that, joined with the architecture's planning capabilities, affect their behaviour. FAtiMA uses emotions and emotional behaviour based on OCC to achieve believable characters that evoke empathy in the user. The OCC Model of Emotion [12] is a conceptual model that characterizes 22 different emotions and organizes them in a hierarchy that explicits the conditions for them to be active.

GAMYGDALA [14] provides NPCs with OCC emotions. Game events affect NPC Goals, which in turn react by producing specific emotions to the NPC. This way, different NPCs can generate different emotions when submitted to the same situation.

2.2 Conan Exiles

Conan Exiles (2018) [6] is an open-world survival video game published and developed by Funcom. Funcom has released a modding tool, the DevKit, and is continuously releasing updates that build on and improve the game's mechanics.

2.2.1 Overview. The video game is set on a barbaric wasteland inspired by the world of Conan the Barbarian [9], created by Robert E. Howard. The player assumes the role of an exile in this hostile land and it is up to them to endure the many dangers of this environment, be it attacks from hostile NPCs and other players or dealing with the physical necessities of their character (hunger, thirst, sleep).

[8] https://www.nexusmods.com/skyrim/mods/77792/

Dialogue NPCs are named characters that have their own backstory. Most of them are priests that talk about their devotion or motivations with the player. When interacting with the Dialogue NPCs the player can:

- Choose the "Talk" option, the NPC then selects a sentence from their dialogue set and displays it.
- Choose to learn an Emote (only some NPCs have this option).
- Choose to learn a Religion (only some NPCs have this option).
- Choose to learn a crafting Recipe (only some NPCs have this option).

2.2.2 Conan Exiles DevKit. Conan Exiles was created using the Unreal Engine 4 (UE4)[9], one of the cutting-edge engines used for developing numerous video games[10]. Funcom released a modified version of UE4, the *DevKit*, downloadable in the Epic Games Launcher, granting the modding community access an environment to create and publish mods.

The DevKit has however one limitation, despite providing most of the tools that the developers use to make the game, it does not permit modders to interact with or even consult the game's code. This means that some classes are inaccessible, can't be changed directly and their internal functionality will have to be assumed.

The assets that can be used are available through one of the features of the UE4, the system called *Blueprints Visual Scripting*[11], *blueprints* for short, designed to define object-oriented classes and objects using a graphic node-based interface.

Thanks to the DevKit, Conan Exiles has served as environment for the implementation of other works such as *A Procedural quest generator for Conan Exiles* [10] and in particular *A Merchant Model* [4], that adds some basic social capabilities to the NPCs of the video game.

2.3 Discussion

CiF models NPCs with traits, status, relationships and social networks between them, and an algorithm that appraises the NPCs' desires, starting social exchanges that will modify the social panorama when concluded. As such, CiF is an ideal suitor to become the base for our solution. FAtiMA and GAMYGDALA explore and model emotions, an interesting concept that we will approach and expand upon.

CiF-CK is an extension of the original CiF model, tailored to fit the needs of the platform that it was implemented on: the RPG video game *The Elder Scrolls V: Skyrim* [2]. The modifications that CiF-CK proposed, such as the the Player controlling only one character (highlighting the role-playing aspect of the game) and the addition of the belief system have proven their effectiveness in creating a rich interactive social AI environment. We expect that our system, deeply inspired by the above mentioned, will also achieve satisfactory results.

Conan Exiles is a AAA video game that features a rich world environment populated by various NPCs (some of which possess basic social capabilities) and modding tools, presenting itself as a great candidate to be the testbed for our model.

[9] https://www.unrealengine.com/en-US/what-is-unreal-engine-4
[10] https://en.wikipedia.org/wiki/List_of_Unreal_Engine_games#Unreal_Engine_4
[11] https://docs.unrealengine.com/latest/INT/Engine/Blueprints/index.html

3 COMME IL FAUT - EXILES (CIF-EX)

Our model, the *Comme il Faut - Exiles (CiF-Ex)*, is based on the Comme il Faut [11] architecture and takes inspiration on the concepts introduced in the Comme il Faut - Creation Kit architecture [8], extending both models by:

- **exploring character emotions (in the form of *Emotion and Social Emotion Status*,** based on the OCC model of emotion). The CiF-Ex emotions fluctuate as an immediate consequence of a Social Exchange and *contribute to create detailed characters that respond realistically*;
- **extending the CiF-CK's *Social Network Belief*.** Instead of just keeping track of the Social Network values that the NPC believes the other NPCs have towards them, NPCs also have beliefs on how much the other NPCs like each other. This allows us to *convey complex behaviours that rely on the expectation that NPCs have for the others' relationships*. For instance, a NPC can notice that their loved one has a great affection for another NPC and feel *envy* for the latter, expressing it by desiring to initiate negative social interactions with them;
- **extending the representation of the *Status* to a continuous scale** instead of a binary variable. This way we can express the intensity of an emotion: rather than just declaring that a NPC does or not feel an emotion, we can *detail the depth of that emotion and also decay its value with time*;
- **adding a new possible Social Exchange Outcome, *Neutral*,** to the already existing *Positive* and *Negative*. Having two polar possible reactions to a social exchange is a simplification of what happens in the real world, people do not just answer intensively to every social interactions. The two outcomes also limit the author's freedom of expression for the dialogue, having a middle ground allows them to express two opposites and also a more calm response;
- **giving the Player the ability to respond to all the Social Exchanges** that the NPCs initiate with them, determining the Outcome. Instead of being a passive receiver, *the Player can role-play their character and articulate their feelings, deciding the outcome of the Social Exchange*. CiF-CK already allowed the response to some special SEs (like "Dating proposal").

