Little Computer People: A Survey and Taxonomy of Simulated Models of Social Interaction

SASHA AZAD, Department of Computer Science, North Carolina State University, USA
CHRIS MARTENS, Department of Computer Science, North Carolina State University, USA

Bolstered by a growing interest in simulating believable non-player characters (NPCs), work on NPC models has spanned topics such as planning, procedural storytelling, decision-making, and social dynamics. However, research groups work in isolation, designing and discussing their character models with disparate approaches, often using project-specific terminology. This makes it challenging to identify, classify, and accumulate existing knowledge. It is our position that since modelling of virtual characters has become an integral part of the scientific practice in our field, we must develop a common taxonomy to discuss these models. With this goal in mind, we conduct an in-depth analysis of a selection of projects, categorizing existing agent social interactions, and comparing results from research-based and commercial social simulation works in the entertainment domain. We conceptualize a taxonomy that classifies agent interactions by their social behaviours, inter-agent communication, knowledge flow, and the change in their relationships. We posit such a taxonomy would allow scientists to reproduce and evaluate existing models, collaborate on standards, share advances with other researchers and practitioners, allow for better communication and methodologies developed for new techniques, and allow for a more rigorous model-to-model analysis.

CCS Concepts: • **Human-centered computing** → **Interaction design theory, concepts and paradigms**; **HCI theory, concepts and models**; • **Computing methodologies** → **Interactive simulation**; **Artificial life**; **Model development and analysis**.

Additional Key Words and Phrases: social simulation; non-player characters; game design; taxonomy; vocabulary, conceptual tools; social behaviours; social relationships; emotions; virtual characters; artificial life; artifial societies; knowledge model

ACM Reference Format:
Sasha Azad and Chris Martens. 2021. Little Computer People: A Survey and Taxonomy of Simulated Models of Social Interaction. *Proc. ACM Hum.-Comput. Interact.* 5, CHIPLAY, Article 245 (September 2021), 30 pages. https://doi.org/10.1145/3474672

1 INTRODUCTION

Creating believable simulations of human behaviour in virtual worlds via non-player characters (NPCs) represents a long-term vision in games [85]. In pursuit of this vision, the industry has developed virtual social characters for games such as *Stardew Valley* [40], and *The Sims* [47], and *Animal Crossing* [62] franchises. These games achieve consistently popularity with diverse audiences of players who report that interacting with and building relationships with virtual characters positively impacts their play experience [23, 26, 42].

Authors' addresses: Sasha Azad, sasha.azad@ncsu.edu, Department of Computer Science, North Carolina State University, Raleigh, North Carolina, USA, 27695; Chris Martens, crmarten@ncsu.edu, Department of Computer Science, North Carolina State University, Raleigh, North Carolina, USA, 27695.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.
© 2021 Copyright held by the owner/author(s). Publication rights licensed to ACM.
2573-0142/2021/9-ART245 $15.00
https://doi.org/10.1145/3474672

Inspired at least in part by the success of these games, social intelligence research aims to advance the ability of virtual characters to make believable decisions in social situations, such as conversation. This work has arisen in contexts including procedural storytelling [46, 53, 73], narrative planning [15, 94], knowledge and belief propagation [7, 74], social relationship dynamics [18, 71, 72], group behavior [7], and more. Collectively, this set of approaches for computationally enacting inter-character behaviour, intended to model some aspects of human interaction, is known as *social simulation.*

However, despite the plethora of social character models developed, there is no consensus on what constitutes social simulation. For some researchers and developers, it means simulating human behaviour on a timescale of hundreds of years, encompassing the rise and fall of civilizations and societies [3, 74]. At this scale, characters are more or less interchangeable because it is impossible to examine each character at an acceptable level of detail. For others, social simulation refers to the minute intricacies of conversation between a small, fixed cast of characters, whose lines of dialogue and range of possible behaviours are manually authored and differ for each specific character [19, 46, 58]. Still, others model the social dynamics of interchangeable sets of characters who can form and break alliances or trust [7, 49].

This lack of consensus has several disadvantages. First, it impairs *reuse*, including the ability for outside groups and new members of the field to contribute by building on prior work. Most groups develop their simulations from scratch without building on prior work, resulting in a proliferation of disparate implementations using similar words to describe wildly different social and computational phenomena. Second, it impairs *reproducibility* of research: system descriptions and results of experiments tend to be reported in ways that rely too much on metaphor and intuitive explanation, rather than formal definition or open-source code, making it challenging for others to reproduce [24, 68]. Finally, these two problems together impair *comparability*: we cannot meaningfully measure or even qualitatively compare the effects of two systems with superficially similar sets of simulated social phenomena.

For other game technology, such as physics engines and graphical rendering systems, the standardization of features has led to these technologies being widely available in commercial and hobbyist game development platforms. We envision a future in which the same can be said for social simulation via a "social physics engine," to borrow a term from McCoy et al. (2010)[51]. To do this we need to identify and formalize a common language of social interactions that can be used to tell many different kinds of stories, given at a level of specificity that it can be implemented as an API or library in any game development environment.

With this goal in mind, we conducted a "requirements gathering" investigation of existing social simulation projects, i.e. games and research implementations whose goals include social interaction as a key mechanic. We did an in-depth analysis of 7 research projects and 2 commercially available and popular social simulation game franchises, including research papers and community wikis describing their internal logic. We organized this information into a data set, conducted a thematic analysis, and created a vocabulary and taxonomy of modelled virtual character relationships, behaviours and actions.

Our contributions in this paper are as follows: we (1) identify key differences and similarities among existing social systems; (2) propose a taxonomy for components of social simulation systems to inform the development for future social simulation storytellers; and (3) identify what is missing: unexplored territory in the space of social simulation design that could lead to exciting future crossover between the social sciences, game design, and artificial intelligence.

2 PAIN POINTS: THE NEED FOR A TAXONOMY

Our taxonomy-building work arises from observing several pain points in our research and implementation practice. In this section, we describe these pain points and discuss how they motivate our goals.

2.1 What do words mean?

In prior literature [50, 75, 78, 87], a *social state* refers to any subset of emotions (e.g. happy, sad), moods (e.g. good mood, negative mood), relationships or intentions of the virtual characters, or personalities (e.g. using the OCEAN model). Social states occur either in individual characters or are shared between characters associated through affiliations across regions, occupations and can affect the behaviour of an agent.

Fig. 1. Example of how our surveyed artifacts implement a single social behaviour, "brag". From the left, we see the interaction in *Prom Week* [49], *The Sims* [47] and *Animal Crossing* [63] artifacts.

Prior literature has shown that *social relationships* are instrumental in driving narratives and social behaviours [28, 53]. However, models of relationships differ across simulations. The start of a relationship may compare personality models or randomly generate a "spark" amongst the characters [73]. Another simulation may create relationships based on group attachments and affiliations [7]. Still others look at forming relationships based on resources exchanged or traded such as love, status, information, money, goods, or services [63, 90].

A *social verb or action* may vary in granularity across models. Two agents collaborating on a task may be considered social [12], and two agents simulating a family over a decade are also social. Similarly, there is no clear classification of the different ways in which agents can communicate: each model proposes its own interaction structure. For instance, a model may choose to simulate an agent being "happy" as a binary value if something good occurs. However, another system may simulate happiness using a more complex emotion model taking into account intensity, duration of happiness, and its intersection with other emotions experienced at the time [37, 67, 79]. Without a shared vocabulary or expectations, it is difficult to compare or discuss these design choices.

Finally, what "social interactions" are considered meaningful to form or influence *social relationships*? The projects all influenced the relationship amongst virtual characters, with the assumption that performing "social activities" would improve their relationship, and "anti-social" behaviour would degrade it. The natural question that arises would be should all such social activities be treated the same? How much should each activity influence a relationship?

2.2 Reusing Social Models

Existing social interaction models have varied contexts, rules, narratives and even timescales for the interactions in their NPC simulations. Social simulation systems embed differing assumptions within their language of interactions that makes it hard to compare them. Fig. 1 shows how the

surveyed artefacts implement a single "brag" interaction differently using a combination of verbal, or gestural cues.

This lack of consensus in what comprises a social interaction, and what features or requirements must be developed to simulate a social character successfully leads to research groups frustrated and with no choice but to reinvent the wheel. While each disparate model, thus created, has a wealth of knowledge associated with it stemming from the researchers attempt to understand and emulate human interactions, creating these models from scratch takes time and effort. Researchers aiming to study, for instance, a new model of conversation must first familiarize themselves with how to create a rich, society of characters, which relationships to model, and decide whether their choice of relationships modelled, or the power dynamics socially associated impact their knowledge model.

This leads to a large proliferation of implementations, each with a varying subset of the human life simulated, and variation within each subset of simulation and implementation.

2.3 Reproducibility and Evaluation

Far too often, it is difficult to understand the details of the implementation of NPC models. Richiardi et al. discuss how current models have difficulty with replication and identify the aspects of models that affect replicability, namely programming language, tools, representation formalisms, and development methodologies [68]. Many well-accepted models communicate conceptual descriptions excellently, but do not define their models using unambiguous formal notations that could be reimplemented in a new project.

We posit that having a common taxonomy, and a vocabulary with set expectations of implementation details when choosing to describe projects will improve reproducibility and evaluation. Game designers can actively understand and consider existing project features, as well as the novelty, and their contributions when discussing their work. A taxonomy and vocabulary would be the right step towards a formal definition simulating social human behaviours, and interactions.

2.4 Comparison of Models

Traditional practices in social sciences rely on a very well established and implicit methodological protocol, both with respect to the way models are presented and the kinds of analysis performed. The field of machine learning also has very precisely defined benchmark tests and metrics commonly accepted as a useful measure of model performance or evaluation [1, 2]. Models created for social character simulation lack such a reference to an accepted methodological standard.

Additionally, it is currently difficult to compare the assumptions made regarding the input and output of the social simulations analyzed in this paper. For instance, *Lyra* [7], *Juke Joint* [72], and *Prom Week* [49] have social models that can influence the views of a character on various topics such as politics, a personal dilemma, or social status and popularity. These models can affect change in the relationships of the interacting characters. However, the streaming output from the simulations themselves can not currently be compared. In another instance, with Table 2, we see the documented results of a single "Appreciate" interaction being performed in *The Sims*, and its effect on the *valence* of the relationship between the participating characters [47]. Similarly, the attack interaction reduces the valence of the relationship by a factor of -60 to -100. Similar interactions exist in *Prom Week* [49], *PsychSim* [67], and several other social simulations. However, currently, it is nearly impossible to compare their effects.

We set forth that there needs to be a more rigorous model-to-model analysis. Demonstrating social behaviours that are agreed upon by an existing body of research is interesting. However, we can learn a great deal from when these models do not agree. This would allow us to understand better and evaluate existing models, and replicate their behaviours.

2.5 Research Collaboration

The vast quantity of prior work on NPC models has the potential to lead to reuse of accepted behaviours, constraints, or "social practice templates" and norms instead of reinventing the wheel. However, it is currently unclear how to go about the same. A key pain point that many new researchers in the field experience is that in order to test any new interactive technique or AI behaviour, they must *first reinvent the wheel*. For instance, in their project *Talk of the Town*, Ryan et al. describe creating a rich society of characters within a small American town [73]. Similarly, in *Lyra* [7] to test their discussion model Azad and Martens had first to implement a believable society from scratch. In both cases, authors made independent decisions on the programmatic encoding of similar social norms and interactions, even though the projects simulated the same granularity level. This is because current simulations make it hard to reuse existing models, and can hamper progress.

