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การออกแบบออนโทโลยีสำหรับการเขียนบทภาพยนต์แอนิเมชั่นเพื่อการเรียนรู้องค์ประกอบที่สำคัญและความสัมพันธ์ระหว่างองค์ประกอบ

A Design of an Ontology for Animation Scripts Writing Towards the Learning of Necessary Elements and Relationship Among Them

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Abstract

Purpose: This research aims to develop an ontology for interoperable of basic knowledge of essential elements in animation script according to story-telling theory in a form of an ontology. The ontology is for helping the students to realize and clearly map their thought to the predefined schema towards the completion and reasonable of idea and design.

Methodology: The knowledge of script writing theory is extracted and represented as ontological concepts. The concepts involve story structure of the scripts including characters and their relationship, events with the cause and effect, and overall themes and settings. The instances are then generated into a knowledge graph of the script to represent the core story and its elements. Furthermore, SPARQL can be applied to the instances to query them logically based on the designed ontology schema. The ontology is evaluated by 3 ontology experts and 3 animation script experts. For the test, we asked 4 instructors to make queries for testing the potential of the application. There were 16 items to test searching performance of application. The data comes from student animation scripts that were collected as samples for 350 search chapters.

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Findings: This research findings ontology as a schema for animation script design. The ontology captures the elements necessary for many aspects of story design, including character details in terms of setting and relationship events based on the play of the script to link the story in the desired direction and overall settings. Based on expert evaluation results, the conciseness and accuracy obtained the highest assessment for 4.67 and 4.5. In overall, the evaluation is in good results.

Applications of this study: The ontology is applicable as a knowledge base for a script writing supporting tool to help learning of animation script writing. The tool helps students to be aware of their idea as elements are segmented into concepts of different categories for clarification. Furthermore, the instances following the ontology schema can be semantically queried for statistical study including trend of story style, trend of genre, and similarity checking of the script content in abstract level.

Keywords: Ontology, Scripts writing, Animation script elements, Learning supporting tool

บทคัดย่อ

วัตถุประสงค์: งานวิจัยนี้มีวัตถุประสงค์เพื่อพัฒนาออนโทโลยีสำหรับแสดงความรู้พื้นฐานเกี่ยวกับองค์ประกอบที่จำเป็นในการเขียนสคริปต์แอนิเมชั่นตามทฤษฎีการเล่าเรื่อง เพื่อช่วยให้นักศึกษาเข้าใจบริบทและจับคู่ร่วมกันระหว่างความคิดของตนกับแผนผังที่เหมาะสมได้อย่างชัดเจน

วิธีการศึกษา: การสกัดองค์ความรู้เกี่ยวกับทฤษฎีการเขียนบทจะถูกนำเสนอผ่านแนวความคิดของออนโทโลยี โครงสร้างดังกล่าวจะนำองค์ประกอบของเรื่องราว ตัวละคร ความสัมพันธ์ของตัวละคร ธีม และเหตุการณ์หรือผลกระทบมาสร้างเครือข่ายความสัมพันธ์ ข้อมูลอินสแตนซ์จะถูกแสดงในรูปแบบกราฟความรู้ของการเขียนบทภาพยนตร์เพื่อนำเสนอเรื่องราวและองค์ประกอบหลักๆของเนื้อเรื่อง นอกจากนี้ได้ประยุกต์นำข้อมูลเพื่อมาสืบค้นค้นอินสแตนซ์โดยใช้ SPARQL ตามสคีม่าของออนโทโลยีที่ออกแบบไว้ ออนโทโลยีได้รับการประเมินโดยผู้เชี่ยวชาญด้านออนโทโลยี 3 คน และผู้เชี่ยวชาญด้านสคริปต์แอนิเมชั่น 3 คน สำหรับการทดสอบกำหนดให้อาจารย์ 4 คนทำการทดสอบศักยภาพของแอปพลิเคชัน โดยการสืบค้นข้อมูล 16 รายการเพื่อทดสอบประสิทธิภาพการค้นหา สำหรับข้อมูลมาจากสคริปต์แอนิเมชันของนักศึกษาที่ถูกเก็บรวบรวมไว้เป็นตัวอย่างสำหรับการสืบค้นจำนวน 350 บท

