A Common Model for Representing Stories in Automatic Storytelling

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Abstract. The present paper proposes a common representation model that allows the free exchange of knowledge between different story generation systems as a base for a collaborative environment to run an enhanced process of literary creation. In addition to this objective, this model aims at the development of a story representation formalism for creating a common knowledge base that can be fed in the future with the outcomes of new storytelling systems, without the need to adapt it to every system-specific representation model.

Keywords: computational creativity, story generation systems, knowledge representation, formal languages

1 Introduction

Automatic story generation is a part of a wider research area in Artificial Intelligence named Computational Creativity (CC), which is the pursuit of creative behaviour in machines [28]. A story generator algorithm (SGA) refers to a computational procedure resulting in an artefact that can be considered a story [9]. The term story generation system can be considered as a synonym of storytelling systems, that is, a computational system designed to tell stories.

Story generation systems are faced with a significant challenge of acquiring knowledge resources in the particular representation formats that they use. They face an inherent difficulty when using formal languages in the detachment between the formulation of the needs in the real world and its representation in a formal construction. These difficulties are increasingly greater when the systems participate in a co-creation model with humans [6]. The co-creation process in the context of Computational Creativity implies the involvement of several systems and humans working together in an iterative cycle of enhancement.

The present paper introduces a model for expressing knowledge related to the domain of narrative. The goal of this formalism is to ease the interchange of information between different story generation systems operating in a collaborative ecosystem. Its purpose is to establish a co-creation cycle inside an architectural model that allows the involved systems to take advantage of the shared knowledge model and use it for enhancing the quality of the generated texts.

2 Background

This section reviews the way story generation systems represent the knowledge they need to create stories. The existence of commonalities across the existing systems is necessary to establish a shared model for knowledge representation.

TALE-SPIN [17] was basically a planning solver that wrote up stories by narrating the steps performed for achieving the characters' goals. TALE-SPIN stories were set in a forest. The system took as input a collection of characters with their corresponding goals, and generate a sequence of steps while resolving them. After that, it wrote up a story narrating the steps performed for achieving those goals. TALE-SPIN knowledge representation relied heavily on Conceptual Dependency Theory [25], and it represented the problem domain using a set of primitives, expressed in a formal language.

Author [7] was the first story generator to include the author intentionality as a part of the story generation process. Dehn considered that stories were a retrospective justification for a plot conceived in authors mind. For this reason, Author tried to emulate a real writer's mind. The process considered that there were underlying objectives driving the storytelling process, even when the author had not clearly expressed them. From an architectural point of view, Author was a planner, but, unlike TALE-SPIN, it used the planning to fulfill authorial goals instead of character goals. During story generation, Author built iteratively the plot for better meeting the goals of the author, that could also be readjusted in every iteration after a reviewing stage.

Mexica [21] was developed as a computer model whose purpose was studying the creative process. It generated short stories about the early inhabitants of Mexico. Mexica was a pioneer in that it took into account emotional links and tensions between the characters as a means for driving and evaluating ongoing stories. Mexica knowledge management could be considered complex and sophisticated. Its knowledge base included several types of structures for representing things like characters relationships, actions, emotional links, and a literary base composed of previously generated stories.

Thespian [26] introduced a richer representation of characters subjectivity by modelling their beliefs. Every character had a representation of their own beliefs about the story world, and those beliefs could even be false. This feature made characters could reason about the way the others see the world.

Fabulist [23] is a complete architecture for automatic story generation and presentation. It combines an author-centric approach together with a representation of characters intentionality, and an open-world planning for creating highly believable stories. Fabulist has been designed to enable story generation with little prior knowledge built into the system [24]. This feature was intended to allow Fabulist to generate stories of types that were not anticipated by the systems creator. Thus, Fabulist includes among its goals plot coherence and character believability when performing story generation.

STellA (Story Telling Algorithm) [15] is a story generation system that mixes a non-constrained simulation-based production of world states and narrative actions as source material for a conceptual space exploration engine. The system

manages states in a non-deterministically generated space of partial stories, making choices until it finds a satisfactory simulation of events progression of the simulations that is rendered as a story.