3 RELATED WORK

In this section, we identify the prior work done in social dynamics and psychology. We hope to situate the need for similar research and analysis for virtual characters. Next, we introduce the reader to the class of virtual characters, called social characters or social agents, that we survey. Finally, we discuss key existing shared vocabularies and taxonomies that have helped guide our taxonomy.

3.1 Social Dynamics and Psychology

Social Dynamics [14] is the explicit study of the interactions linking individual behaviour and group outcomes, and social psychology [80] is the study of the dynamic relationship between individuals and the people around them. In their work, Allport (1968) described why social behaviours were necessary to be studied, "Social psychology attempts to understand and explain how the thoughts, feelings, and behaviours are influenced by actual, imagined, or implied presence of others" [5]. Social behaviours are emergent from the formation of relationships, groups, and institutions among individuals, independent of individual characteristics.

3.2 Social Agents

The entertainment industry has long studied virtual characters. Prior work [9, 60, 92] had broadly categorized agent models into *Reactive agents* that receive and respond according to fixed rules; *Intentional agents* that include meta-rules to define goals and are capable of detecting goal conflict within specified bounds; and *Social agents* that contain models of other agents and can reason about agents goals expectations and motives and incorporate these into their actions.

Furthermore, Brassel et al. (1997) described how describing a simulated social agent model usually consist of the following details:

- *Agents:* A group of one or more agents representing the individuals that make up the real-world or system being emulated. Stangor (2020) describes how the individuality of the agents or subjects must be maintained at all times and how an agent's desires, motivations, and emotions have an important impact on their social behaviour.
- *Behaviour or Interaction Modes:* A subset of distributed, discrete and localized behaviours that encapsulate the phenomenon, operations or interactions being studied. There should be flexibility to incorporate different kinds of agent models to represent real-world agents. It should support the design of heterogeneous multi-agent systems, i.e. systems with agents differing in behaviour and capabilities such as communication, movement, etc.

- *Representation of the environment:* Conceptual and technical representations of the environment in which the agents interact, further categorized as a:
  - *A Common Environment* to be one common to all agents in the simulation or at a given level of aggregation.
  - *A Specific Environment* for an agent to be the comparably complex agents (or environment) that interact specifically with it (can change over time).

With our work, we focus on simulations of large populations of social agents [9, 60, 92] . We conceptualize a taxonomy to better communicate the *social behaviours or interaction modes* [9, 25] described above.

3.3 Existing Shared Vocabularies

There have been several surveys, and analysis performed of existing work in the field of interactive narratives. Existing taxonomies and surveys have focused on elements such as human creativity [20], interactive narratives [41], computational narratives [13] and narrative planning [94].

Human behaviour is unpredictable, and adding the ability for interactivity while maintaining the experience's narrative is a problem many have tried to solve. Researchers have created a spectrum of audience interaction [82], surveying ways in which audiences of interactive entertainment experiences can express their individuality and agency as consumers of interactive experiences.

For producers of these experiences, prior work has created a vocabulary to describe, compare and interpret research in the field. In the past, shared representations of drama and experience managers [69, 84] have evolved to characterize this need. Roberts and Isbell (2007) compared various existing drama management technologies describing a set of desiderata for the qualitative analysis of such systems varying narrative generation techniques [69]. Kybartas and Bidarra (2016) surveyed mixed-initiative narrative generation techniques, classifying a large body of research based on the degree of generated and manually authored content proposing a formal model of narrative to allow for collaboration in the space [35].

With regards to social characters inhabiting these works, Tosic and Agha (2004) describe efforts to form a taxonomy of agents from a systems perspective [86]. Lisetti (2002) describes a hierarchical taxonomy integrating personality, affect, mood and emotion for social characters [37]. In other work, Zoric et al. (2007) surveyed facial gestures for embodied conversational agents to create a taxonomy and guideline for their implementation in believable agents [95]. Our work extends this research by adding a taxonomy of social interactions implemented by both scientists and practitioners of the field.

Finally, Isbister and Doyle (2002) surveyed embodied conversational agents considering several criteria such as social interface, and believability. The authors described the need for a social agent to carry on discourse, understand or cooperate with other agents, have a capacity for social relationships and social behaviors [29]. For these behaviours and domain behaviours to be believable, they must have contextuality, display appropriate behaviours, and intentions. They should do nothing "clearly stupid or unreal" having well-integrated capabilities with the environment [29]. While these prior works have been able to pinpoint the need for believable social characters with strong, coherent social behaviours, they differ from our work. This paper aims to describe a taxonomy of social interactions in virtual characters.

To the best of our knowledge, ours is the first attempt to characterize and create a taxonomy of existing social interactions, knowledge, and social relationships modelled between social agents.

4 METHOD

This section overviews the underlying factors for our choice of research artefacts to analyze as our representative data set. Next, we describe our review process.

4.1 Choice of Artefacts for Analysis

Over the past few decades, agent-based modelling techniques and social simulation have been increasingly popular in the field of entertainment intelligence. Social agents have been used to study emergent narratives [33, 73], interactive drama and improv systems [16, 43], model characters for players to interact with [46, 88], and to study macro-level phenomenon produced by changing micro-agent details and interactions [65].

Our goal was to conduct an in-depth analysis of a selection of projects from the field, comparing results from research-based and commercial social simulation works in the entertainment domain. This allowed us to categorize an initial set of social interactions.

4.1.1 Choice of Research Artefacts. To select the research artefacts to review, we systematically reviewed prior research published on databases such as the Association for the Advancement of Artificial Intelligence (AAAI), Association for Computing Machinery (ACM), and Institute of Electrical and Electronics Engineers (IEEE). We looked at work published at venues such as the AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment (AIIDE), artefacts and talks from Game Developers Conference (GDC), ACM's Foundations of Digital Games (FDG) Conference Series and the Journal of Artificial Societies and Virtual Worlds. Additionally, we scanned Google Scholar, and ResearchGate to identify work similar to the projects and papers we chose to review. We searched these sites for a range of topics and keywords including but not limited to social agents, social simulations, multi-agent social simulations, non-player characters, agent interactions, agent models, virtual characters. We expanded our keyword list to search in conjunction with our targeted venues (for instance, AAAI AIIDE, ACM FDG, and so on as mentioned before). With our focus on simulations of large populations of social agents, we collated all published papers, and code repositories published or publicly available for each shortlisted project. Simply perusing the keywords listed above, we were able to generate several research artefacts to choose from. We chose to limit ourselves to social agents and social simulations as defined by prior work [9, 60, 92]. We shortlisted projects with discoverable published papers, code and the granularity of details describing the agent behaviours and interactions that we were looking for. Regarding our expectations of granularity of interactions described we discarded papers that described vague umbrella interactions or scripts, for instance, systems that discussed high-level "romantic interactions" over those where a more detailed interactions list, for instance, "kiss", "hug", "ask other out" interactions, were available to us. We reached out to authors for more details, a list of agent behaviours simulated and clarifications where necessary.

In summary, we looked specifically at social agents [60, 92]. We decided to constrain ourselves to analyze the differences in large-multi-agent systems [9] with well-detailed environments, both common and specific. We searched multiple databases for a wide range of search terms and related terms described above. In the end, we were able to conduct an in-depth review of 7 academic research projects: Islanders [71], CiF/Prom Week [49], TALE-SPIN [53], Lyra [7], Thespian/PsychSim [67, 79], Talk of the Town [73], and Versu [19].

4.1.2 Choice of Commercial Games. We decided to include two social simulation video games to analyze the gaps between industry practice and research. In lieu of easy availability of code artefacts (given copyright restrictions), we looked at existing official and community wikis for the games. The rest of the criteria for the games selection remained the same as those of the

research projects. We also searched for popular, topical games [22, 81], shortlisting the selection by the numbers of players globally. We were narrowed our choice down to two commercially available game franchises, *The Sims* [47] and *Animal Crossing* [62], with their rich community wiki information. We feel these choices are both current and topical within our community.

4.2 Review Process

Once we had shortlisted our 7 academic research projects and 2 commercially available games, we could begin our review for the same.

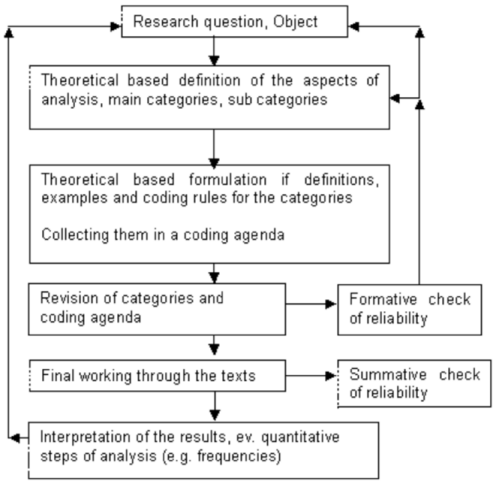

Fig. 2. Step model of deductive category application [48] used during the Review Process.

4.2.1 Identifying Interactions. We define *interactions* to be any interaction between the social characters in the studied simulations. This includes their actions and social behaviours, emotions, and ability to form relationships. Since we were interested in social interactions, for the purpose of this survey, we excluded individual interactions such as sitting, standing, moving between locations, or fishing when alone.

We first collected all available written material on the selected projects. This involved collecting and combing through any papers associated with the research projects or wikis available for every game in the selected franchises during various development stages. When available, we cross-listed interactions mentioned within academic papers with their code artefacts. In every case, since the written publications had disparate goals (ranging from entertainment to simulation of social science phenomenon), we found the code artefacts and repositories artefacts contained a more complete set of interactions than mentioned in the paper. We listed each of the interactions found this way.

We were able to discard some interactions from *The Sims* as too arcane or specific for our purposes. For instance, discarded interactions include a Vampire screeching "Bleh!" to a subject of their choice, or a Sim asking a High Evil Witch to "Teach [them] the Path of Darkness." These interactions were categorized as *Special* even in The Sims Wiki pages.

By the end of this stage, we had a list of around 700 interactions across the simulations. Additionally, we had metadata around the interactions pertaining to when they could be triggered and the relationship type required, social events, moods or emotions they would induce.

4.2.2 Deductive Category Development. We performed an initial open coding and used content analysis to analyze the curated list of interactions. As we were familiar with the underlying theory in virtual character interactions, our initial codes had a structured and directed approach [27] described by Mayring [48] as deductive category development application. Our analysis process followed [48]'s step model as depicted in Fig. 2. The data was read from start to end to obtain a sense of the whole. We noted down first impressions and thoughts to capture key concepts based on the variables of interest [66]. Next, we tackled each group individually, making notes for an initial coding schema.

Table 1. Early categorization during an initial iteration of the Mayring Deductive Development process [48].

Category	**Initial Subcategories**	**Example Interactions**
Relationship	Friendship, Enimity, Romance, Vocational (Classmate, Colleague)	Get divorced (Romance)
Mood or emotion	Happy, Gratitude, Embarrassed, Angry	Take an angry poop (Angry)
Personality	Flirty, Angry, Competitive, Friendly	Conversation flirt (Flirty)
Type of Interaction	Social, Individual, Normal, Romantic	Declare an enemy (Social)

The first few iterations through our dataset produced the following general categories and subcategories [48], as shown in Table 1. For instance, the "Get Divorced" interaction was coded under the Romance subcategory since it directly affected the romantic relationship between characters. These categories helped us sort through the somewhat unwieldy set of interactions.