3.1 Solution

The CiF-Ex architecture features five main components:

- **Social Exchanges**: the space of possible social interactions;
- **Characters**: a structure that holds the social attributes of an NPC;
- **Social State**: a structure that represents the social panorama;
- **Trigger Rules**: sets of rules that when activated change the Social State.
- **Microtheories**: General rules applied to the initiator and the receiver for all the SEs.

The Figure 1 shows the CiF-Ex components and their interaction. **Characters** initiate **Social Exchanges** that they desire in the role of the *initiator*, setting another character with the role of the *receiver* (some SEs may even have a third character participating, the

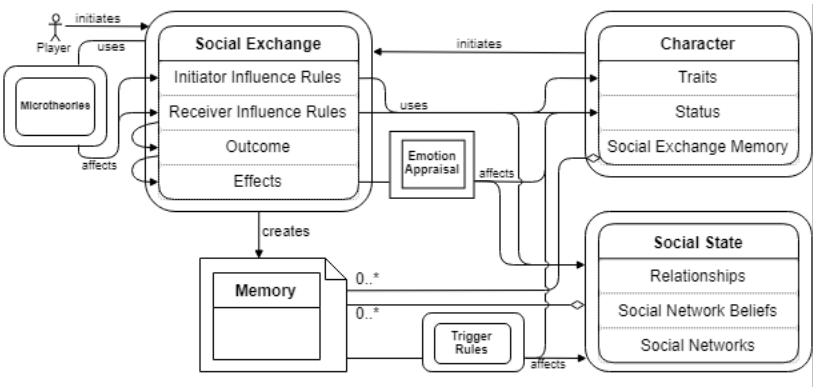


Figure 1: The CiF-Ex Components

other). The Social Exchange's *Influence Rules* use the characters' **attributes** (*gender, traits, status and social exchange memory*), **Social State** and **Microtheories** to calculate the volitions, quantifiable representations of the NPCs' desire to carry out a specific SE.

The receiver's volition determines the *Outcome* of the Social Interaction, if it ends positively, neutrally or negatively. In turn, the Outcome dictates both the *Effects* (the immediate changes to the characters' Status (*Emotion Appraisal*) and Social State) and the *Instantiations* (the character's visual performance of the Social Exchange). The end of a SE is marked by the creation of a **Memory**, an object that summarizes a past SE, including some metadata. The new memory is archived by the participating and other characters that witnessed the SE in their *Social Exchange Memory* and by the Social State's *Social Facts Knowledge Base*. The **Trigger Rules** process the new memory for each character that receives it, affecting their Status and the Social State.

3.1.1 Social Exchanges. **Social Exchanges** are structures that represent the social interactions (in this work we focus mainly on dialogue interactions) that the characters and the player can have with each other. The outcome of one SE is dependent on the Social State, personality traits and status of the SE participators and has the capacity of modifying the Social State.

Compliment, *Insult* and *Brag* are some examples of SEs. It is up to the author to decide whether the SEs that they craft are of a more universal significance or more specific, depending on the detail that they want to reproduce (e.g.: having one *Insult* SE vs having one *GraveInsult* and one *LightInsult* SEs with appropriated social impact and dialogue lines).

- **Intention** represents the purpose behind the SE (for example, the *Insult* SE has *Negative* as intention, the *Compliment* SE has *Positive* intention, the *Flirt* SE has *Romantic* intention). Intentions are used to generalize behaviour when calculating Microtheories and Trigger Rules.
- **Influence Rules** are used to calculate *volitions*. The *Initiator Influence Rules* are used to prioritize which SE the initiator wants to perform the most and the *Receiver Influence Rules* are used to calculate how favourably the receiver will react to the SE. The parameters used by Influence Rules are traits, social network and status values.

  The Influence Rule is a weighted sum between a vector of the influence rule Weights (different for each SE) and the actual Values for each parameter:

  v_i is the current value of the parameter
  w_i is the weight of the parameter

  $$Volition = \sum_i v_i w_i \tag{1}$$

  For example, if there are three status in total, *Happiness*, *Disgust* and *Hunger*, with the values [4, 0, 1]and the Influence Rule Weights are the vector [3, -1, 0]the resulting volition would be equal to: $4 * 3 + 0 * (-1) + 1 * 0 = 12$.
  The only exception to this rule is the *Goal* value of the Social Networks (see Section 3.1.3). Instead of using the direct value, we subtract the *Current* value to the *Goal* value. This means that if the Goal is greater than the Current value the character will desire to perform SE that improve the Current value. For instance, if the *Friendship* social network's Goal is 5 and the Current value is 3, the value used in the Influence Rule will be: $5 - 3 = 2$.
- **Pre-conditions** are rules that are calculated before the Initiator Influence Rules (and only influence the initiator volition). These rules disable SEs that would not be coherent with the current social context (for example, a NPC should only introduce itself once to the Player).
- **Outcome** can be *Positive*, *Neutral* or *Negative*, depending on the calculated receiver volition and will dictate the reaction of the receiver. Each SE has two different thresholds that decide the Outcome: if the volition is less than the lower threshold value the outcome is *Negative*, if it's in-between the values the outcome is *Neutral* and if it's greater than the higher value, the outcome is *Positive*. The outcome is used to select what instantiation will be acted and Effects of the SE.
- **Effects** are the consequences of the SE. Effects modify the participating characters' Status, their Social Networks, Beliefs and Relationships. For each SE and possible Outcome there are fixed values that are added to the *Social State* and *Character Status*.
- **Instantiations** is a term originated from the CiF architecture. These are the "theatrical performances" of the SEs'

outcomes. *Instantiations* are mainly dialogue lines specific to each SE participator complemented by NPC animations.