 PropperWryter [10, 11] is a story generation system that creates russian folktales according to Propp's generation rules [22]. These rules provide a very clear description of how the folktales morphology could be used for story generation. It uses a set of abstractions for representing the essential concepts defined by Propp, especially the character function, and defines a procedure that first chooses a sequence of character functions to act as abstract narrative structure to drive the process, and then progressively selects instantiations of these character functions in terms of story actions to produce a conceptual representation of a valid story.

Charade [18] is an affinities-based story generation system which generates stories after simulating the evolution of a relationship between two characters using their mutual affinities, and operating as decoupled as possible from the story domain. This system is an agent-based architecture developed using JADE.

In addition to these single storytelling systems, Slant [20] must be considered as an example of storytelling systems interoperating for producing a enhanced outcome. It is a complete architecture for creative story generation that integrates different types of story generation systems. Its architecture is the result of the integration of several different components: one based on Mexica [21], one based on GRIOT [13] , and a new system specifically developed for Slant.

Slant represents the story in a shared data structure, according to the blackboard architectural pattern. This resource allows the participating storytelling systems and components to create stories collaboratively. The goal is to allow the systems to influence each other for generating an enhanced result. The blackboard architecture and the Slant story XML format that is used, open up new possibilities for collaboration between creative literary systems, allowing models of creativity to be developed and added in different configurations.

The process for generating stories in Slant begins with minimal, partial proposals from a simple unit, named the Seeder [20]. In turn, the subsystems MEXICA, Verso, and Fig-S read and complete the set of proposals, each according to its focus. When they have finished the processing, the enhanced story specification is sent to GRIOT-Gen so conceptual blending can be applied to the relevant templates and then to the text generation component of Curveship. Finally, Curveship-Gen generates a finished story in natural language, delivered as a text file that can be read and considered by human readers.

3 Statement of the problem

To enable a better understanding of the problem, let us consider how to develop an automatic story generation system that could generate a story like "War and peace" [27]. This novel tells the story of the Napoleonic invasion of Russia and its impact on Russian society through the stories of five Russian aristocratic families. The novel is a truly monumental work, containing several chapters de-

voted to philosophical disquisitions, detailed military strategy scenes, and a rich description of the emotional evolution of the characters. From an anthropological perspective, it provides a complete historical and cultural context.

In the light of the above, creating such a system would be a formidable challenge. Considering the capabilities of the existing storytelling systems, the target generator should be able to operate at different levels of detail and resolve many interwoven subplots. For example, when generating the narration of the war, the system should create a detailed description of the movements carried out by the Napoleonic army on Russian territory, and the corresponding response of the Russian generals. To do this, it would need to focus on strategy, with a discourse aimed at describing the movements of troops, the relationships between the actions of the Napoleonic army and the countermeasures of the Russian army, the activity of the convoys of military supplies, the terrain difficulties, and finally, a detailed description of the battles fought during the campaign. In such type of narration there is no room for long dialogues, nor for focusing on individual thoughts or feelings. Narrative resources are aimed at representing the complete picture of events. The detail is used in the description of the facts and the scenarios in which they take place.

On the other hand, to develop the story of the relationships between the characters that take place during the war, it would require the system to be able to simulate the various characters involved, their feelings, their intentions, their social norms and their actions. The interaction between the characters would lead to changes in mutual perception and feelings. To convey all this evolution, it would be necessary to resort to witty dialogues, in which the characters reveal their feelings and intentions, or to minutely narrated scenes that show how they behave. Of course, a believable love story can only be achieved by employing a good amount of knowledge about every single character. This knowledge includes a complete psychological portrait, which allows a deep understanding of its motivations, a proper representation of the historical context, and many other aspects related to the characters' consistency.

The above examples do not exhaust the list of requirements. In a novel like "War and peace" there are multiple aspects that would require of a specific processing in a storytelling system. To mention some of them: the thematic aspects require a simulation model centred on the intentions of the author; the description of a duel requires a simulator of physical world; and a philosophical reflection about the status of the servants requires a reasoning engine that includes knowledge concerning the social context in nineteenth-century Russia.

It seems quite difficult to generate such a novel with a single storytelling system. The prior example just tries to pose a question about the complexity of working at different levels of knowledge representation. The simplest way of creating rich and complex stories is using different systems, generating different types of content according to their capabilities.