Performing open coding analysis, we read through each of the collected interactions to note down codes to describe them [54, 57]. Many interactions in the dataset were found to have a valence or affinity associated with them. For instance, the "Declare an Enemy" interaction had a negative influence on the friendship relationship, and the "Give a backrub" interaction influenced the romantic relationship. These interactions were found to have effects that were encoded into the projects. In the research codebases, we found that projects had explicit reference to this change in valence, describing the interaction as "Sparking Romantic relationship", or "Charging [of a] social meter" [73]. Similarly, these effects were documented in the wiki of the commercial games [47]. In Table 2, we detail the effect for the "Admire" interaction on the daily and lifetime relationship between the initiating (character A) and receiving (character B) Sims based on whether the interaction is accepted or not from *The Sims* wiki [18].

Table 2. Effects of the "Admire" interaction on the strength of a relationship - The increase or decrease in the valence of A's relationship with B is depicted based on whether B accepts the interaction initiated by A in *The Sims* [18]

Interaction: A(Admires, B)	**Accept**	**Reject**
A's Daily Relationship with B	5	-10
A's Lifetime Relationship with B	1	-1
B's Daily Relationship with A	4	-7
B's Lifetime Relationship with A	2	-2

To account for these valence shifts in relationships or behaviours, we created a separate Valence category with tags such as "Increasing", "Decreasing", and (in cases where a change was identified but not the direction) "Influence". These tags could be used in combination with the others to indicate the expected outcomes of an interaction. For instance, #Romance#Increase indicates the

Table 3. Part of the codebook provided to the external coders - Some high frequency categories and subcategories with corresponding definitions derived after the deductive category development application.

Category	Subcategory	Definition and Example Interaction
Communication - exchange of information, or feelings. May be added to knowledge base.	Verbal	Relating to or in the form of speech. e.g., conversation flirt, announce promotion
	Gesture	A physical movement to express an idea, or meaning. e.g., friendly hug, give medicine
	Physical	Perceived to be or have an affect on a tangible, sensation (as opposed to verbal, or emotional). e.g., embrace, commit murder
Relationship - interactions that change the status or valence of a relationship or require a relationship to occur	Familial	Requires a familial relationship or changes the status or valence of the familial relationship. e.g., Get married, have baby
	Romantic	Requires a romantic relationship or changes the status, or valence of the same. e.g., physical flirt, break up
Change in Valence - an increase or decrease associated with the valence (or strength) of the interaction	Increase Decrease Influence	Induces or influences a change in valence. Should be used in conjunction with another code as a modifier e.g., #SocialRank:Influence

tagged interaction produced an increase in the valence of the romantic relationship between the initiating and receiving character.

We were able to shortlist an initial set of 54 tags that could be used to categorize interactions. These codes were organized into meaningful clusters to make lookup easier for the evaluators of the coding schema. We were also able to list the explicit definitions, examples, and coding rules for each deductive category discovered through iterative analysis. A few codes from this initial coding scheme (or codebook) have been described in Table 3.

4.2.3 Validating the Coding Schema: To further establish rigour, reliability, reduce the coding scheme's discriminant capability, and validate this initial codebook, two additional independent coders were recruited. The coders would be categorizing a random 15% of the shortlisted dataset of virtual character interactions.

The new coders were unfamiliar with the project and the eventual goal of developing a taxonomy. They were given a brief description of the research to explain its purpose. We then walked through the definitions, codes in our codebook, and one defining example of each code selected from the remainder 85% of our interactions dataset. The coders were instructed to use as many or few codes or categories for an interaction as they felt necessary. They were also instructed that they could create new categories if they felt the existing coding schema could not describe the social behaviour or interaction correctly. One of the authors also re-coded the same section of interactions as the coders. A sample of these coded interactions has been shown in Fig. 3. The coded interactions were collected on independent Google Sheets (one per coder) and later collated and integrated into a single spreadsheet. The final spreadsheet (as seen in Fig. 3) included the names of the artefacts the interaction was retrieved from, the name or title of the social interaction (as mentioned in the project documentation), the codes generated by the author, and the two external coders. You can see that the final sheet was also tagged using the Wiki data to specify which games in the

commercial franchises contained the interaction (for instance, the “Gossip” interaction is available in The Sims 2, The Sims 3, and The Sims 4).

Project	Social Interactions	Author	Coder #1	Coder #2
Animal Crossing	Give #Gift	#Gift;#Appreciate;#Gesture;#Happiness;#RelSocial#Increase;#Emotions	#Gift, #RelSocial#Increase, #Errand, #Appreciate, #Gesture, #Happiness	#Gift, #Appreciate, #Gesture, #Happiness, #RelSocial#Increase
The Sims	Gossip[TS2][TS3][TS4]	#Communication;#Verbal;#RelSocial#Influence;#Status#Influence;#Mean	#Mean, #SocialStatus#Influence, #RelSocial#Influence, #Communication, #Verbal	#Communication, #Mean, #Verbal, #RelSocial#Influence, #SocialStatus#Influence
Talk of the Town	Visit friend	#Movement;#Happiness;#RelSocial#Increase;#Travel;#Emotions	#Movement, #Happiness, #RelSocial#Increase	#Movement,, #Happiness, #RelSocial#Increase
Islanders	Establish town	#RelCommunity#Increase;#RelEmployment#Incrcease;#SocialNetwork#Increase	#RelCommunity#Increase, #RelEmployment#Increase, #SocialNetwork#Increase	#RelCommunity#Increase, #SocialNetwork#Increase, #RelEmployment#Increase, #Communication

Fig. 3. A small sample of the interactions from our dataset along with their tags coded by the author and external coders and used to perform the inter-rater reliability (IRR). Each project reviewed was assigned a color (not shared with the coders) for a later distributive analysis of codes per projects

The coded sections were compared and negotiated. Some adjustments were made to the codebook during this phase. For instance, the tags #Relationship:Friend and #Relationship:Enemy was found to be confusing. There was no agreement as to what interactions could cause a change in the status from friend to enemy (except, the interaction "Plot Murder"). Instead, these were replaced with a #Relationship:Social tag and associated with a valence, for instance, #Relationship:Social:Increasing denoting the social relationship would increase between the characters due to the interaction. The tag #SocialNetwork was added to indicate an increase in the social network of an NPC (for instance, in response to interactions such as "Hire Employees" or "Establish Town") as can be seen in Fig. 3. A few more code definitions and examples were clarified and refined based on the feedback from the coders.

Next, we calculated the inter-rater reliability between the two coders and the author. Since multiple codes could be applied to each interaction (a one-to-many coding scheme), we used the Fuzzy-kappa statistic [32], an inter-rater reliability statistic based on Cohen’s Kappa and modified for the application of multiple codes to a single response. Our calculated values of inter-rater agreement (82.86%) and the inter-rater reliability (0.819, Fuzzy Kappa) indicate an “excellent” to “almost perfect” consistency for the application of the model characteristics coding scheme [32, 52].

The high agreement allowed us to finalize our coding schema. We proceeded to use these codes to tag the rest of our interactions data set. Once tagged, we were able to analyze our coded dataset to develop our taxonomy.

4.3 Developing the taxonomy

Our taxonomy was created as a result of two separate levels of analyses done on the surveyed projects.

First, a qualitative thematic approach using deductive category development on the coded interactions described in the methodology section. Once the coding schema was finalized, we reviewed them to identify, organize, analyze and report the recurring themes discovered across the 700 interactions dataset. We used reflexive thematic analysis [10], first mapping and grouping initial codes that identified broader patterns, then gradually refining these categories, and testing them against our dataset. We were then able to review the derived themes, splitting and combining categories until we were satisfied with how they represented and told a story about our data. We named the themes, formalized their definitions and the rules associated with their use, and classified the sub-themes and interaction tags associated with each.

Once these themes were obtained, we did a second iterative analysis, deep-diving into the projects' code repositories (when available) and the published manuscripts associated. We searched both of these artefacts for the themes we had identified, trying to understand the underlying theory of the theme, and reaching out to the authors when necessary for further clarification. By doing this, we understood how the projects encoded notions of social norms, rules and theories into their social characters to make them more believable or relatable for their human players. At this stage, we also read player reviews, and play-through narrative accounts of their experiences with the simulations (where available) to understand the reception of the design choices. This allowed us to refine the rules and constraints associated with the identified themes.

4.3.1 Vocabulary and Nomenclature Decisions. The taxonomy's nomenclature was decided on after the themes, sub-themes, rules, and constraints for our taxonomy were refined and detailed. During this stage, we referenced project publication materials and community wikis, social science publications and other existing vocabularies.

- *Project Publications and Wikis:* We looked at publications from the authors of the project detailing the theme we were categorizing. We made a note of individual project vocabularies, comparing similarities and differences. An example of nomenclature adopted in this manner is the attribute of *Relationship Symmetry* that matches the description in Evans and Short (2013)'s Versu.
- *Social Science Publications:* For most academic projects, we were able to identify the social phenomenon the project was attempting to encode from their associated published manuscripts. We were able to follow their reasoning and choices back to the social science, cognitive science or computational narrative intelligence sources they referred to. Additionally, we searched Google Scholar for existing nomenclature representing the phenomenon or rules we were describing when necessary. An example of vocabulary adopted from social science papers includes the *Principles of Contingency, Inertia, Regulation and Interaction* that help categorize Emotion interactions in our taxonomy. These principles are widely accepted and discussed in further detail in social science papers [34, 70].
- Other Vocabularies: We also used terminology from the logic, mathematical and computer science domain where necessary if the earlier methods did not result in the development of a satisfactory term to express our findings. An example of adopted vocabulary that falls into this category includes the terms *Cardinality, Periodicity, and Exclusivity* listed under relationships in our taxonomy.

5 A TAXONOMY FOR SOCIAL CHARACTERS

In this section, we describe the final taxonomy that resulted from our analysis.

5.1 Theme: Communication

Almost a third of the interactions discovered across the artefacts surveyed were tagged as *communication*. We classified these interactions into primary and secondary themes further refining the nature of communicative interaction.

Primary themes of communication included communication interactions that could be classified as verbal, physical or emotional[1]. Primary themes include verbal, physical and emotional communication were derived and found to be some combination of the primary modes of communication.

[1]Our dataset included only the title or name of the interactions. Coders did not have access to the associated animation, expressions or other media associated with the same and were free to interpret the same. For instance, coders interpreted the interaction, "Threaten," as including the tag *#Physical*.

These included gestures, queries, and a final category termed as mixed communication. Secondary themes include queries, gestures and mixed modes of communication.
2

Table 4. Overview of the Communication themes

Primary Themes	Verbal	*e.g. Greet a character*
	Physical	*e.g. Hug a character*
	Emotional	*e.g. Console a friend*
Secondary Themes	Queries	*e.g. Ask someone out*
	Gestures	*e.g. Throw drink in face*
	Mixed Modes	*e.g. Bragging*

5.1.1 Primary Theme - Verbal. We defined verbal communication as any product of spoken or written language used between two or more social characters to communicate. For instance, we see two examples of interpersonal dinner conversations amongst friends in Fig. 4. Approximately 75% of the communication interactions across all projects surveyed were tagged as Verbal. This included interactions such as flirting, asking about one's day, yelling at another character, and so on. A high-frequency code associated with the Verbal tag is #RelSocial#Increase that indicating coders felt Verbal interactions produced an improvement in social relationships

5.1.2 Primary Theme: Physical. These communications were perceived to be or have an effect on a tangible, sensation (as opposed to verbal, or emotional). For instance, pushing someone in anger, physically flirting with another, or the act of mutiny on a ship. A high frequency code associated with the Physical tag is *#RelSocial#Increase* indicating that coders felt physical interactions influenced social relationships positively.