3.1.2 Characters. A *Character* is a structure that holds each NPC's personal CiF data. The data described bellow allows the architecture to add social behaviour to the NPCs.

- **Name** is used to identify the character. The *Nickname* is the name that will be presented to the Player before they either introduce or a NPC introduces themselves. Nicknames are false names based on the NPC looks (e.g.: if a male NPC wears a helmet with horns the nickname could be "Horned Man").
- **On cooldown** is used to verify if a character is on cooldown. After performing a SE the characters go into cooldown and aren't able to start SEs until this expires. The time of the cooldown is dependent on the character's traits (e.g.: a character with the trait *Shy* will have a greater cooldown than average).
- **Busy** is used to check if other characters can start interactions with this character. If a character is targeted as the receiver for one SE (either by another character or the Player) they will be flagged as *busy*. The Player is able to interrupt an on-going SE, bypassing the busy flag.
- **Traits** are used to give the characters a distinct conduct, they shape the character's personality. Traits are predetermined when the character is authored and immutable. *Friendly*, *Hostile* and *Brave* are examples of traits.
- **Status** are attributes that portray the character's emotional condition. Status are changed at the end of all SEs and decay or increase with the passing of time. Status have three categories: *Emotion Status* (depicts the character's mood, e.g: *Anger*, *Happiness*), *Social Emotion Status* (depicts what the character is feeling towards other characters, e.g: *Admiration*, *Resentment*) and *Physical Status* (depicts the character's physical needs, e.g: *Hunger*, *Tiredness*).
  A list of the Social Emotion, Emotion and Physical status can be seen in Table 1, Table 2 and Table 3, respectively. The descriptions for the Emotion and Social Emotion Status are based on the descriptions of the OCC Model of Emotion [12]. The process of adjusting the *Emotion and Social Emotion Status* is called the *Emotion Appraisal*. When a Social Exchange is performed, the Emotion Appraisal uses the asserted Outcome to apply a set of changes to the participants' Emotion and Social Emotion Status. As such, there is one set for each Social Exchange and possible Outcome.
  Both CiF and CiF-CK represented status as binary, a character was under a certain status or not. In our model, each status is represented by a bounded continuous scale, which allows for a greater detail when describing a character's disposition. The influence rules take advantage of this: instead of just checking if a character is *Angry*, we are able to check how *Angry* the character is and create rules that take this distinction into account. These values are changed at the end of SEs, depending on the Outcome. Status can also gradually decay (for example, characters can progressively get less angry) or increase (for example, if you are modelling a Physical Status like hunger) with the passing of time.

Table 1: Examples of the Social Emotion Status

Status name	Description
Shame	disapproving of one's own blameworthy action
Admiration	approving of someone else's praiseworthy action
Reproach	disapproving of someone else's blameworthy action
Pity	displeased about an event presumed to be undesirable for someone else
Gloating	pleased about an event presumed to be undesirable for someone else
HappyFor	pleased about an event presumed to be desirable for someone else
Resentment	displeased about an event presumed to be desirable for someone else
Anger	disapproving of someone else's blameworthy action

Table 2: Examples of the Emotion Status

Status name	Description
Sadness	displeased about an undesirable event
Happiness	pleased about a desirable event
Disgust	disliking an unfamiliar aspect of a character
Fear	displeased about the prospect of an undesirable event
Satisfaction	pleased about the confirmation of the prospect of an undesirable event

Table 3: Examples of the Physical Status

Status name	Description
Hunger	Influences the Ask For Food and Offer Food SE volitions.
Thrist	Influences the Ask For Drink and Offer Drink SE volitions.
Tiredness	Increases periodically and each time a character starts an SE as the initiator. When maxed out, the character will go rest by their home

- **Social Exchange Memory** stores representations of the SEs that happened in the vicinity of the character, including the ones that did not involve them. Each individual memory (one entry of the SE Memory) is composed of the names of the participators, the SE's name, the outcome, the origin of the memory (it will be the character's name if they witnessed the SE themselves), the world's timestamp of the event and an ID that is generated to identify each SE. The characters are able to look-up their memories which will in turn influence volition calculations. A memory is added to the SE Memory

if the character is within a fixed distance of the SE initiator when the SE is happening.

The user is an entity that interacts with the CiF components. In both the video games that CiF-CK and CiF-Ex were implemented in (Skyrim and Conan Exiles, respectively) the user impersonates his own character. However, in the original CiF architecture the user was able to control all the characters. Conan Exiles would not be the most suitable video game if we were to keep this design choice as we would be required to dramatically change its base gameplay. As such, in CiF-Ex the user only controls one character, which will be referred as the "*Player*". This change was proposed in CiF-CK and was kept for our architecture.

The user is able to choose any SE that they wish to perform using the Player as a proxy. The trigger rules are not calculated for the Player since they have no internal attributes to be modified. From the perspective of the CiF-Ex components the Player is just like another character; characters will want to interact with the Player, the Social State will keep the values related to the Player and the SEs can be initiated by the Player just like a NPC would.