The existence of different story generators, each with a different approach not only to how to identify the next action to continue an existing draft, but also to how to evaluate the quality of a partial draft requires the definition of

a specific interaction protocol to guide the way they collaborate among them to create a single consensus draft. The context of the interaction would be a set of story drafts that are being developed over a sequence of interactions. As such, every draft contains a fusion of the information provided by the various generators, represented in the shared format.

4 Methodology

From a methodological point of view, this paper focuses on identifying the dimensions considered by the knowledge managed by storytelling systems. The strategy being followed was originally outlined in a previous paper [5]. A set of dimensions was selected for identifying the common aspects in the representation of knowledge in storytelling systems.

The representation model is strongly influenced by the components of narrative identified in the classic Narratology [2] [1]. Narratology is a humanities discipline dedicated to the study of the logic, principles, and practices of narrative representation [16]. Its concepts and models are widely used as heuristic tools, and narratological theorems play a central role in the exploration and modeling of our ability to produce and process narratives in a multitude of forms, media, contexts, and communicative practices.

In order to clarify the developed model, it is necessary to set out the main concepts that come into play. The following definitions are based on those established by the traditional literature [2] [1]:

Narrative is considered as a story articulated in a discourse. It is a complex concept, which involves several components itself.

Story is the content of the narration; it includes what happens, namely, the plot, and the space in which the action occurs.

Space includes the characters, settings, props and anything which is present either physically or abstractly in the space of the narrative —that is to say, the existents. Because existents change and evolve over time, the space also consists of an initial state which contains the set of all existents' states as they exist before the start of the plot.

Plot is the basic structure of any story. A plot is a set of events with an overall structure which represents both the temporal ordering, and the causal relations between the events. Events typically consist of one or more low-level actions, instigated by and/or affecting a number of entities in the space. The concept of plot encompasses the ways in which the events and characters' actions in a story are arranged and how this arrangement in turn facilitates identification of their motivations and consequences.

Discourse is the particular mean of telling a story. This may include several aspects such as the narrator's perspective, the ordering and duration of the events in the plot, etc.

Apart from these high level concepts, that constitute the roots of the model, there are other relevant concepts that have been considered due to its importance in this representation model. The representation of the characters is one of them.

According to Jannidis [16], there are three forms of relevant knowledge for the narratological analysis of the characters:

– The basic type, which provides a very fundamental structure for those entities which are seen as sentient beings.
– The character models or types —that is to say, character stereotypes.
– An encyclopedic knowledge of human beings behaviour, ranging from everyday situations knowledge to any other relevant knowledge that could contribute to the process of characterization.