5.1.3 Primary Theme: Emotional. Relating to communications of the emotions and feelings of a character to another, or interactions that subsequently affected the emotions of another character. For instance, the former could include expressing joy about a promotion at work or announcing a pregnancy. In contrast, the latter could include apologizing to another character, or appealing to the kindness of another. The emotion was expressed in varying ways across projects using emoticons, a textual representation of joy, change in animation with expressions, style of walk, or posture. These account for the "facial expression" part of Lisetti (2002)'s taxonomy [37]. A high frequency code associated with the Emotions tag is *#Appreciation*, indicating a charcter was being appreciative of another, with the effect of improving the social relationship between characters (i.e. *#RelSocial#Increase*). [18, 49, 67]

5.1.4 Secondary Theme: Gestures. Gestures are used primarily in conjunction with physical communication. They are defined as a form of non-verbal communication or non-vocal communication in which visible bodily actions communicate particular messages, either in place of or sometimes in concert with verbal communication. For instance, waving a friend over, greeting someone at the door, or throwing a drink at another. A high-frequency code associated with the Gesture tag is *#Gifts*, indicating that a common gesture could be seen as the giving of a gift.

5.1.5 Secondary Theme: Querying. Queries were used primarily in conjunction with verbal communication while trying to obtain information, although they may have a physical component included. For instance, an example of a verbal query could be one character querying another for the location of an object or person [18, 49, 53, 62]. In contrast, a physical query could be a marriage proposal [18, 73].

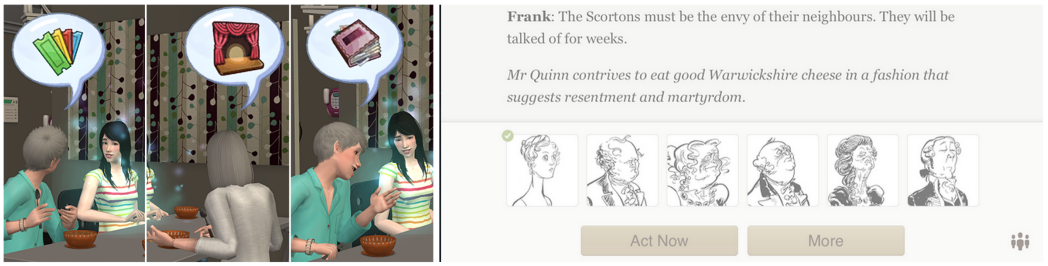

Fig. 4. Two interactions of dinner conversations. The left interaction plays from *The Sims* [47] where communication occurs primarily through icon images representing topics. The other in *Versu* [19], with conversation depicted primarily through text. However, both interactions are examples of Verbal, Bi-directional Knowledge Propagation and will influence the social relationships amongst the participants.

5.1.6 Secondary Theme: Mixed Modes. Some communication interactions did not fall neatly into one of the categories listed above. For these interactions, we concluded there were many ways to accomplish the interaction goal, and either projects implemented the same interaction in different ways or did not give enough information for us to classify them into a specific mode. We classify these exceptions as mixed-mode communications, including bragging, embarrassing oneself, reacting to ghosts, and expressing that one is impressed by another character.

5.2 Theme: Flow of Knowledge

Several research groups are interested in simulating the phenomenon of the flow of knowledge through a system. This phenomenon has long been associated as a source of drama and interest between characters and generates a large amount of storytelling [7, 15]. Examples of such narratives in our dataset include social characters forming plans to obtain objects, influencing relationships, forming alliances, or even enacting revenge based on information they learnt throughout their lives.

We tracked the specific changes to the characters' knowledge base and the world to classify the interactions under the sub-themes of Knowledge Creation, Knowledge Propagation, and Knowledge Termination as depicted in the overview in Table 5. These categories have been discussed in greater detail in this section.

5.2.1 Knowledge Creation: We define *Knowledge Creation* as any interactions to do with the addition of new knowledge, either into the simulation or to the social character's knowledge base. On further analysis, we found that these interactions could be further classified based on whether new knowledge was created or discovered by the NPC itself, generated by the system, or generated through interactions with other NPCs. We define these categories further below:

- **Generated By NPC:** Artifacts dealt with the production of knowledge in varying ways. While some chose to instil all known facts into the system at the start of the simulation [53], others chose to allow for the creation of new knowledge or even languages during the simulation [71]. We discuss the themes we discovered below.
  - **By Characters:** This includes knowledge generated by the character directly. This could include interactions such as choosing a name for a baby[7], discovering and naming a new island[71], or a skilled product from an NPC (e.g. a painting by an artist, or a musical composition) [18].

Table 5. Overview of Flow of Knowledge in our taxonomy. Knowledge was categorized into creation of knowledge, propagation of knowledge, and termination of knowledge.

Creation	Propagation	Termination
By the Agent - Invented - External Observation - Introspection or Evaluation *e.g. starting a business*	Type of Propagation - Circulation of information - Using influence of persuasion *e.g. share hobby*	Deterioration or termination of knowledge over time *e.g. forgetting* information
By the System *e.g. news broadcast generated in the world*	By Direction - Unidirectional propagation - Bidirectional propagation *e.g. debate politics*	
Through social interaction *e.g. eavesdropping on a conversation*	Veracity of knowledge - Truth - Unintentional misinformation - Wilful lies *e.g. lie about job*	

  - **By External Observation:** Social characters can also generate information based on their observations of the environment. An example of this would be an NPC noting the whereabouts of a character [18, 62, 73, 79], or an object they desire to obtain [53].
  - **By Introspection or Evaluation**: This includes interactions where knowledge is created through the introspection by a character. For instance, determining one's political leanings or ideologies [7], or knowledge unintentionally created by concocting new knowledge through confabulation or transference[74]. It could also include a character evaluating another NPC's work, abilities, or skills [18, 19, 62, 73, 79], the interpretation of another character's actions, or even the discovery of new likes or dislikes.
- **Generated by the System:** Some knowledge was inserted into the system by the authors or generated by the system itself and then propagated by the social characters. Examples of such knowledge include a random event occurring at a workplace [18], news events found through a newspaper subscription [7], or a new fishing challenge announced by a tradesman [62]
- **Generated through Social Interactions:** Knowledge was created through the interaction amongst characters. For instance, the mutation, propagation or creation of languages [71], or information learnt from eavesdropping on others, or by noting of relationship or affiliations of another character [7, 18, 19, 62, 73, 79]

5.2.2 Knowledge Propagation: Interactions that dealt with the exchange and flow of knowledge through the simulation. Knowledge propagation was further categorized as follows:

- **By Direction:** *Unidirectional* propagation of knowledge occurs for instance when an NPC obtains information from a source. For instance, by directly querying an NPC [7, 18], or eavesdropping on a conversation [73]. *Bidirectional* propagation of knowledge could occur if all participating characters shared or exchanged information, for instance, deep conversations [18] sharing the character's likes and dislikes, or sharing of news or personal opinions [7, 18].
- **By Veracity:** We found that the information the characters propagated could be further classified based on its veracity. Characters could share news that was truthful, unintentionally propagate a confabulation, or even tell an outright lie [7, 53, 73]. In addition, characters were

also seen to bend the truth when trying to fit in with groups [7], or based on their perceptions of the expectations of the participating dialogists [49]. The decision of the veracity of the knowledge to impart was found to be made based on the decision-making algorithm of the work. This decision varied based on the relationships of the participating characters, their intentions, beliefs and the trust they shared.

- **Persuasion and Influence:** NPCs were able to persuade, influence or reinforce their views and those of others around them. This could be seen in interactions such as subscribing to a news source [7], defending an evaluation [19], persuading a friend for a favor [53], or imposing one's views or positions into a conversant [19].

5.2.3 Knowledge Termination: Knowledge could also deteriorate or terminate over time. The deterioration of knowledge was found to affect the veracity of the knowledge propagated [74]. The artefacts we surveyed modelled deterioration in various ways, from characters unsubscribing from a news source or the propagation of misinformation overriding other knowledge [7] to the literal forgetting or corrupting of knowledge learnt over time [71, 73, 74].

5.3 Theme: Relationships

Across our surveyed artefacts, we were able to see how social relationships were instrumental to extrinsic, nonsocial ends, or as constraints on the satisfaction of individual desires, driving character decision making, and narrative plot [46, 53, 73, 79]. Ho (1998) defined the term relationship as a connection existing between people related to or having dealings with each other, with attributes that are more specific, sharply defined, or lasting. They argued that irregardless of socioeconomic or cultural variations, relationships and relational contexts affect social behavior [28]. We feel that this definition captures the features discovered in our taxonomy.

With this section, we first identify and classify the *Relationship Types* present in the surveyed artefacts as depicted in Figure 5. Next, we were able to identify the more specific *Relationship Attributes* associated with these relationships. These attributes were seen to be the encoding of social norms and customs associated with the specific relationship. Next, we were able to identify the primary and secondary derivatives of the temporal complexities governing the development, growth and decay of *Relationship Dynamics*. Finally, the surveyed artefacts were seen to have additional *Relationship Dimensions* representing the individual participants' perceptions of the relationship, and helping us to identify the distinctions between similar relationships. An overview of the attributes, dynamics and dimensions have been included in Table 6 for easy retrieval and understanding.

5.3.1 Identified Relationships: We created a tree structure (seen in Fig. 5) to depict the classes of relationships in our taxonomy and make them more easily understandable. A relationship formed can be classified under multiple categories, for instance, a character may be a sibling and a colleague to another character if they worked at the same family-owned business. Thus, we define the relationship between any two NPCs to be an overlapping subset of classes. The surveyed projects were found to have some subset of the following relationships:

- **Familial:** Familial relationships consist of direct family connections – for instance, parents, children, spouse/partner – and extended family – for instance, grandparents, in-laws, grandchildren, etc. This could be further differentiated into biological and chosen family. Some codes associated with the forming of new familial relationships are *#Communication*, *#Emotions*, *#Happiness*, and *#Baby*. Example interactions tagged with these codes include having a baby, getting married, spending time with family, talking to family, asking for help with homework, and adopting a baby.