The NPC cycle begins by the NPC's default behaviour, *Idle*. At any time, if the NPC is nearby an ending Social Exchange performance, they can *receive a SE memory and process* it. If the NPC is selected as initiator, they can start a SE with the receiver. If the Player interacts with a NPC, the NPC participates in the SE as the receiver.

3.1.3 Social State. The *Social State* is the snapshot of the social panorama at any time. This tracks the evolution of the social scene of the world. By examining the *Social State* the social dynamic between the NPCs (and the Player) are evident: *Social Networks* represent how NPCs feel about each other, *Relationships* are strong associations between them and the *Social Facts Knowledge Base* holds all the SEs that have occurred.

- **Social Networks** are private feelings, that may or may not be reciprocal, felt by character towards another. Each Social Network has three variables: *Current* (the current value of the network), *Goal* (the value that the character wants the Current value to tend to) and *Belief* (the current value that one character thinks the other character has for the former, as introduced by CiF-CK). As a result of being non-reciprocal, the Belief value can be wrong. Examples of Social Networks are the *Friendship* and *Attraction* networks.
- **Social Network Beliefs** works the same way as the Belief variable of a Social Network but instead of connecting themselves with one other character, it connects other characters ("Lydia" thinks that "Benor" has a negative *Friendship* value for "Farkas"). There is one Social Network Belief structure for each Social Network that exists.
- **Relationships** are reciprocal social relationships like being *Friends* or *Dating*. Relationships are private, so two characters can be in a relationship without the others knowing about it. Relationships can be inferred using the Social Network Beliefs.
- **Social Facts Knowledge Base** is an archive of all the SEs that happened in the world. Much like the SE Memory (see Section 3.1.2) it saves memory entries.

3.1.4 Microtheories. Microtheories (MT) are rules applied when calculating the pre-conditions and the initiator and receiver volitions. These rules represent conventional behaviour in the world, social norms. As an example: if "Lydia" and "Benor" are friends, "Lydia" is expected to desire SEs with the *Positive* intention and "Benor" is more prone to positively accept them. As Microtheories represent general attitudes that apply to all the Social Exchanges, the author won't have to detail every nuance when defining the SEs influence rules, effectively reduce the authoring burden.

Examples of Microtheories are:

- *Dating MT:* if the characters are dating, they will desire to perform SEs with the *Positive* and *Romantic Intentions*.
- *Friendship MT:* if the characters are friends, they will desire to perform SEs with the *Positive Intention*.
- *Envy MT:* if "Farkas" is highly attracted to "Lydia" and believes that "Benor" is also attracted to "Lydia" or that "Lydia" is attracted by or admires "Benor", "Farkas" will desire to initiate *Negative Intention* SEs with "Benor". "Farkas" is envious of "Benor".
- *Memory Outcome MT:* the characters will avoid doing interactions that have previously ended with *Negative Outcome* and reluctant of doing the ones that ended with *Neutral Outcome*.
- *Memory Frequency MT:* characters will have a penalty on the volition of the last SEs that have been performed. Characters that have the trait *Obnoxious* have a smaller penalty.
- *Memory Decay MT:* if the SE has occurred a long time ago, this MT will lessen the Memory Frequency penalty.

3.1.5 Trigger Rules. Trigger Rules are rules that provoke secondary effects, applied after a SE has ended. After a character receives a new memory the Trigger Rules process the said memory (checking the participants, the SE that took place and the outcome) and modify the Social State. Akin to Microtheories, Trigger Rules illustrate social patterns and generalize that behaviour (e.g.: if "Lydia" hears "Farkas" insulting "Benor", it is expected that they will like each other less and "Lydia" can decrease the *Friendship* Social Network Belief for those characters).

3.2 CiF Cycle

Now we will describe how the above mentioned components interact with each other when executing a CiF cycle. The stages of the cycle are the same as on the original CiF algorithm, adapted to the CiF-Ex components.

3.2.1 Desire Formation. The first step of the algorithm decides *what SE will be executed and their participants*. Before this process starts the system checks if the number of on-going SEs is less than the defined maximum of concurrent SEs, if the CiF cycle is not on cooldown (after a SE has finished a timer is started that stops the cycle from staring, so the interactions don't happen all in a row) and if the Player is in their local area (a fixed distance). If the maximum has not been reach, there's no cooldown and the Player is nearby, the *Desire formation* process is started. When the process can't be started, it aborts and is restarted after a cooldown.

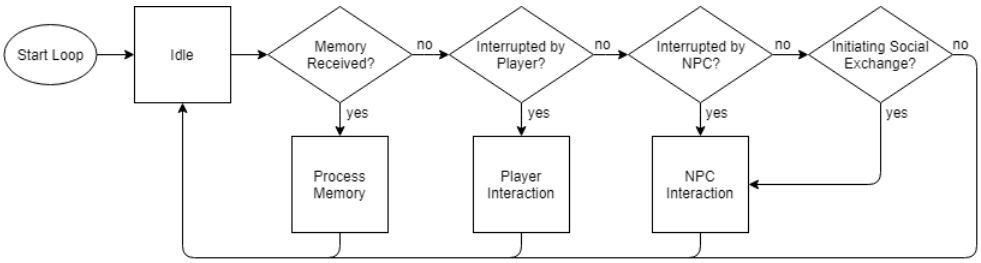


Figure 2: CiF-Ex NPC Cycle

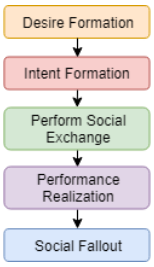


Figure 3: The CiF Cycle

For each character of the world we check if they are both not *Busy* and not *on cooldown*. If these conditions are validated, we can start the cycle to calculate the *initiator volitions*. The cycle iterates through each character and the Player, checking if they are busy; in case they are the cycle continues to the next character, if they aren't a new cycle that iterates through all Social Exchange space begins.