ข้อค้นพบ: งานวิจัยนี้ได้ออนโทโลยีในรูปแบบสคีมาสำหรับการออกแบบสคริปต์แอนิเมชั่น ออนโทโลยีรวบรวมองค์ประกอบที่จำเป็นสำหรับแง่มุมต่างๆ ของการออกแบบเรื่องราว รวมถึงรายละเอียดของตัวละครในแง่ของการตั้งค่าและความสัมพันธ์ เหตุการณ์ตามบทละครเพื่อเชื่อมโยงเรื่องราวในทิศทางที่ต้องการ

และการตั้งค่าโดยรวม จากผลการประเมินของผู้เชี่ยวชาญ ความกระชับและความถูกต้องได้รับการประเมินสูงสุดสำหรับ 4.67 และ 4.5 โดยรวมถือว่าได้ผลดี

การประยุกต์ใช้จากการศึกษานี้: การใช้องค์ความรู้พื้นฐานออนโทโลยีร่วมกับเครื่องมือสนับสนุนการเขียนบทภาพยนตร์จะช่วยนักศึกษาในการเรียนรู้และตระหนักถึงกระบวนความคิดในการเขียนบทภาพยนตร์ตามรายบุคคล เนื่องจากองค์ประกอบที่สำคัญได้ถูกแบ่งอย่างชัดเจน นอกจากนี้การสืบค้นข้อมูลผ่านอินสแตนซ์ตามโครงสร้างออนโทโลยีสามารถสืบค้นข้อมูลเชิงความหมายเพื่อใช้สำหรับศึกษาข้อมูลทางสถิติ แนวโน้มรูปแบบการเขียน แนวโน้มประเภทและการตรวจสอบความคล้ายคลึงของเนื้อหาบทภาพยนตร์ในระดับนามธรรม

คำสำคัญ: ออนโทโลยี บทภาพยนตร์ องค์ประกอบบทภาพยนตร์ เครื่องมือสนับสนุนการเรียนรู้

1. Introduction

The value of the worldwide entertainment and media market is around two trillion U.S. dollars for the year 2020. (Guttmann, 2022) Among the market, animation industry is expected to be worth around 270 billion trillion U.S. dollars in 2020. (José Gabriel Navarro, 2021) Animation is a highly anticipated and competitive business with consumers increasingly expecting higher quality graphics, better visual-effects, and more innovative content. Although the entertainment and media industry has witnessed a transformation from emerging technologies and applications in recent years to improve graphic and visual effect quality, most of the tasks greatly relies on humans who control the applications and tools. Especially, quality of animation content is significantly reflected from a combination of writer's imagination, strategic thinking, and storytelling ability.

With the demand on animation creators, universities and colleges have opened the animation and multimedia department for students to enroll and train to become a professional animation creator. One of the studying subjects is script writing. In learning, script writing is the most complicated one since it requires artistic systematic thinking and critical thinking. (Redvall, 2009) In the subject, theoretical concepts of script writing are taught such as essential components of a script, and types of scripts. In a class of the subject, it is common to have several assignments to submit a manuscript for short animation as practical training. Since students are novice on the task, their practice results are apparently incomplete and enigmatic. Moreover, script writing is a task of expressing ones' view and experience towards the world (Demorest & Alexander 1992); thus, the resulted scripts of students are fairly similar

to each other or to existing works. Furthermore, a task of scoring and analyzing weakness from student works is difficult and subjective.

Although the creation of animation scripts leans toward art and imagination, it is undoubtedly necessary for a script to be complete in terms of necessary elements as a basis. In this work, we aim to create an ontology to represent components of the animation scripts regarding theoretical concepts of animation script writing. The ontology will assist to explicate the underlying concepts and elements of a written script from a student so it is easier for students to follow the basics and for an instructor to understand what a student aiming to convey. In addition, with a clear ontological schema, scripts become easier to be analyzed and compared for similarity and grading. With an ontological structure, semantic-web based supporting services can also be applied such as SPARQL querying and inferencing via semantic-web rule language.

2. Purpose

The most common issues in learning of writing an animation script are underdeveloped plot, lack of escalation, and poor structure. Since writing the script is about one own creative idea and thought, students and amateur writers may miss necessary elements in composing process. Thus, this research aims to develop an ontology demonstrating the basic knowledge, which regards to the essential elements in animation script conforming to script-writing techniques in the storytelling theory. This work may help students to comprehend and to map their thought with the appropriate schema.