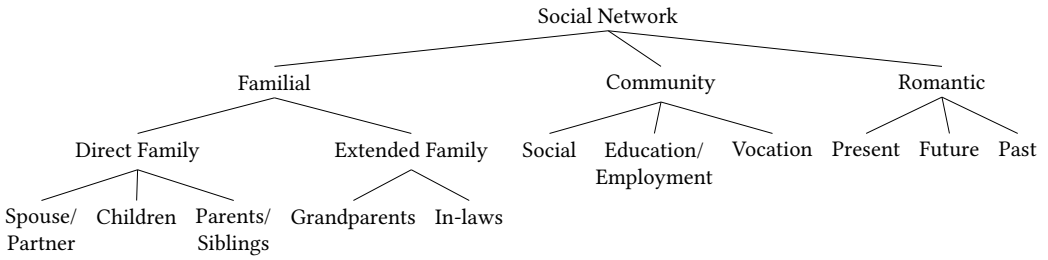

Fig. 5. Categories of relationship types identified during our review

- **Romantic:** Romantic relationships were handled differently across projects surveyed. Overall they could be divided into an overlapping set of present or ongoing relationships, future ones, for instance, where a spark of romantic interest seemed to be budding or was acted upon, and past relationships. Some high frequency codes associated with the forming of new romantic relationships are *#Physical*, *#Gesture*, *#Romance*, *#Happiness*, *#Emotions*, and *#Verbal*. Example interactions tagged with these codes include kissing, holding hands, asking another character out, and sexually propositioning a character.
- **Community:** Coders tagged all other social relationships under community relationships. This could include social relationships, for instance, those forged with neighbours, or friends; educational or workplace relationships amongst classmates or colleagues; and vocational or affiliation-based relationships, including those amongst NPCs sharing the same hobby, for instance, gym buddies, or with local business owners or community members interacted with. Some high frequency tags associated with the forming of new Community relationships *#Hobby*, *#Trade*, *#Employ*, *#Work*, *#Verbal*, *#School*. Example interactions tagged with these codes include asking about a character's career, visiting a neighbour, establishing a settlement, cheering up a character, giving a gift, and sharing a mutual interest.

With these classes, our taxonomy aims to be generic enough to record simple relationships between a few characters in a smaller simulation and the more complex societal or group connections in larger environments. Based on the project goals, these relationship states may be added, deleted or modified with [19] or without the knowledge of the characters involved [7, 18, 73].

5.3.2 Relationships Attributes: Relationships can have various attributes associated. These attributes were seen to be the encoding of social norms and representative of the social phenomenons associated. The discovered attributes are thus constraints on the relationship, and have been listed below:

- **Acceptability:** All the projects incorporated notions of social norms of accepted or unaccepted relationships in their implementations. However, unlike real life, where a social norm can be flouted or disregarded, these norms are programmatic exclusions. Thus, for instance, cinematic or narrative moments with disturbing reveals of incest [31] do not occur. Instead, the projects forbid these interactions from occurring. This leads to scenarios where players are surprised if they cannot flirt with another character, only to realize later they may be distant cousins [26].
- **Exclusivity:** Whether the relationships and attachments are exclusive, or whether they are general. For instance, one may have only a single biological mother. This is not a relationship that can be broken or exchanged for any other. Alternatively, one may have an aggregative relationship among several colleagues or friends.

Table 6. Overview of the features of Social Relationships in the taxonomy.

Attributes *Encoded social norms, phenomenon, constraints and expectations.*	**Dynamics** *Temporal factors, or dynamics determining the strength of the relationship*	**Dimensions** *Internal differentiating factors and perceptions of participants in a relationship.*
- Acceptability - Exclusivity - Cardinality *(one-one, many-one, one-many, many-many)* - Symmetry - Membership - Volition - Available Behaviours	- Valence - Duration or Permanence - Change in Valence *(Non Recurring, Constant, Accelerated, Unchanged)* - Periodicity	- Trust - Deceptiveness - Competitiveness - Indebted Towards - Power and Domination - Likability - Social Rank - Attractiveness - Compatibility

- **Cardinality:** Relationships may have a cardinality associated. For instance, the relationship may be a one-to-one relationship (for instance, that between a husband and wife), many-to-many (for instance, group affiliations in a work environment), or one-to-many (for instance, a mother may have several children) in nature. These attributes tell us whether the relationship is considered a unique one, or is a more general one. For instance, in a social system that encourages one-to-one relationships between a husband and wife, characters may have just one married partner at a time. To start another such relationship, a social character would need to end the former.
- **Symmetry:** Symmetry in a relationship is defined by whether both parties in a relationship classify or value it similarly. Relationships can be symmetric; for instance, A's views on B may be considered to be precisely the same as B's views on A. In contrast, for asymmetric relationships, X may regard Y differently. This disparity in relationships could lead to narrative drama and tension.
- **Membership:** Relationships can also form between social characters that share the same membership, affiliation or interest as another. For instance, the relationship between two individuals with the same political affiliation, or belonging to the same cultural group or ethnicity.
- **Volition:** Relationships may be voluntary, for instance, the bonds of friendship formed amongst neighbours, or involuntary, for instance, the relationship amongst siblings, or that in an unwanted, or arranged marriage.
- **Available Behaviours:** Once a character is in a particular relationship with another, certain behaviours may become available to them. For instance, allowing a character in a budding romantic relationship to flirt with their love interest [18, 19] or to give a gift to a friend [18, 62].

These constraints can affect the character's behaviour with one another, encouraging or dissuading certain sets of interactions that could be tagged with these constraints. For instance, a married character may not flirt with another character, or one fancying themselves in love may propose to their loved one. A situation where these encoded social norms or constraints are broken would lead to narrative tension. For instance, generating a narrative with one character cheating on their spouse.

5.3.3 Relationship Dynamics: Every relationship has temporal factors or dynamics associated with it that determine the current strength of the relationship. We divided these discovered factors into

two categories: First, the primary derivatives and temporal factors that affect the relationship – the charge and duration or permanence of the relationship. We also looked at the secondary or second derivative of these factors – change in valence and periodicity of the relationship. These have been described in further detail below.

- **Valence:** Artifacts surveyed encoded the strength of the relationship by associating with it a valence, a primary factor or derivative in relationship dynamics. The valence would reflect the permanence or trigger the eventual termination of the relationship. A valence is denoted by an intrinsic positive or negative quality in the relationship. The valence of a relationship can be asymmetric, or one participant in the relationship may judge the valence or strength of the relationship differently than the other.
- **Duration or Permanence:** Another primary factor or derivative of relationship dynamics, relationships were found to have varying degrees of permanence. This could range from one-time or situational encounters and consultations, for instance hiring an architect [73], or those of temporary tutelage or apprenticeship [7], to more permanent ones, such as those between close friends or family [18].
- **Change in Valence:** A secondary derivative of valence, artefacts were able to programmatically encode the social phenomenon of the change in the intensity relationship between characters. They achieved this by including a numeric quantity that charged or decayed the valence of the relationship. The change in valence is asymmetric and based on the participant's perceptions of the relationship. The degree of difference allows for interesting narrative scenarios. For instance, more outgoing characters vs introverted characters could have differing social needs. Thus, a sudden charge in a relationship for an extrovert attending a party might correlate to a decay in the same for an introvert. Some high frequency codes associated with the charge of a relationship are *#Gift*, *#Errand*, *#Appreciate*, and *#Entertain*. In contrast, coders attributed the decay in a relationship to interactions coded with *#Fight*, *#Violence*, or *#Mean*. To encode this change in valence, we list the secondary derivatives of relationship valence dynamics:
  - ***Non-Recurring :*** A relationship could undergo a one-time enhancement or decrease in the charge based on a single interaction. For instance, being the recipient of a rude gesture may involve a one time decrease in the relationship's valence.
  - ***Constant:*** A steady decay or charge in a relationship based on periodic interactions amongst characters.
  - ***Accelerated:*** Acceleration in the charge of decay caused by a specific event or circumstance that has occurred. For instance, going out for drinks with your colleague could charge the valence acceleration for a co-worker relationship.
  - ***Unchanged:*** No change in the relationship amongst characters.
- **Periodicity of relationship:** Finally, a secondary derivative of *duration*, the periodicity defined whether a relationship once ended could restart, or how past relationships could influence the new. For instance, relationships involving ex-lovers that get back together, remarrying an old spouse, or friends reuniting after several decades.

5.3.4 Relationship Dimensions: The surveyed artefacts were seen to have additional dimensions representing the individual participant's perceptions of the relationship. These further dimensions help us to identify the distinctions between similar relationships. Evans and Short (2013) describe these as role evaluations that are taken into account. These factors were found to vary with projects based on the social phenomenon being evaluated, the social environment in which the characters are situated or the individual attributes or personalities encoded in the work. For instance, in *The Sims*, characters may have a proclivity to admire characters with blue eyes [18].

Table 7. Overview of the model of Emotion in our taxonomy

Type	Principle of Contingency	Principle of Inertia vs Principle of Regulation	Principle of Interaction
Happiness, Anger, Sadness, Worry, etc	Emotions are responses to extrinsic events called moodlets.	Emotions have inertia and must be regulated to maximize utility.	How the components of emotions continually interact with, augment and blunt one another
	- Antecedent Cause - Emotion Type - Valence	- Inertial Duration (e.g. 10 mins) - Regulated Effects (e.g. apologize to reduce mortification)	- Composite - Exclusive

Our taxonomy identifies some of the common personal dimensions evaluating these relationships. Each dimension can be seen as the character's evaluation of the other. These dimensions include but are not limited to:

- ***Trust:*** How trustworthy is the other?
- ***Deceptiveness:*** How deceptive is the other?
- ***Competitiveness:*** How competitive is the other?
- ***Indebted towards:*** Is this character indebted towards the other?
- ***Power and Domination:*** What is the power dynamic between the characters? Does one dominate the other?
- ***Likability:*** Is this character likable?
- ***Social Rank:*** What is the social rank or status of the other ?
- ***Attractiveness:*** How attractive does this character find the other?
- ***Compatibility:*** How compatible are the characters?

Some subset of these dimensions can be seen across various academic papers [39, 49, 53] as well as several commercial games. A character's evaluation of another character across these dimensions were found lead to emergent narrative dramatic arcs, or cause a change in the relationship or types of interactions available to the NPC when dealing with the other.

5.4 Theme: Emotions

The exercise of accurately modelling emotion can often spur the development of new mechanisms that may be of general use to agent systems. For instance, Mao's effort to model anger led to a general mechanism of social credit assignment and a model of social coercion [21, 44]. This improves social utility by minimizing cultural conflicts [37, 67, 93].

We used a model-free approach to classify expressions of emotions and the factors associated in our dataset. During our analysis, we realized that the factors and principles we identified in our dataset are those commonly associated with the field of Emotional dynamics [34]. We structured our discovered factors by these principles, and note how our surveyed artefacts incorporated them into development below. An overview of our findings has been summarized in Table 7.

For the purpose of illustration, we will use the running example of a character responding to a sudden death (or murder) of a loved one to describe the factors below [19, 26, 73].

5.4.1 Identified Emotion Types: Several computational models of human emotions have been developed in the past [17, 45]. For the scope of this work, we looked at the emotional states most

prevalent in our surveyed projects. We tagged our list of interactions with the emotions resulting from or associated with the interaction.

From our coded interactions, we were able to shortlist the emotions associated commonly with the interactions to the following: *Happiness, Anger, Sadness, Worry, Envy, Appreciative, Disparaging, Bragging, Scared, Neutral, Ignored, and Rebelliousness.*

In the case of our example, a character may be dealing with sadness or grief caused by the death of a loved one.

5.4.2 Principle of Contingency: Characters did not randomly move into emotional states, but instead in each case reacted to a change in external, or internal social environments. The one exception to this cause-effect emotional state is that in *Animal Crossing*, where an NPC may be *Cranky*, *Irritable*, *Perky*, and so on by default as their personality [62].

Prior research defines this observation as the *Principle of Contingency* of Emotions. Simply stated, emotions consist of responses to things extrinsic to them. They can be contingent on internal or external events, often social in nature [34].