For each iteration of the cycle the initiator volition towards all available characters is calculated: first the *Pre-conditions* check if the SE can even be selected and output a temporary volition, then the *Microtheories* are checked and summed to the volition, lastly the *Initiator Influence Rules* are ran and their output added to the temporary volition, forming the initiator volition for that SE and receiver. We store the name of the SE and respective receiver that have the highest volition, else, we continue to the next iteration of the cycle.

In the end if no SE has positive volition, we do nothing and continue to the next character. Otherwise, we save the information of the highest volition SE and then continue to the next character. After all characters are checked, we verify which of the SE's has the greatest volition and select it to begin the next algorithm step. Both the initiator and receiver are marked as *Busy*. If no SE was chosen during this process, the Desire Formation step is started again after a timer ends.

3.2.2 Intent Formation. In this step the Social Exchange structure is created. If the Player interacts with the initiator or the receiver before the initiator gets to the receiver the SE is canceled and the character that isn't interacting with the Player is unmarked as *Busy*. If the initiator manages to get close enough to the receiver the *Social Exchange* is created.

3.2.3 Perform Social Exchange. This step commences right after the previous step. The receiver response is now calculated like in the *Desire Formation* step (the Pre-conditions aren't calculated for the receiver however).

The *Pre-conditions* and *Microtheories* use conditions that verify *Social Network* values, *Social Network Belief* values, *SE memories*, *Relationships*, *Traits* and *Status*. The *Influence Rules* are based on conditions that examine *Relationships*, *Traits* and *Status*. After determined, the receiver response value is compared to pre-defined thresholds, particular to the SE in question. This way the *Outcome* is asserted as *Positive*, *Neutral* or *Negative*. If the receiver is the Player, instead of calculating a response, the Player chooses between three dialogue lines, each corresponding to one of the possible outcomes.

3.2.4 Performance Realization. After the *Outcome* is decided the characters are ready to perform the appropriate *Instantiation*. Each *Social Exchange* has three animations, one for each possible outcome and different dialogue lines for each character and Player, depending on their role (initiator or receiver). When these are selected the *Instantiation* is instanced. Some *Social Exchanges* may also require additional steps (e.g.: if *Outcome* of the *Give Food* SE is *Positive* it is required to transfer food from the initiator's inventory to the receiver's).

3.2.5 Social Fallout. The *Effects* related to the SE *Outcome* are applied to the *Social State* and character *Status*. A *memory* with the information of the SE is created, stored in the *Social Facts Knowledge Base* and broadcasted to all the characters in a certain range of the initiator (including the SE participators). The initiator and receiver are unmarked as *Busy* and the initiator is marked as being *On cooldown*. The CiF cycle cooldown begins.

Every character that has received a new memory now has to process them with the *Trigger Rules*, changing their *Social Network* values, *Social Network Beliefs* and possibly their *Relationships*.

4 EVALUATION

In order to evaluate our model, we have developed an implementation in the AAA video game Conan Exiles using its modding tools and later conducted user tests. This implementation featured details that fit the apocalyptic setting of the game and the survival mechanics.

The default behaviour of the NPCs was to wander around a home location, represented in-game by a bonfire. The *Tiredness* physical status was created. The value of this status would increase periodically or whenever the NPC took part in a social exchange

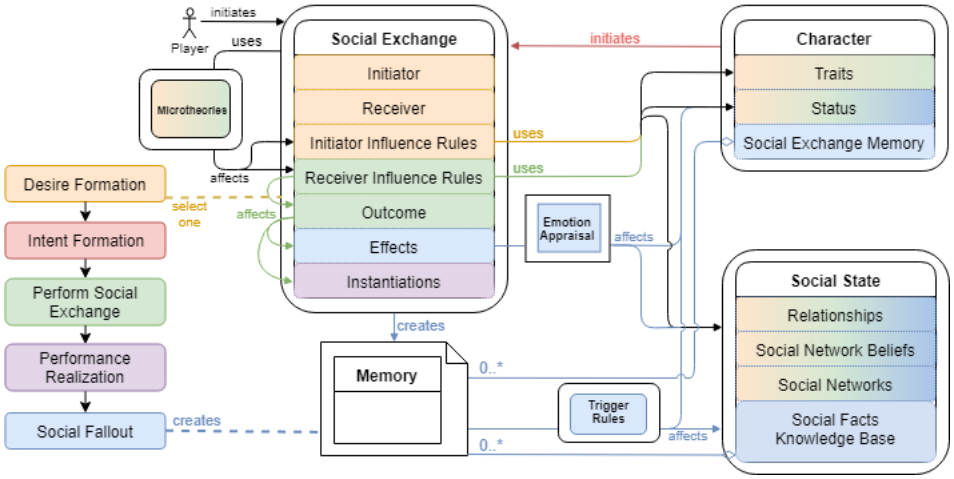


Figure 4: The CiF Cycle and CiF-Ex Components

as the initiator. When the NPC's *Tiredness* reached its maximum, they would go to their bonfire, perform a sit animation and rest until the status was back at its minimum again or until they were interrupted by a character.

Another two physical status, related to consumables, were created: *Hunger* and *Thirst*. These had a probability of increasing with the passing of time and could be decreased by successfully performing SEs that granted the NPC consumables (like the *Ask for Food* SE).