3. Backgrounds and Related Work

3.1 Basic Theory in Animation Script Writing

Fundamentally, a script for an animation is similar to a screenplay of other medias including movie and theater play as they share common elements (Scott, 2003). An animation script is a form of literary as it is intended to be interpreted by other such as producer, graphic designer, illustrator, and voice actor. Therefore, an animation script is not an end-product that audiences can directly enjoy. Apparently, an animation script is written using technical jargon and tight, spare prose when describing stage directions. (Marx, 2012) Unlike a novel or short story, an animation script focuses on describing the literal, visual aspects of the story, rather

than on the internal thoughts of its characters. Hence, the aim of script writing is to evoke thoughts and emotions through subtext, action, and symbolism.

The general script writing theory is an approach to organize the structure, goals and techniques of writing a script in a systematic fashion. (Boudreau, 2004) The common and widely used structure of a script is a 'three act structure'. (Khalili, 2018) The three acts include a setup (first act), a confrontation (second act), and a resolution (third act). Ratio of the acts is 25:50:25 percent for setup act, confrontation act, and resolution act, respectively.

3.1.1 The setup act is to establish and introduce the main characters, their relationships to other characters, and the world and its setting. In the later of the first act, an inciting incident, known as the first plot point, is launched to raise a dramatic question that will be answered in a later act for the climax.

3.1.2 The confrontation act features the main characters and their attempt to resolve the problem from the first turning point. In this act, character development is introduced with the aid of other characters.

The resolution act gives the resolution of the story. In this act, a climax is mentioned as a sequence of the story ss brought to the most intense point and an answer to the given dramatic question.

Besides the common 'three act structure', four or five acts are also proposed, but they are more complex and not suitable for novice script writers. Hence, this work focuses on gathering concepts related to the 'three act structure'.

For elements in an animation script, this depends on the respective act. However, the common elements are such as characters and their characteristics, locations of the stage, time of the scene, and major incidents of the story. These elements should not be in conflict to prevent a mazy viewpoint, and they should be carefully designed to logically relate to one another. The quality of a script is normally assessed by scriptwriting rubric (Gutierrez, 2014)

3.2 Related Work

In this part, we studied into two topics. First, we look into the use of an ontology to representing abstract concepts. Second, we study the works on the information technology field related to script writing.

An ontology has been used in many fields of domains. This work relates to representation of abstract concepts from an animation script. Thus, we survey similar works towards conceptualizing the abstract idea into formal representation and summarize them as follows.

Table 1 Information related work to script writing

Title	domain and scope	main objective/usage
Development of the Belief Culture Ontology and Its Application: Case Study of the GreaterMekong Subregion (Chansanam et al., 2014)	Imaginary beings in folklores and tales in GreaterMekong Subregion	to realize relationship between imaginary beings and cultural heritage
OntoMedia: An Ontology for the Representation of Heterogeneous Media (Jewell et al, 2005)	Online amateur fiction including contents, and sound effects	to develop a shared vocabulary to annotate the collection of heterogeneous media
Representing Dramatic Features of Stories through an Ontological Model (Cataldi et al, 2011)	Narrative media in video, text, and audio	to develop an ontology to model dramatic features in narrative media
Ontology-Based Visualization of Characters' Intentions (Lombardo, & Pizzo, 2014)	Movie characters' actions and intentions	to develop the model for representing movie characters' actions and intentions
Thai Tattoo Wisdom's Representation of Knowledge by Ontology (Chansanam et al, 2021)	Belief within Thai Tattoo	to represent knowledge on Thai culture/belief hidden in a tattoo presentation

For existing systems related to support script writing, we found a few of works as follows. There are several tools for screenwriting. These tools provide an outline for writing a movie/ animation script and a screenwriting management for media production. WriterDuet (WriterDuet, 2021) is a free screenwriting web-based software, which allows authors real-time co-writing and get feedback online. Final Draft (Final Draft, 2013) is a screenwriting software highly used in the entertainment industry. It provides templates for screenplays, animation scripts, and television shows to assist in an initial writing process with the user interface to navigate. Furthermore, the tool has the capability of syncing with a production planning software. Fade In (Reese, & Olasky, 1989) is another tool for screenplay writing. It has

application interfaces for each part of scripts allowing writers to control page layout and appearance and collaboration writing online. These writing tools is a software to help on organizing scripts and formatting the work into standard format. It also allows authors to work together in collaboration. However, they are suitable for those already know of how to write a screenplay/script and ease the process of writing for authors. For script content analysis, Arnav Jhala (Jhala, 2008) proposed to use information within a structure and conventions of movie scripts as data for querying. The work focuses on automatically annotating information within movie scripts regarding narrative patterns, character direction, blocking, and camera control. The annotated data thus are used for information retrieval and text mining. The annotation process exploits a script standard structure of a content section format such as title, author, scene heading, dialogue, and scene transition. The work then attempts to apply language toolkits to tackle narrative details including conversation dialogue and action description for annotation.