In *The Sims*, the Principle of Contingency is programmatically achieved by a creation of a *Moodlet* [47] for any external event that causes an emotion or mood-altering circumstance. *Moodlets* detail their cause, and the effect experienced by the character. For the purpose of our taxonomy, we adopt this term. An interaction may produce multiple *moodlets*, each affecting a separate emotion of the character. We consolidate the representation of these *moodlets* across the surveyed systems[2]. We define a *moodlet* to consist of a single causal factor, modifying valence, and type of emotion associated with any emotion modifying extrinsic event.

- **Antecedent Event or Focality:** Specific internal or external event or interaction causing the emotional effect[37, 70]. Further, it is necessary to note that a character may not correctly identify or attribute the antecedent event to be the cause of the emotion. In our example, the traumatic event of experiencing or witnessing the death of a loved one would be the external causal factor.
- **Emotion Type:** We found that coders tagged interactions with multiple emotions, indicating the same interaction could have multiple effects on a character's mood. Thus, an interaction could add more than one *moodlet* to the character's set of emotions. For instance, witnessing death could add an Anger *moodlet* (blaming a suspect) and a Sadness *moodlet* (attributing grief to the felt loss) to a character [15, 19].
- **Valence:** Every *moodlet* is associated with an effect or valence by which it adds or alters the current emotion experienced by the character. In the case of our example, witnessing death could increase sadness in a character by a unit of, say, +20. In this case, valence corresponds to the horizontal pleasure-displeasure scale in Russell (2003)'s theory [70]. *The Sims* [47], further relates these valences to ranges comparable to a mapping of the intensity [37] of the associated emotion. Every emotion has a range and a superlative for the same associated with it. If the emotion is not dealt with, a character may die of emotional exhaustion. For instance, a sim could be embarrassed, very embarrassed, mortified and then die of mortification. This mechanic has lead to very dark, but fascinating and chronicled user-generated narratives [26].

5.4.3 Principle of Inertia vs Principle of Regulation. Emotional states display an intrinsic resistance to change, even in the presence of forces that motivate change, causing them to display a general inertia, or tendency to carry over from one moment to the next [34]. Additionally, emotions are

[2]A version of Prom Week's CiF was paired with Fear Not! Affective Mind Architecture (FAtiMA), an agent architecture extension of the BDI (Belief, Desires, Intension) and OCC model, that treats emotions as valenced evaluations of the world integrated with coping mechanics [36]. However, this version of the system was not incorporated in our taxonomy

continually regulated to maximize fit with the current desired state. These two factors act together influencing the duration and valence of the emotions associated.

To represent this phenomenon, artefacts were found to have a duration associated with their *moodlets*. Additionally, while in the emotional state, certain reactions [19], or interactions were found to be available to the character that are specific to that emotional state that could influence or regulate the emotion.

- **Inertial Duration:** Similar to relationships, *moodlets* have a duration associated. For our example, the sadness could persist for up to a week [19, 73]. During this time, the entire effect of the *moodlet* may be felt by the character [18], or the effect could decrease over time. Our survey did not unearth sufficient proof to recommend a method to recommend how to handle *moodlet* decay.
- **Regulated Effects:** Some agent behaviours or interactions were only available in specific emotional states. These behaviours were seen to regulate these states. They can affect a change in the intensity of the experienced emotion or help resolve the situation. Programmatically, this was implemented by some interactions having emotional preconditions associated with them. This was seen to manifest across the artefacts explored. For instance, in *The Sims*, Taking an Angry Poop (available when angry) reduces the intensity of anger. In another project, a character may choose to dissolve a relationship or leave a job that made them unhappy regulating the effects of drawn-out depression [18, 19, 72, 73]. Uniquely, *The Sims* allow characters to die due to being in an extreme or unregulated emotional state for a prolonged time. For instance, one can die of mortification.

5.4.4 Principle of Interaction: We found that interactions in our dataset had overlapping emotional states associated with causal events. Multiple emotions were found to react together to produce an overall emotion or mood for the character. Further, characters were able to be in multiple emotional states at a time.

Kuppens and Verduyn (2017) describe how the components of emotions (physiological, experiential, and behavioural), or the emergent emotional states as they are experienced, continuously interact with, augment and blunt one another, creating a system that displays evolving patterns of synchrony and networks of interacting elements. We categorized them as follows:

- **Composite:** In *The Sims* [47] universe, characters can experience multiple simultaneous emotional states. The emotions and their associated *moodlets* are not exclusive, so, for instance, it is possible to be in a positive mood from "Beautiful surroundings" and a negative one from "Vile surroundings" from another object at the same time.
- **Exclusive:** A simple model of emotion where one emotional state may persist for a short period; however, it will be overridden by another. Thus, a social character may not experience more than one emotion at the same time. For instance, in Versu [19] while characters remember their earlier emotional states, the system can *shift* them to a new emotion.

Interestingly, both Versu [19], categorized as having an exclusive emotional model, and *The Sims* [47], categorized as a composite model, discuss how certain events and objects can *enhance* the intensity of already existing character emotions [19, 61]. For instance, looking at a photograph reminder of a lost one may enhance sadness, or gussying up may make one feel more optimistic about a day. However, they both point out that while these events enhance emotions' valence, they cannot change existing emotions completely. For instance, a character may not laugh if they are already in a bad mood.

6 ADDRESSING THE UNSEEN: UN-SPUN TALES

Our surveyed social simulation projects had disparate goals, ranging from pure entertainment to enabling systems understanding of real-world social phenomena. These disparate goals make the set of phenomena they choose to simulate interesting in their overlap, in our comparison of the models and the different choices their authors made for computational representation. However, equally interesting is the set of social phenomena and theories that they *did not* simulate, and that we did not come across.

Phil Agre's theory of Critical Technical Practice [4], and Phoebe Sengers' extension of this concept to HCI [77], guide us to consider the underlying assumptions, values, and metaphors that simulation authors rely on, and to identify alternatives. In this set of social simulation projects, we identify the underlying assumptions and encoded social norms pertaining to (1) notions of identity; (2) the structure of human families and relationships; (3) relative power between agents; and (4) human needs and access to resources that meet those needs.

6.1 Identity and Social Norms

Every system we studied had a formal representation of a character or an abstraction of human identity. The data structure representing a person may contain a name, age, set of parents, personality traits, and gender, for example. The choices of data fields, types, and their use in the simulation all reflect assumptions about the role of identity in society [6, 91]. When gender is represented as a binary [7, 49, 73], it also enables explicit representation of sexual orientation and attraction. For instance, the game Rimworld [83], which was not included in our study, was heavily critiqued [38] for encoding gender-essentialist differences in the attraction models between men and women in the simulation. Gender also sometimes affects the clothing choices available for simulated characters [55].

Apart from *The Sims* [47], that released an update for their most recent release that received acclaim for breaking down gender barriers [11], the simulations we surveyed typically enforced these norms without actually *modelling* their role as norms: they may remove the option for male characters to wear dresses, for example, or they may allow characters of any gender to wear any clothing, but the concept of *norm breaking*, e.g. that a man wearing a dress violates a social norm is not encoded.

6.2 Family Structure

Simulations of family structure tend to replicate the nuclear, heteronormative, natal family: a child is born to a mother and a father, and those relationships are permanently maintained throughout the simulation [7, 49]. Romantic relationships are typically ruled out between natal family members, leading to sometimes surprising situations for players, such as being unable to perform the Flirt action between characters who happen to be distant relatives (as seen in Section 5.3.2). These design choices are of course a simplification of real life, choosing to simulate what is considered socially normal for the target audience of players and choosing to omit social phenomena that break social norms.

As social norms in target player audiences evolve, so do the simulated phenomena of commercial social simulation games. The inclusion of same-sex relationships in *The Sims 4* and *Animal Crossing*, for example, has been a site of controversy [30].

6.3 Power Relationships

Of the simulations we surveyed, few represent power relationships between characters [53, 79]. In general, edges in the relationship graph are assumed to be *consensual*, even if not reciprocal,

and each character has the same set of actions and constraints as every other character. Power imbalances such as the privilege afforded racial and gender bias are not simulated, nor are coercive relationships that in real life may emerge between someone dependent on another for necessary resources [53], such as an employee and their boss [73] or a child and a bully [79]. Generally, the only sources of conflict between characters are due to one-on-one interactions, such as bullying and insulting, rather than systemic, trans-generational power imbalances between groups.

6.4 Meeting Needs

Power imbalance, described above, is strongly related to the idea that some people may depend on others to meet their basic needs. In American capitalism, people need to earn money through work to obtain food, shelter, and clothing. In reality, jobs may not be available, a person may not possess the skills needed to get a job, or the money earned from a job may not be sufficient to meet the living standards. In the simulations we surveyed, basic survival needs (if simulated) are generally *possible* to meet through non-coercive means. It is always possible for a character to find work, and in some cases, they are given jobs as favours by family members if they need one [73]. Of course, the real-life dynamics of labour and pay are much more complicated. Some playable simulations exist as effective critiques of capitalism's exploitation of labour, such as *Papers, Please* [59], and *To Build a Better Mousetrap* [56]. However, these games simulate economic phenomena in isolation from their effects on social interaction.

6.5 Modeling Social Norms

A frequently observed pattern in all of these examples is that simulations may *encode* certain social norms [64]. For instance, programmatically enforcing or creating different responses to socially abnormal actions. However, they do not model the formation, absorption, perpetuation, and transformation of those norms. Additionally, they do not describe how these expected norms may change across culture [89]. Some academic projects are attempting to develop richer models of social norms and propriety in other simulations [8]; however, these models have not yet been realized in playable experiences.

7 DISCUSSION

It is our position that it is time for our field to have agreed upon taxonomies and conventions that allow us to discuss both past and new social character models and frameworks. Our taxonomy could better facilitate our understanding and use of agent-based modelling in the entertainment domain and allow for better communication and collaboration among researchers and practitioners developing social simulation systems.

This section discusses how our taxonomy can be operationalized and used to fulfil our goals to reuse, reproduce, and compare existing models. We also discuss and review our analysis, keeping in minds our initial goals.

7.1 Using the Taxonomy

We propose that researchers referring to our taxonomy could use it in several ways.

7.1.1 As an Analytical Tool. Our taxonomy can be used to analyze existing work and set standards for the evaluation based on the area of contribution. For instance, can we standardize experiment designs or target audiences that can be used to compare or evaluate physical interactions amongst social characters? What are the existing physical interactions modelled between characters

that increase familial relationship valences? How does a proposed new physical interaction behaviour compare? Will adding these interactions make agents more believable, sociable, or improve communication between agents and the player?

Relatedly, the taxonomy can also be used as an object of critique in and of itself: because it encapsulates a range of choices made in a representative set of systems, we can study identify the underlying assumptions, theories, and metaphors embedded in existing social simulation systems, and we can identify alternatives to them that are missing from this canon. Section 6 demonstrates this usage as a key step of the Critical Technical Practice methodology.

7.1.2 As a Design Tool. To contextualize new work, designers can enumerate their specific design choices for their system using the taxonomy. They can clarify where their contribution lies, and help situate their work with respect to previous systems. For instance, consider a narrative designer creating a simulation of the spread of political news and misinformation. Then questions they might ask of our taxonomy could be, what existing projects have designed models of knowledge, communication and relationship that allow for the deliberate spread of misinformation? What are projects that represent character knowledge and veracity of information? Are there existing relationship models that take into account trust or deceptiveness of the participant as a dimension? What communication methods would need to be used to depict truthfulness in information being dissembled.