The study participators played the same scenario with two different conditions: the *Experimental Condition*, where the participant was able to interact with three CiF-Ex NPCs; and the *Control Condition*, where the participant played Conan Exiles and interacted with three NPCs, as they are in the video game. To evaluate our model we have chosen *User Experience* and *NPC Believability* as measures because we consider them important for interesting NPC interactions.

4.1 Scenario

When the user began their journey a camp with three NPCs could be seen on the flat land in front of them. They were told that they could interact with the NPCs whenever they wanted during their play time and that they were free to explore the map and do anything they pleased. The user had the choice to continue the interaction if they wanted to, influenced only by the appeal that the initial interaction provoked.

4.1.1 Control Condition - Conan Exiles Dialogue NPCs. For this condition we used three Conan Exiles NPCs. The characters wandered around a bonfire up to a defined distance and stopped when the Player interacted with them. These NPCs had voice acting complementing their dialogue lines and shared bits of lore of the world. Each character had about 5 unique interactions that could last up to around 30 seconds.

4.1.2 Experimental Condition - CiF-Ex NPCs. For this condition we created three CiF-Ex NPCs with similar physical aspect to the ones in the *Control Condition*. Each of these CiF-Ex NPCs supported 15 Social Exchanges, had different dialogue lines for each SE (some also inspired by the Skyrim NPCs), 13 traits, 2 relationships, 15 Status and 3 social networks. The characters had different traits that defined their personality, social network and relationships that simulated backstory between the three of them.

The NPCs wandered around one bonfire, where they could sit nearby and rest. The CiF-Ex were capable of initiating Social Exchanges (small dialogues) with other NPCs or with the Player, to which they would then respond. The Player was also able to start the same Social Exchanges and watch the NPCs react to them, depending on past interactions and the NPC's personality.

4.2 Procedure

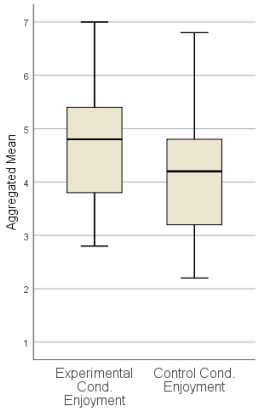
Ahead of starting the experiment, the user was asked to fill a questionnaire that traced their basic profile. Then they would be briefed on Conan Exiles and its gameplay. We told the users that their only objective was to talk to at least one of the exiles in front of them and to recall their name afterwards. This objective was purely to give the user a reason for them to interacted with at least one NPC.

Afterwards a 15 minutes play session of one of the conditions would start. When the time was up, the user would fill a questionnaire related to their testing. Then they would be asked to play the game once again for another 15 minutes, with a different condition, and later fill a questionnaire similar to the former, with an additional question to answer which was the session that they had enjoyed interacting with the NPCs the most.

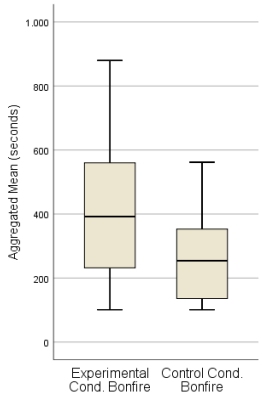
The initial condition was alternated, so 50% of the users played the *Experimental Condition* as the first condition and the other 50% played the *Control Condition*.

4.3 Results

This study had 25 participants, most male in the ages of 22 to 25 years old. Most of the users said that they played video games on a weekly basis but had never played Conan Exiles before.

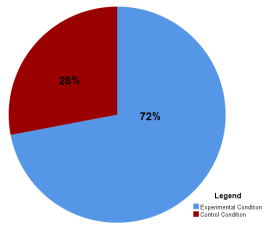


(a) Enjoyment Means Boxplot

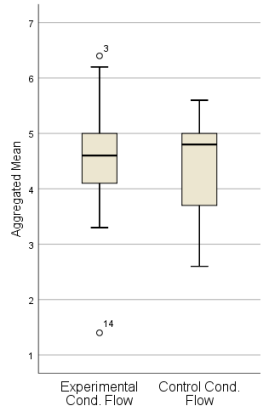


(b) Bonfire Time Means Boxplot

Figure 5: Enjoyment and Bonfire Time Means Boxplots



(a) Condition Preference Piechart



(b) Flow Means Boxplot

Figure 6: Condition Preference Piechart and Flow Means Boxplot

The *User Experience* was measured using three metrics collected by questionnaires (*Enjoyment* [13], *Flow* [18] and *Condition Preference*) and one in-game metric, *Bonfire Time* (a counter whose value was incremented for each second that the player was within a radius from the bonfire). The *NPC Believability* was measured with a questionnaire that assessed the *Believability* [7] metric.

One of the questions of the original Believability questionnaire, "The NPC's behaviour was predictable", was more connected to *Predictability*, and so analyzed separately. The value for this metric should not be maximized as it would mean that the NPCs' behaviour was repetitive but it also should not be minimized as it would mean that the characters were inconsistent. We believe that a value slightly greater than the middle of the scale should be optimal.

4.3.1 Data Analysis. As the *Cronbach's Alpha* test showed acceptable inter-relatedness, the *Enjoyment*, *Flow* and *Believability* dimensions were each aggregated in one variable. *Normality tests* were applied to the aggregated means: the Enjoyment, Believability and Bonfire Time data followed a normal distribution, the Flow and Predictability data did not.