The proposed representation model considers these three levels, covering totally the two first, and partially the third one.
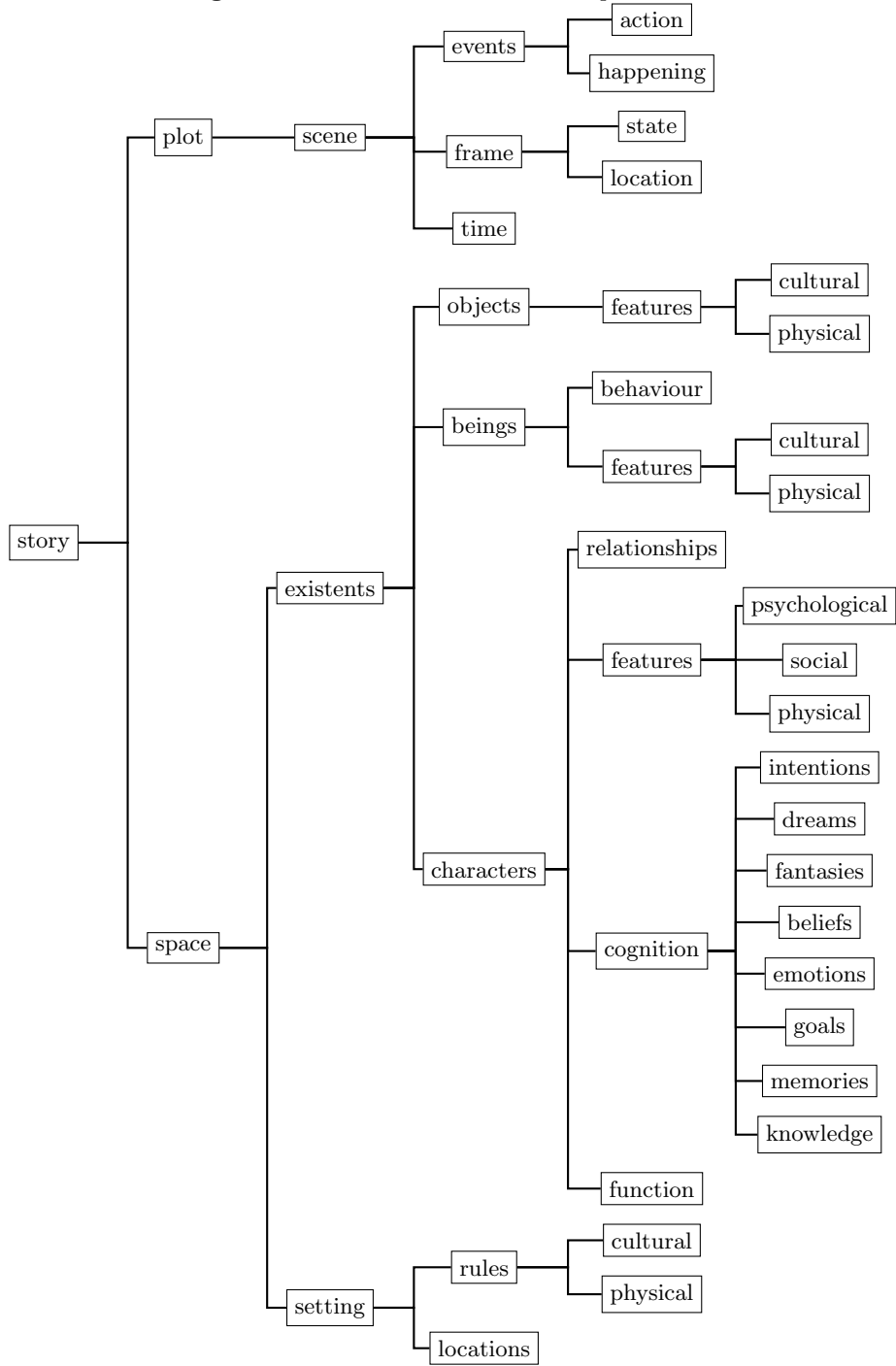
Another key concept is the narrative space, that goes further than the representation of a world in terms of a simple container for existents and a location for events. Resorting again to narratology, we have considered five levels [16] for modelling the narrative space:

– Spatial frames: the immediate surroundings of actual events. Spatial frames are shifting scenes of action, and they may flow into each other. They are hierarchically organized by relations of containment, and their boundaries may be either clear-cut or fuzzy.
– Setting: the general socio-historic-geographical environment in which the action takes place. In contrast to spatial frames, this is a relatively stable category which embraces the entire text.
– Story space: the space relevant to the plot, as mapped by the actions and thoughts of the characters. It consists of all the spatial frames plus all the locations mentioned by the text that are not the scene of actually occurring events.
– Narrative (or story) world: the story space completed by the reader's imagination on the basis of cultural knowledge and real world experience.
– Narrative universe: the world (in the spatio-temporal sense of the term) presented as actual by the text, plus all the counterfactual worlds constructed by characters as beliefs, wishes, fears, speculations, hypothetical thinking, dreams, and fantasies.

5   Proposed model

If we analyse in detail the existing storytelling systems, two conclusions can be reached regarding knowledge representation [5]. On the one hand, the knowledge related to the story generation process is inherently ad hoc, and consequently hardly exportable from one system to another. On the other hand, we can observe that there is a common element for every storytelling system that can be interchanged, the generated story. By means of a careful analysis of the structure of the stories, the common elements arises. The resulting representation model is summarized in Figure 1.