7.1.3 As a Social Physics Engine or API. We posit our taxonomy can be used as a list of features or requirements to implement during the construction of a social physics engine, library or API. Designers could search this social physics API, for instance, for PDDL definitions of behaviours that increase the valence of romance relationships by a small amount in a newly budding relationship amongst co-workers. Thus, interactions one may not see recommended could be, "Propose having a baby." Of course, simulating such behaviours could lead to entertaining narrative tropes such as a *One Night Stand Pregnancy.*

7.1.4 For Software Engineering Processes. We propose using this taxonomy as a project planning guide. This would allow development groups to assemble team members with expertise in simulating various phenomena, such as engineers to animate characters, a developer with expertise in knowledge engineering, etc. Additionally, the taxonomy can inform architecture decisions, allowing developers to reuse components, for say, emotions, from their or other researcher's existing projects.

Additionally, our taxonomy can be used during the requirement gathering stage in a software development project. It can dictate what features must be implemented, and prioritize them in increasing order of complexity. For instance, an initial proof of concept for an emotions model could be developed including just a binary trigger (or behaviour tree) that lets characters express (e.g. using facial expressions) a type of emotion (e.g. happy) when an event occurs (for instance, at a birthday party). In a more complex model, the Principle of Contingency could be developed, with programmatic implementation to track the antecedent cause (e.g. the event of the birthday party), and the valence in happiness (e.g. +10 to happiness), and so on for the other principles in Section 5.4.

7.2 Does this taxonomy support our goals?

The goals of developing a taxonomy and a vocabulary were to enable researchers and industry designers building social agent models to communicate effectively, reuse one another's work, and compare projects across a wide variety of narrative domains. Here we review the outcome of our analysis in light of our goals.

- We conducted a preliminary investigation into the need for NPC model-based analysis

- We conducted an in-depth investigation of a few selected models from research and industry and were able to:
  - Identify the commonalities and differences in the various systems in terms of the level of granularity, social state assumptions, communication, the flow of knowledge, social relationships and behaviours
  - Identify differences in implementation: where systems shared similar "verbs" but implemented them according to different models or assumptions
  - Discuss how this taxonomy could be used to compare play experiences or research methods or goals

The strength of our contribution stems from that it is the first in the literature to explore, identify, and classify themes of social state assumptions, models of communication, social relationships and behaviours across exemplary research and commercial artefacts in our field. We posit that game designers can use our framework to understand and better design the effect NPC behaviours and interactions created within their games may have on the social state of the characters.

7.3 Limitations and Future Work

We established our proposed vocabulary and taxonomy by reviewing the selected research and commercial artefacts and existing cognitive and social science theories. However, there is ample room for refinement and evaluation.

In terms of refinement, some of the categories in our taxonomy are quite abstract. For instance, the modes of communication in our taxonomy could be further expanded, including modes or vocabulary for ways in which social characters can interact with the player or vice versa. For instance, comparing romantic interactions possible to make characters perform using Monkey Island's SCUMM engine with those in *The Sims* or comparing player feedback obtained from characters across experiences. Currently, our results are particular and limited to the characteristics of the list of artefacts we chose to analyze.

In our dataset, we only consider written titles and descriptions of interactions. As such we are unable to articulate or observe how the visual enactment of the interaction may be perceived by a player during the course of the game. However, future studies could investigate the enactment of an agent behaviour with the authorial intent of the behaviour.

Additionally, by considering each interaction independently from the others, our analysis does not capture interactions' roles within the larger context of characters' plans or social scripts script [76]. We limited the scope of our study to constructing an initial conceptual framework to categorize NPC social state and interactions, and our chosen artefacts did not include implementations of plans or scripts. A systematic review of social simulation models may reveal modes of interaction that challenge this simplifying assumption.

More generally, our future work will evaluate the taxonomy for its ability to describe other existing projects effectively, its ability to guide new game designs, and its clarity and ease of use for the purposes described in Section 7.1. For example, a future will might evaluate the clarity, precision, and effectiveness of the taxonomy by asking practicing game designers to compare existing projects with and without the aid of our taxonomy. Further, we plan to implement an API within a social simulation engine based on this taxonomy so that it can be more easily accessed, used, and evaluated by working researchers and game designers.

REFERENCES

[1] [n.d.]. Papers with Code - Image Classification. https://paperswithcode.com/task/image-classification
[2] 2021. UCI Machine Learning Repository: Data Sets and Benchmarks. https://archive.ics.uci.edu/ml/datasets.php

[3] Tarn Adams and Zach Adams. 2006. Slaves to Armok: God of Blood Chapter II: Dwarf Fortress. *PC Game). Bay* 12 (2006).

[4] Phil Agre. 1997. Computing as a social practice. *Reinventing Technology, Rediscovering Community, P. Agre and D. Schuler,(eds)* (1997).

[5] Gordon W Allport. 1968. The historical background of modern social psychology. *Handbook of social psychology* (1968).

[6] Ruth Aylett, Natalie Vannini, Elisabeth Andre, Ana Paiva, Sibylle Enz, and Lynne Hall. 2009. But that was in another country: agents and intercultural empathy. In *Proceedings of The 8th International Conference on Autonomous Agents and Multiagent Systems-Volume 1*. International Foundation for Autonomous Agents and Multiagent Systems, 329–336.

[7] Sasha Azad and Chris Martens. 2019. Lyra: Simulating Believable Opinionated Virtual Characters. In *Proceedings of the AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment*, Vol. 15. AAAI, 108–115.

[8] Joseph Blass and Ian Horswill. 2015. Implementing Injunctive Social Norms Using Defeasible Reasoning. In *Proceedings of the AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment*, Vol. 11.

[9] Kai-H Brassel, Michael Möhring, Elke Schumacher, and Klaus G Troitzsch. 1997. Can agents cover all the world? In *Simulating social phenomena*. Springer, 55–72.

[10] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. *Qualitative research in psychology* 3, 2 (2006), 77–101.

[11] Janet Burns. 2016. 'The Sims' Drops Gender Barriers, Extending Freedom Of Self-Expression By Avatar. https://www.forbes.com/sites/janetwburns/2016/06/03/the-sims-drops-gender-barriers-extending-freedom-of-avatar-self-expression/

[12] Cristiano Castelfranchi, Fiorella de Rosis, and Rino Falcone. 1997. Social attitudes and personalities in agents. In *Proceedings of the AAAI Fall Symposium on Socially Intelligent Agents*.

[13] Marc Cavazza and David Pizzi. 2006. Narratology for interactive storytelling: A critical introduction. In *International Conference on Technologies for Interactive Digital Storytelling and Entertainment*. Springer, 72–83.

[14] Steven N Durlauf and H Peyton Young. 2001. The new social economics. *Social dynamics* (2001), 1–14.

[15] Markus Eger. 2020. Murder Mysteries: The White Whale of Narrative Generation?. In *Proceedings of the AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment*, Vol. 16. 210–216.

[16] Markus Eger and Kory W Mathewson. 2018. dAIrector: Automatic Story Beat Generation through Knowledge Synthesis. *In Proceedings Joint Workshop on Intelligent Narrative Technologies and Intelligent Cinematography and Editing (INT-WICED) at AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment (AIIDE'18). Edmonton, Alberta, Canada* (Oct 2018).

[17] Paul Ekman. 1992. Are there basic emotions? *Psychological review* 99 (1992), 550–553.

[18] StrategyWiki Electronic Arts. 2000. The Sims - StategyWiki. https://strategywiki.org/wiki/Category:The_Sims

[19] Richard Evans and Emily Short. 2013. Versu—a simulationist storytelling system. *IEEE Transactions on Computational Intelligence and AI in Games* 6, 2 (2013), 113–130.

[20] Pablo Gervás. 2009. Computational approaches to storytelling and creativity. *AI Magazine* 30, 3 (2009), 49–49.

[21] Jonathan Gratch and Stacy Marsella. 2005. Evaluating a computational model of emotion. *Autonomous Agents and Multi-Agent Systems* 11, 1 (2005), 23–43.

[22] Julia Gray. 2020. The Sims and Animal Crossing rise among Amazon's best selling products as people simulate a life outside of quarantine. https://www.businessofbusiness.com/articles/the-sims-rises-among-amazons-bestselling-products-as-people-simulate-a-life-outside-of-quarantine/

[23] Anying Guo. 2020. https://www.washingtonpost.com/video-games/2020/05/05/pandemic-anxiety-animal-crossing-sims-tomagotchi/

[24] David Hales, Juliette Rouchier, and Bruce Edmonds. 2003. Model-to-model analysis. *Journal of Artificial Societies and Social Simulation* 6, 4 (2003).

[25] Barbara Hayes-Roth and Patrick Doyle. 1998. Animate characters. *Autonomous agents and multi-agent systems* 1, 2 (1998), 195–230.

[26] Patricia Hernandez. 2015. The Sims Players Confess Their Most Evil Deeds. https://kotaku.com/the-sims-players-confess-their-most-evil-deeds-1694855714

[27] Gary Hickey and Cheryl Kipping. 1996. A multi-stage approach to the coding of data from open-ended questions. *Nurse researcher* 4, 1 (1996), 81–91.

[28] David YF Ho. 1998. Interpersonal relationships and relationship dominance: An analysis based on methodological relationism. *Asian Journal of Social Psychology* 1, 1 (1998), 1–16.

[29] Katherine Isbister and Patrick Doyle. 2002. Design and evaluation of embodied conversational agents: A proposed taxonomy. In *The first international joint conference on autonomous agents & multi-agent systems*.

[30] Patrick Kelleher, Maggie Baska, and Ed Nightingale. 2020. Nintendo shuts down rumours two Animal Crossing characters are in a gay relationship – but fans simply aren't having it. https://www.pinknews.co.uk/2020/04/20/animal-