From reviews, we learned that an ontology is a good representation that can conceptualize the implicit and abstract entities into a formal conceptual structure. With clear relations among well-defined concepts, knowledge can be shared and tangible for discussion. Despite the ability to form a concrete network of concepts for representing knowledge as a knowledge base for computers, the reviews indicate that there is no existing work to apply the concept relevant to animation script writing and its components to an ontology prior to this work. Since idea and concept of entities in content of script writing are very abstractive, they can become clearer if they are mapped with ontological schema in which should help in learning process of script writing in terms of completeness and relativeness of the idea. For the tools towards script writing, they are mainly for organizing the outline and providing comfortable environment on writing processes. They are not designed for author to learn on solidifying the idea or to ascertain completeness of required elements of the content. This work thus designs an ontology that can explain content-elements and relation among them in an animation script for students to be aware of necessary content entities and importance of solid setup idea. The instances of the ontology then can be used for querying and examining to compare to the existing scripts for referencing and obtaining inspiration of similar stories.

4. Methodology

In this section, we provide details of the ontology designed to represent knowledge of animation script writing as well as a set of instances of the ontology. Additionally, we give a demonstration on how to apply the ontology with semantic-web technologies to showcase the usefulness of the designed ontology in practice.

4.1 Design of Animation Script Ontology

This ontology is designed to represent domain knowledge of script writing for animation. Hence, concepts in this ontology are about elements in an animation script. We choose an ontology to represent the domain knowledge since it can help to define a common vocabulary in the domain to share and distinct information from the relevant concepts. One of the benefits of using ontology is to share common understanding of the structure of information among people or software agents (Musen 1992; Gruber 1993).

Based on the domain knowledge of script writing for script writing for animation, the base knowledge is from a structural form of 'three act structure'. Relevant concepts are extracted and assigned with their relations. Accordingly, we obtain ontological classes from the concepts and relations including object properties and data properties from relationships among these concepts. Details of the major ontology classes are given in Table 1 The ontology in a graph form to show relations of classes is illustrated in Figure 1.

Table 2 Details of the designed major ontology classes

Object Name	Type	Definition	Sub Items	Properties
Script	Class	A main division of a script following structural theory	First_Act Second_Act Third_Act	OP: has_incident [Event] OP: has_setting [Setting]
Character	Class	a live form in an animation	Main Character Mob Character	DP: has_name {string} OP: has_characteristic [Characteristic] OP: has_family-relation to [Character] OP: has_relation_to [Character] ...
Setting	Class	Place, Time, Condition, and	World_Type Time_Setting Location_Setting	- None

Table 2 Details of the designed major ontology classes

Object Name	Type	Definition	Sub Items	Properties
		Environment of a story	Specified_Setting	(Continued)
Event	Class	a noteworthy happening in a story		OP: involved_character [character] DP: located_in {string} OP: caused_by_prior_event [Event]
has_family-relation_to	Property	Familial relationship among character	is_parent_of is_sibling_of	**- None**
Object Name	**Type**	**Definition**	**Sub Items**	**Properties**
has_relation_to	Property	Relationship among character	is_friend_of is_lover_of ...	**- None**