Fig. 1. The structure of the common representation

```
story
├── plot
│   └── scene
│       ├── events
│       │   ├── action
│       │   └── happening
│       ├── frame
│       │   ├── state
│       │   └── location
│       └── time
└── space
    ├── existents
    │   ├── objects
    │   │   └── features
    │   │       ├── cultural
    │   │       └── physical
    │   ├── beings
    │   │   ├── behaviour
    │   │   └── features
    │   │       ├── cultural
    │   │       └── physical
    │   └── characters
    │       ├── relationships
    │       ├── features
    │       │   ├── psychological
    │       │   ├── social
    │       │   └── physical
    │       ├── cognition
    │       │   ├── intentions
    │       │   ├── dreams
    │       │   ├── fantasies
    │       │   ├── beliefs
    │       │   ├── emotions
    │       │   ├── goals
    │       │   ├── memories
    │       │   └── knowledge
    │       └── function
    └── setting
        ├── rules
        │   ├── cultural
        │   └── physical
        └── locations
```

The model has been designed in a hierarchical structure, in which the root concept is the **story**. A story represents what both intuitively and narratologically can be considered a story, that is, a narration of events happening in a setting. It is composed by the two classic narratological components: the plot and the space.

The **plot** is represented as a sequence of scenes. A **scene** is conceptually related to the division of a play, that represents a single episode inside the plot. It is clearly conditioned by the time division, which means that is a sequence of events that happen during a time frame. From a spatial point of view, it is also constrained to take place in a single spatial frame —considering the spatial frame definition mentioned before. So, the scene is composed by a sequence of **events**, that can be actions or happenings. An **action** is an act performed by one or more characters in the story, generating consequences. The resulting consequences of every action are expressed as a modification in the global state of the space —considering it as the whole setting and the existents. A **happening** is an event that happens in the plot, as an accident or as a consequence of a prior action or happening. A happening can be natural —it rains— or artificial —a car accident.

The **space** encompasses the whole universe in which the plot is developing. It is composed by the setting and the existents. The **existents** are the whole set of actors that take a part in the story. They can be characters, living beings —an animal—, and an object in the setting. The two last types are mainly defined by their physical features and their cultural significance in the story. The **characters** are the most relevant, and also the most complex to represent, elements in the story. The proposed model considers not only their physical, psychological and social features, but also their cognitive-related characteristics. The cognition of the characters is represented in a very detailed manner due to its importance for ensuring story consistency and characters liability. The aspects considered have been chosen after analysing those used by the existing storytelling systems [26, 15, 7, 14, 19, 21] and theoretical studies about Narrative [1, 16]. So, the representation of cognition includes the following facets:

- Goals: The goals are the results or achievements toward which the character effort is directed. The model considers two types of goals: conscious and unconscious. In the first case, the character is aware of them, in the second, they drive the character's actions, but he/she is not aware of them.
- Intentions: The intentions refer to the general plan that every character has, and the drive for his/her actions.
- Knowledge: Despite the characters act and interact in the same space, every single character could have different levels of knowledge concerning it. That means that the characters are not considered to be omniscient. This knowledge can evolve over the time, so characters can be acquiring or discarding knowledge as the story develops.
- Memories: Unlike the general knowledge, the memories refer to some past situations that have relevance in the story. For example, a memory can be referred to a past scene in which the character took part.

- Beliefs: The beliefs are a very subjective part of every character's cognition. They refer to facts about the world which the character considers as axioms, regardless of they are true. They can be part of the character's cultural or religious code, or simply originate in a particular misconception of the world.
- Dreams: The dreams represent the unconscious aspirations of the character. He/she may not be aware of them, but they can operate at a subconscious level and inspire his/her intentions.
- Fantasies: The fantasies are product of characters' imagination. They are beliefs or notions based on no solid foundation, a fact which the character is perfectly aware of. They represent aspirations that the character considers unreachable, but he/she enjoys thinking about them.
- Emotions: The emotions are related to the feelings of the character. They are usually influenced by the relationships that the character establishes with the others, and the evolution of them during the story.

Another relevant element of character's representation is the **function**. Although many approaches treat characters as entities subject to specific rules that interact in a simulated story world, there is another important line of thought in the treatment of characters: the functional view. In this perspective, pioneered by Aristotle [12] and followed by contemporary authors such as Propp [22], characters are subordinate to the narrative action. There are storytelling systems [10] that describe characters in terms of a structure based on their roles in the plot. Hence, the function tag refers to this approach and provides a way for defining the functional role of the character in the underlying structure of the story.