crossing-new-horizons-nintendo-cj-flick-gay-partners/
[31] Hillary Kelly. 2019. It's Pretty Creepy to Root for Game of Thrones Incest, Right? https://www.vulture.com/2019/04/game-of-thrones-incest-jon-dany-creepy.html
[32] Andrei P Kirilenko and Svetlana Stepchenkova. 2016. Inter-coder agreement in one-to-many classification: fuzzy kappa. *PloS one* 11, 3 (2016), e0149787.
[33] Max Kreminski, Melanie Dickinson, and Noah Wardrip-Fruin. 2019. Felt: a simple story sifter. In *International Conference on Interactive Digital Storytelling*. Springer, 267–281.
[34] Peter Kuppens and Philippe Verduyn. 2017. Emotion dynamics. *Current Opinion in Psychology* 17 (2017), 22–26.
[35] Ben Kybartas and Rafael Bidarra. 2016. A survey on story generation techniques for authoring computational narratives. *IEEE Transactions on Computational Intelligence and AI in Games* 9, 3 (2016), 239–253.
[36] Mei Yii Lim, Joao Dias, Ruth Aylett, and Ana Paiva. 2008. Improving adaptiveness in autonomous characters. In *International Workshop on Intelligent Virtual Agents*. Springer, 348–355.
[37] Christine L Lisetti. 2002. Personality, Affect and Emotion Taxonomy for Socially Intelligent Agents.. In *FLAIRS Conference*. 397–401.
[38] Claudia Lo. 2016. How RimWorld's Code Defines Strict Gender Roles. https://www.rockpapershotgun.com/rimworld-code-analysis
[39] Sandy Louchart, Ruth Aylett, Joao Dias, and Ana Paiva. 2005. Unscripted Narrative for Affectively Driven Characters.. In *AIIDE*. 81–86.
[40] Chucklefish LTD. 2017. Stardew valley.
[41] Linbo Luo, Wentong Cai, Suiping Zhou, Michael Lees, and Haiyan Yin. 2015. A review of interactive narrative systems and technologies: a training perspective. *Simulation* 91, 2 (2015), 126–147.
[42] Sofia Lyon. 2020. Why "Animal Crossing" Wins Over "The Sims" Every Time. https://thebottomline.as.ucsb.edu/2020/05/op-3-why-animal-crossing-wins-everytime-the-sims-vs-animal-crossing-debate
[43] Brian Magerko, Waleed Manzoul, Mark Riedl, Allan Baumer, Daniel Fuller, Kurt Luther, and Celia Pearce. 2009. An empirical study of cognition and theatrical improvisation. In *Proceedings of the seventh ACM conference on Creativity and cognition*. 117–126.
[44] Wenji Mao and Jonathan Gratch. 2004. Social judgment in multiagent interactions. In *Proceedings of the Third International Joint Conference on Autonomous Agents and Multiagent Systems-Volume 1*. 210–217.
[45] Stacy Marsella, Jonathan Gratch, Paolo Petta, et al. 2010. Computational models of emotion. *A Blueprint for Affective Computing-A sourcebook and manual* 11, 1 (2010), 21–46.
[46] Michael Mateas and Andrew Stern. 2003. Façade: An experiment in building a fully-realized interactive drama. In *Game developers conference*, Vol. 2. 4–8.
[47] Electronic Arts Maxis. 2003. The Sims.
[48] Philipp Mayring. 2004. Qualitative content analysis. *A companion to qualitative research* 1 (2004), 159–176.
[49] Josh McCoy, Mike Treanor, Ben Samuel, Michael Mateas, and Noah Wardrip-Fruin. 2011. Prom Week: social physics as gameplay. In *Proceedings of the 6th International Conference on Foundations of Digital Games*. 319–321.
[50] Josh McCoy, Mike Treanor, Ben Samuel, Aaron A Reed, Noah Wardrip-Fruin, and Michael Mateas. 2012. Prom week. In *Proceedings of the International Conference on the Foundations of Digital Games*. 235–237.
[51] Josh McCoy, Mike Treanor, Ben Samuel, Brandon Tearse, Michael Mateas, and Noah Wardrip-Fruin. 2010. Comme il Faut 2: A fully realized model for socially-oriented gameplay. In *Proceedings of the Intelligent Narrative Technologies III Workshop*. 1–8.
[52] Mary L McHugh. 2012. Interrater reliability: the kappa statistic. *Biochemia medica: Biochemia medica* 22, 3 (2012), 276–282.
[53] James R Meehan. 1977. TALE-SPIN, An Interactive Program that Writes Stories.. In *Ijcai*, Vol. 77. 91–98.
[54] Matthew B Miles, A Michael Huberman, Michael A Huberman, and Michael Huberman. 1994. *Qualitative data analysis: An expanded sourcebook*. sage.
[55] Monica K Miller and Alicia Summers. 2007. Gender differences in video game characters' roles, appearances, and attire as portrayed in video game magazines. *Sex roles* 57, 9 (2007), 733–742.
[56] Molleindustria. 2014. To Build a Better Mousetrap. https://www.molleindustria.org/to-build-a-better-mousetrap/
[57] David L Morgan. 1993. Qualitative content analysis: a guide to paths not taken. *Qualitative health research* 3, 1 (1993), 112–121.
[58] Hannah Morrison and Chris Martens. 2018. Making First Impressions: A Playable Model of Cross-Cultural Trust Building.. In *INT/WICED@ AIIDE*.
[59] Jason J Morrissette. 2017. Glory to Arstotzka: Morality, rationality, and the iron cage of bureaucracy in Papers, Please. *Game Studies* 17, 1 (2017).
[60] Bernard Moulin and Chaib-Draa Brahim. 1996. An Overview of Distributed. *Foundations of distributed artificial intelligence* 9 (1996), 1.

[61] Graham Nardone. 2014. The Sims 4: Colors, Objects, Clothing & Emotions. https://simsvip.com/2014/01/08/sims-4-colors-objects-clothing-emotions/
[62] StrategyWiki Nintendo. 2001. Animal Crossing - StategyWiki. https://strategywiki.org/wiki/Animal_Crossing
[63] Nintendo EAD. [n.d.]. Animal Crossing Franchise. https://animal-crossing.com/
[64] Helen Nissenbaum. 2001. How computer systems embody values. *Computer* 34, 3 (2001), 120–119.
[65] Julie Porteous, Marc Cavazza, and Fred Charles. 2010. Narrative generation through characters' point of view.. In *AAMAS*. Citeseer, 1297–1304.
[66] W James Potter and Deborah Levine-Donnerstein. 1999. Rethinking validity and reliability in content analysis. *Academia.org* (1999).
[67] David V Pynadath and Stacy C Marsella. 2005. PsychSim: Modeling theory of mind with decision-theoretic agents. In *IJCAI*, Vol. 5. 1181–1186.
[68] Matteo G Richiardi, Roberto Leombruni, Nicole J Saam, and Michele Sonnessa. 2006. A common protocol for agent-based social simulation. *Journal of artificial societies and social simulation* 9 (2006).
[69] David L Roberts and Charles L Isbell. 2007. Desiderata for managers of interactive experiences: A survey of recent advances in drama management. In *Proceedings of the First Workshop on Agent-Based Systems for Human Learning and Entertainment (ABSHLE 07)*.
[70] James A Russell. 2003. Core affect and the psychological construction of emotion. *Psychological review* 110, 1 (2003), 145.
[71] James Ryan. 2016. Diegetically grounded evolution of gameworld languages. *Proc. Procedural Content Generation* (2016).
[72] James Ryan, Tyler Brothers, Michael Mateas, and Noah Wardrip-Fruin. 2016. Juke joint: characters who are moved by music. In *Twelfth Artificial Intelligence and Interactive Digital Entertainment Conference*.
[73] James Owen Ryan, Adam Summerville, Michael Mateas, and Noah Wardrip-Fruin. 2015. Toward characters who observe, tell, misremember, and lie. In *Eleventh Artificial Intelligence and Interactive Digital Entertainment Conference*.
[74] James Owen Ryan, Adam Summerville, Michael Mateas, and Noah Wardrip-Fruin. 2015. Toward characters who observe, tell, misremember, and lie. In *Eleventh Artificial Intelligence and Interactive Digital Entertainment Conference*.
[75] Ben Samuel, Aaron A Reed, Paul Maddaloni, Michael Mateas, and Noah Wardrip-Fruin. 2015. The ensemble engine: Next-generation social physics. In *Proceedings of the Tenth International Conference on the Foundations of Digital Games (FDG 2015)*. 22–25.
[76] Roger C Schank and Robert P Abelson. 2013. *Scripts, plans, goals, and understanding: An inquiry into human knowledge structures*. Psychology Press.
[77] Phoebe Sengers, Kirsten Boehner, Shay David, and Joseph'Jofish' Kaye. 2005. Reflective design. In *Proceedings of the 4th decennial conference on Critical computing: between sense and sensibility*. 49–58.
[78] Daniel Shapiro, Karen Tanenbaum, Josh McCoy, Larry LeBron, Craig Reynolds, Andrew Stern, Michael Mateas, Bill Ferguson, David Diller, Kerry Moffitt, et al. 2015. Composing social interactions via social games. In *Proceedings of the 2015 International Conference on Autonomous Agents and Multiagent Systems*. 573–580.
[79] Mei Si, Stacy C. Marsella, and David V. Pynadath. 2005. Thespian: Using Multi-Agent Fitting to Craft Interactive Drama. In *Proceedings of the Fourth International Joint Conference on Autonomous Agents and Multiagent Systems* (The Netherlands) *(AAMAS '05)*. Association for Computing Machinery, New York, NY, USA, 21–28. https://doi.org/10.1145/1082473.1082477
[80] Charles Stangor. 2020. Defining Social Psychology: History and Principles. *Principles of Social Psychology-1st International Edition* (2020).
[81] Cory Stieg. 2020. Why video games like The Sims and Animal Crossing are so soothing right now. https://www.cnbc.com/2020/03/24/psychological-benefits-of-the-sims-animal-crossing-during-covid-19.html
[82] Alina Striner, Sasha Azad, and Chris Martens. 2019. A Spectrum of Audience Interactivity for Entertainment Domains. In *International Conference on Interactive Digital Storytelling*. Springer, 214–232.
[83] Ludeon Studios. 2018. Rimworld.
[84] David Thue and Vadim Bulitko. 2018. Toward a unified understanding of experience management. In *Fourteenth Artificial Intelligence and Interactive Digital Entertainment Conference*.
[85] Julian Togelius, Georgios N Yannakakis, Sergey Karakovskiy, and Noor Shaker. 2013. Assessing believability. In *Believable bots*. Springer, 215–230.
[86] Predrag T Tosic and Gul A Agha. 2004. Towards a hierarchical taxonomy of autonomous agents. In *2004 IEEE International Conference on Systems, Man and Cybernetics (IEEE Cat. No. 04CH37583)*, Vol. 4. IEEE, 3421–3426.
[87] Mike Treanor, Josh McCoy, and Anne Sullivan. 2015. Social play in non-player character dialog. In *Proceedings of the AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment*, Vol. 11.
[88] Stephen G Ware, Edward T Garcia, Alireza Shirvani, and Rachelyn Farrell. 2019. Multi-agent narrative experience management as story graph pruning. In *Proceedings of the AAAI Conference on Artificial Intelligence and Interactive*

Digital Entertainment, Vol. 15. 87–93.
[89] Gary Weaver. 2013. *Intercultural Relations: Communication, Identity, and Conflict.* Pearson Learning Solutions.
[90] Robert S Weiss. 1991. The attachment bond in childhood and adulthood. *Attachment across the life cycle* 8 (1991), 66–76.
[91] Jess Whittlestone, Rune Nyrup, Anna Alexandrova, Kanta Dihal, and Stephen Cave. 2019. Ethical and societal implications of algorithms, data, and artificial intelligence: a roadmap for research. *London: Nuffield Foundation* (2019).
[92] Michael Wooldridge and Nicholas R Jennings. 1994. Agent theories, architectures, and languages: a survey. In *International Workshop on Agent Theories, Architectures, and Languages*. Springer, 1–39.
[93] Georgios N Yannakakis and Ana Paiva. 2014. Emotion in games. *Handbook on affective computing* 2014 (2014), 459–471.
[94] R Michael Young, Stephen G Ware, Brad A Cassell, and Justus Robertson. 2013. Plans and planning in narrative generation: a review of plan-based approaches to the generation of story, discourse and interactivity in narratives. *Sprache und Datenverarbeitung, Special Issue on Formal and Computational Models of Narrative* 37, 1-2 (2013), 41–64.
[95] Goranka Zoric, Karlo Smid, and Igor S Pandzic. 2007. Facial gestures: taxonomy and application of non-verbal, non-emotional facial displays for embodied conversational agents. *Conversational Informatics: An Engineering Approach* (2007), 161–182.

Received February 2021; revised June 2021; accepted July 2021