The test conducted for the normally distributed dimensions was the *Paired Samples t*-test and for the other dimensions was the *Wilcoxon signed-rank* test. For the *Condition Preference* a *Binomial* test using a test proportion of 50% was applied. For the successful tests we have also calculated the **effect size**, using the boundaries: [0, 0.2[is a weak effect, [0.2, 0.5[is a moderate effect and +0.5 is strong effect.

4.3.2 User Experience. The *Enjoyment (p-value = 0.007; r = 0.512)*, *Bonfire Time (p-value = 0.001; r = 0.623)* and *Condition Preference (p-value = 0.043)* metrics *succeeded in showing positive statistical significance* in the *Experimental Condition.*

The *Enjoyment* and *Bonfire Time* metrics exhibit strong effect sizes. The *Enjoyment* mean increased from 4.13 to 4.64 (Figure 5a). The *Bonfire Time* mean improved from 267 seconds to 419 seconds, an increase of 57%, as seen on Figure 5b. 72% of the participants preferred the *Experimental Condition* over the *Control Condition* (Figure 6a).

The *Flow (p-value = 0.584)* metric slightly increased from 4.46 to 4.57 (Figure 6b) but *did not show statistical significance.*

We can conclude that *these metrics improved, showing that the User Experience has also improved* for the *Experimental Condition.*

4.3.3 Believability. The *Believability (p-value = 0.013; r = 0.482)* metric registered *positive statistical significance* (Figure 7). The effect size of the *Believability* metric is *moderate*, but very close to the strong effect size threshold of +0.5 for the strong effect size.

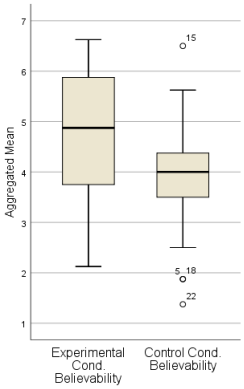


Figure 7: Believability Means Boxplot

The obtained results demonstrate that the NPC Believability improved when the users tested the *Experimental Condition.*

The *Predictability (p-value = 0.012; r = 0.5018)* was *statistically significant* and had a *strong effect size.* The value was lower and nearer to the middle value of the scale for the *Experimental Condition.* This result suggests that the *Experimental Condition* characters were less predictable.

4.4 Discussion

The *Enjoyment*, *Bonfire Time* and *Condition Preference* metrics displayed positive statistical significance for the *Experimental Condition*, despite the quality voice acting and dialogue lines that the *Control Condition*'s NPCs had. This result is *evidence that the User Experience has also improved.* This conclusion is corroborated by the percentage of *users that preferred the CiF-Ex NPCs to the original NPCs, 72%.*

The *Bonfire Time mean was increased from 267 seconds to 419 seconds, an increase of 57%.* The inflation of this metric on our condition implies that the users spent more time on the area neighboring that homes the CiF-Ex NPCs, entailing that, after implementing CiF-Ex, adding these characters to the scenario could be a relatively easy way to raise the gameplay value of a location without changing much of the layout of the environment. The improvement for this metric hints that the users were interacting with the CiF-Ex NPCs for longer periods of time, despite that one interaction with a Conan Exiles Dialogue NPC could last for a bit longer than 30 seconds and the implemented interactions with the CiF-Ex NPCs last for a small portion of that time.

Despite this, the *Flow* dimension did not reveal a significant statistical difference. Even though this was not the best case scenario, this also means that at least the *Flow* did not deteriorate, so our condition did not disrupt the Conan Exiles experience. The fact that no statistically significant differences regarding the *Flow* were found could be explained by the narrow amount of time the users played the game for. Most of the participants (84%) were playing Conan Exiles for the first time, so it's expected that by playing it twice for 15 minutes they would still be in a phase where every aspect of the game is fresh and interesting, and that they wouldn't feel bored. As such, the full effects of our system wouldn't be evident in these test conditions. We believe that if the users tried the video game for longer time periods the *Flow* metric would also be higher for our condition.

The collected data shows us that the CiF-Ex NPCs managed to be seen as more *believable and less predictable*, which may lead to a more engaging, diverse experience. We can affirm that the *NPC Believability was enhanced.*

5 CONCLUSIONS

The conducted study proved that the *Comme il Faut - Exiles* was successful as a social model that enhanced the characters for the video game Conan Exiles. This model extended CiF by featuring:

- **Emotions**, based on the OCC model of emotions, that fluctuate with the Social Exchange's outcome and deeply influence the character's intent;
- **Social Network Belief system** that models the Social Network values that the characters assume for the other characters' relationships;
- **Status described on a continuous scale**, allowing for more fine tuning of the character's social situation;
- **Social Exchange outcomes that are not binary**, each SE can have a *Positive*, a *Neutral* or a *Negative* conclusion to the initiator instead of only two proposed in other CiF architectures;
- **Freedom** for the Player to choose how to react to all of the NPCs' interactions.

The *User Experience* was measured with the *Enjoyment*, *Flow*, *Bonfire Time* and *Condition Preference* metrics. All the metrics were improved in our condition, however only the *Enjoyment, Bonfire Time and Condition Preference showed statistical significance.* The *Bonfire Time mean increased from 267 seconds to 419 seconds, an improvement of 57%, while 72% of the study participants preferred the CiF-Ex characters* to the original ones. The *NPC Believability* increased and displayed statistically significant results for the *Experimental Condition.*

We are convict that we have demonstrated the success of the CiF-Ex model. The results highly suggest that all of the objectives that the *CiF-Ex NPCs were perceived as more believable and improved the user experience.* The NPCs were also less predictable than the unmodified NPCs.