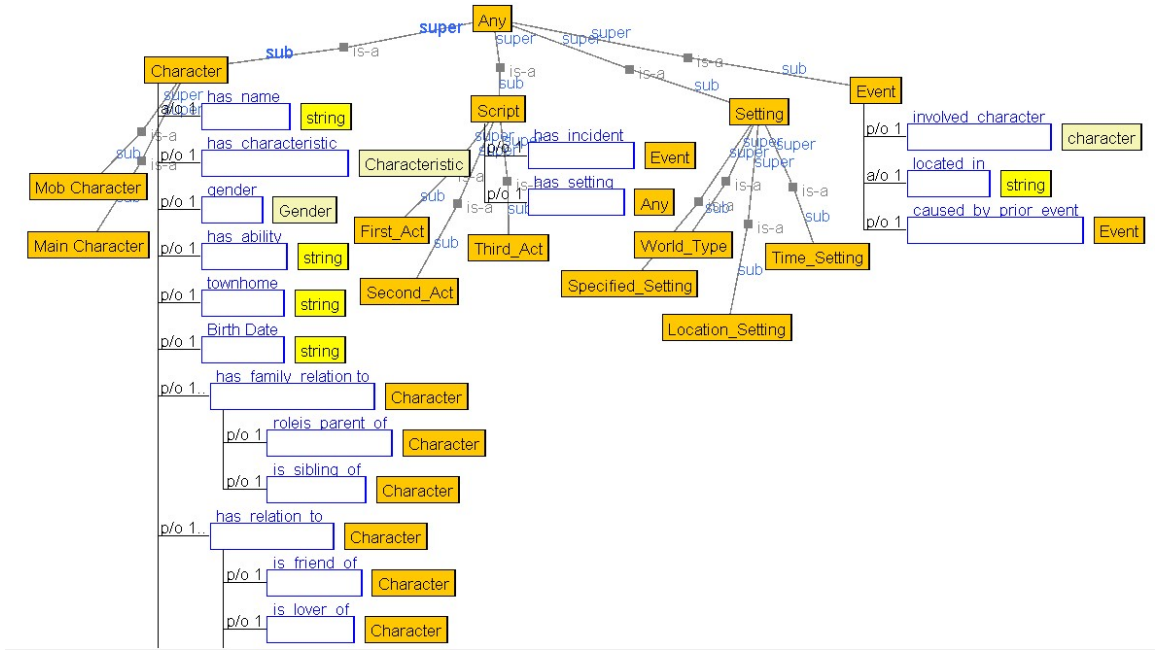

Figure 1 Graphical Relations of Ontology Classes

The classes in this ontology require instances (individuals) for usage. The ontology itself is a schema to control concepts and represent relationship among concepts. This ontology is developed using an ontology editor, called Hozo Ontology Editor (Kozaki et

al., 2002). The editor allows users to develop an ontology in a graphical UI and generate the OWL format of the ontology according to W3C standard. The editor is a tool with a graphical UI allowing a user to design an ontology in a similar manner as designing a mind-map by adding concepts in a form of hierarchical tree and relations of concepts across the trees. Moreover, the tool also allows the attach additional information to the concepts such as a label of a concept and a cardinality of relation to restrict a number of possible relations of a concept to reflect a real-world restriction of a relationship. Although the tool is an editor, it does not have an automatic function to help on designing and correct the errors in designing an ontology, but the graphical UI will help a user to see a graph-like relation that can improve relation understanding and be detectable for unintended design. The tool also has a function to assign an instance to an ontology. The result ontology of the tool will be generated following the standard of ontological markup language to be universally used and reused across applications. The ontology thus is usable for semantic-web applications including query using SPARQL (query language for semantic web) and SWRL (Semantic Web Rule) for reasoning.

4.2 Ontological Instances

To gather instances, a student who creates a script is asked to provide information of his/her own story. However, asking them to directly using an ontological instance editor requires users' knowledge and practice on ontology and tool in which increases unnecessary students' burden. We thus apply (Panawong et al., 2016) and (Buranarach et al., 2015) work to use spreadsheet documents for students to provide their script information.

Since there are several database tables instantiated to the ontology, tabs in a spreadsheet are used to handle separated data for management. An example of spreadsheet for filling script information is given in Figure 2.

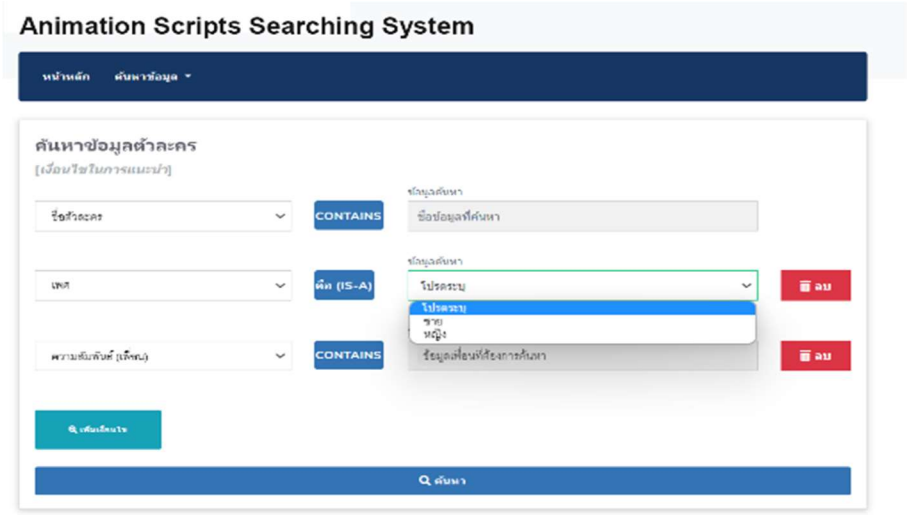

Figure 2 An example of UI to fill up instances

The user who is a student learning on writing an animation script is asked to provide as many as possible details on the idea for script including character details, setting of acts (setup act, confrontation act, and resolution act), and events. In case of the change of character details based on events, such details are also required to be mentioned. Thus, the majority of content information regarding story in the designed script is explicitly declared in a semantically controlled schema. This should help the students to become aware of possible flaw in their thought. Furthermore, the slots for filling the information can visually remind students on what are crucial in designing the animation script.