The **setting** is a combination of a set of physical —or virtual— locations in which the action of the story takes place, and the set of cultural and physical rules that govern the story world. The **locations** can be considered the scenario in which every scene that composes the plot takes place. So, as shown in the model, every scene links to its corresponding location.

6 Application

The model presented before aims at providing a reliable way of interchanging knowledge between different story generation systems, each of them using its own inner representation model.

The application of this model must necessarily rely on an architecture which combines different storytelling systems. For that purpose, it has been proposed a service-oriented architecture[4, 3] that combines three existing story generation systems: STellA (Story Telling Algorithm) [15], PropperWryter [10, 11], and Charade [18]. The involved systems will be adapted for packaging their basic functionalities as microservices that publish their capabilities as REST-based API [8]. This target architecture is summarized by Figure 2.

Every service will understand and generate messages for communicating with the others. The inner story generation processes of every system are unlikely to be interchangeable, but not the final product: the story. To this end, the proposed representation model is centred on the story, that is the common element among
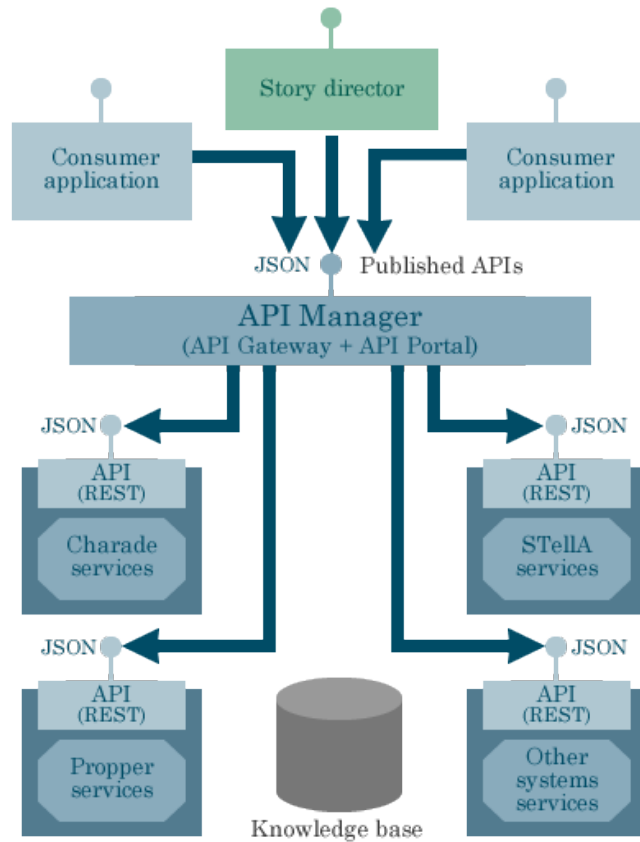
Fig. 2. Architecture of the proposed system.

the various systems. Therefore, by means of the common model it is possible to establish an iterative cycle of story generation, in which every service contributes to the story by generating a part of it. This way, the ability of PropperWryter is to develop the general scheme of the story, while STellA can provide a detailed simulation of the different scenes, and Charade describes the evolution of the relationships between the characters. All the required information for achieving this can be represented by means of the common model.

7 Conclusions

The model presented along this paper is based on the analysis of the knowledge required by existing storytelling systems. It tries to establish a baseline for make easier the interchange of knowledge between different story generation systems, and make possible the generation of richer and higher-quality stories by combining the capabilities of several systems.

In order to avoid to affect the internal story generation process of every participating system, the proposed model focuses on the product, that is the story. This approach seems to be the most convenient for keeping the common representation agnostic from the specifics of each system.

This knowledge representation model requires to be complemented by a architectural model which allow the development of a collaborative generation process involving various storytelling systems. Future work involves the development of a test field for this model, which allow to refine it and overcome its flaws. Currently, the authors are working in the target architecture, which involves the development of a storytelling ecosystem based on the referred systems —STellA, PropperWryter and Charade— as a benchmark for applying the common representation model.

Some of the essential points that will need to be evaluated are those related to knowledge consistency between systems, the possible degradation of the semantics, and the loss of relevant information during the communication between the participating systems. We considered that the future work on the proposed storytelling ecosystem will allow a complete study of these concerns, and also the improvement of the model to guarantee that the final result covers all the specified objectives.

Acknowledgements

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