CiF-Ex is an extension of the CiF model and its implementation is not restricted to Conan Exiles. We believe that our model would obtain favourable results in other environments, be it a video game or a different kind of application (AI assistants, companion robots, etc).

We expect the *Flow* dimension would display a statistically relevant improvement if the users were submitted to a longer study, 30 minutes was not enough for the novelty effect to dissipate. A new study could be conducted in order to verify this claim.

The model could be greatly improved by the addition of *Social Exchange memory sharing* between the characters (like gossiping, telling a happy memory, etc). Alea [1] provides a conceptual model of autobiographical memory sharing for social purposes. The *Cultural Knowledge Base* is a concept from the original CiF architecture not included in CiF-Ex, that would allow to attribute social connotation to the objects of the world, granting new dialogue possibilities, as characters could discuss their likes and dislikes.

REFERENCES

[1] Nicole Alea and Susan Bluck. 2003. Why are you telling me that? A conceptual model of the social function of autobiographical memory. *Memory* 11, 2 (2003), 165–178. https://doi.org/10.1080/741938207 arXiv:https://doi.org/10.1080/741938207 PMID: 12820829.

[2] Bethesda Game Studios. 2011. The Elder Scrolls V: Skyrim. Microsoft Windows, Nintendo Switch, Playstation 3, Playstation 4, Xbox 360, Xbox One.

[3] João Dias and Ana Paiva. 2005. Feeling and Reasoning: a Computational Model for Emotional Agents. In *Proceedings of 12th Portuguese Conference on Artificial Intelligence, EPIA 2005.* Springer, 127–140.

[4] Miguel Oliveira Ferreira. 2017. *A Merchant Model.* Master's thesis. Instituto Superior Técnico.

[5] P.C. Fletcher, F. Happé, U. Frith, S.C. Baker, R.J. Dolan, R.S.J. Frackowiak, and C.D. Frith. 1995. Other minds in the brain: a functional imaging study of "theory of mind" in story comprehension. *Cognition* 57, 2 (1995), 109 – 128. https://doi.org/10.1016/0010-0277(95)00692-R

[6] Funcom. 2018. Conan Exiles. Microsoft Windows, Playstation 4, Xbox One.

[7] Paulo Manuel Fontaínha Gomes. 2010. *MEEMOs: Believable Agents with Episodic Memory Retrieval.* Master's thesis. Instituto Superior Técnico.

[8] M. Guimaraes, P. Santos, and A. Jhala. 2017. CiF-CK: An architecture for social NPCS in commercial games. In *2017 IEEE Conference on Computational Intelligence and Games (CIG).* 126–133. https://doi.org/10.1109/CIG.2017.8080425

[9] Robert Ervin Howard. 1950. *Conan the Conqueror.* Gnome Press.

[10] António Santos Ferreira Machado. 2017. *A procedural quest generator for Conan Exiles.* Master's thesis. Instituto Superior Técnico.

[11] Joshua McCoy, Mike Treanor, Ben Samuel, Noah Wardrip-Fruin, and Michael Mateas. 2011. Comme il Faut: A System for Authoring Playable Social Models.. In *AIIDE*, Vadim Bulitko and Mark O. Riedl (Eds.). The AAAI Press. http://dblp.uni-trier.de/db/conf/aiide/aiide2011.html#McCoyTSWM11

[12] Andrew Ortony, Gerald Clore, and Allan Collins. 1988. *The Cognitive Structure of Emotion*. Vol. 18. https://doi.org/10.2307/2074241
[13] Mikki H. Phan, Joseph R. Keebler, and Barbara S. Chaparro. 2016. The Development and Validation of the Game User Experience Satisfaction Scale (GUESS). *Human Factors* 58, 8 (2016), 1217–1247. https://doi.org/10.1177/0018720816669646 arXiv:https://doi.org/10.1177/0018720816669646 PMID: 27647156.
[14] A. Popescu, J. Broekens, and M. van Someren. 2014. GAMYGDALA: An Emotion Engine for Games. *IEEE Transactions on Affective Computing* 5, 1 (Jan 2014), 32–44. https://doi.org/10.1109/T-AFFC.2013.24
[15] Rui Prada and Ana Paiva. 2005. Intelligent Virtual Agents in Collaborative Scenarios. 317–328. https://doi.org/10.1007/11550617_27
[16] Procedural Arts. 2005. Façade. Macintosh, Microsoft Windows.
[17] David V. Pynadath. 2004. PsychSim: Agent-based Modeling of Social Interactions and Influence. *Proceedings of the International Conference on Cognitive Modelling, ICCM 2004* (2004), 243–248.
[18] Falko Rheinberg, Regina Vollmeyer, and Stefan Engeser. 2007. Die Erfassung des Flow-Erlebens. *Diagnostik von Motivation und Selbstkonzept / hrsg. von Joachim Stiensmeier-Pelster und Falko Rheinberg. - GÃűttingen [u.a.] : Hogrefe, 2003. - (Tests und Trends ; N.F., 2). - ISBN 3-8017-1674-0. - S. 261 - 279* (09 2007).
[19] Mike Treanor, Josh McCoy, and Anne Sullivan. 2016. A Framework for Playable Social Dialogue. https://aaai.org/ocs/index.php/AIIDE/AIIDE16/paper/view/14018