With the designed ontology and its instances, they can be used in semantic-web based applications. We thus demonstrate how to use the ontology in three applications as follows.

4.3.1 Knowledge Graph Visualization

With the ontology to control relations as schema to instances, visualization of instances can be generated as a graph regarding ontological relationship. Since an ontology and its instance are entirely kept in a form of a set of 'subject-predicate-object' triples in OWL or RDF format. (Bechhofer et al., 2004; Klyne, 2004) This triple form provides specific graph traversal syntax for data that can be thought of as a graph. Thus, the concepts related to a story given in an animation script can be visualized in a graph relation. The graph can represent information in either a single act or several acts of the script.

For an example of a graph generated from a single script, properties such as '*has_family-relation_to*' and '*has_relation_to*' of '*Character*' class can be combined

to generate characters' relationship from a script. Let assume that we have 6 character-instances as given in Figure 3(a) for the first act of the script, and we can generate a graph as shown in Figure 3(b) using the designed ontology schema.

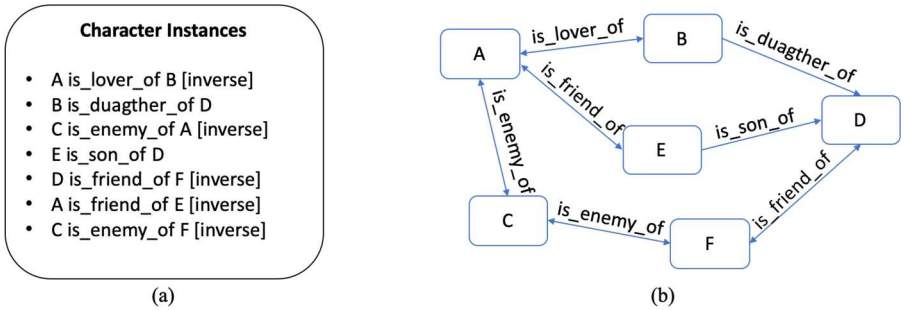

Figure 3 An example of a graph generated from relation of characters in a script using ontology schema

The generated knowledge graph is based on the developed ontology schema with the instances of the script idea provided by a student. The relations of characters from the script are related based on ontologically defined character relations (see Table 2), so a student can explicitly see how the idea can play out in a script and clear his thoughts in the design process. The exemplified graph of characters' relationships can help both a student writer and an instructor to understand an overview of the story. Additionally, a writer can also prevent confusing about a role of characters. The visualization of different acts will help a script writer to clear up the changes in character's relationship from different time settings and make story more creative. Furthermore, not only a graph of relationship can be generated but a graph of cause-effect events in a script can also be generated from '*caused_by_prior_event*' property of '*Event*' class. This sequential event graph should help to clarify if the plot is too thin or too thick from assigned air time of an animation. In a summary, generated graphs from the designed ontology and its instance is as decision-supporting represent of a script to help students and instructor to clearly understand intangible relationship and plot in a explicit visualization as well as a flaw in a story design.

4.3.2 Semantic Query Using SPARQL

Instances mapped to an ontology can be queried using SPARQL (Prud'hommeaux, Seaborne, 2006) which is a query language able to retrieve and manipulate data stored in Resource Description Framework (RDF) format. As advantage from keeping data in a triple form, RDF can have multiple objects per predicate and can be queried for

collections of objects in a single query. Moreover, SPARQL provides a full set of analytic query operations including JOIN, SORT, AGGREGATE for data that are mapped to an ontology schema.

With SPARQL, instances of the designed ontology can be analyzed and returned semantically. For example, let assume that we have a set of animation scripts from an entire classroom. We can query for animation scripts that contain main characters who is Robot and a setting of European theme using a query exemplified in Figure 4. Despite students may put Great Britain and Italy in a setting or have protagonist as an android, the ontological IS-A relation can help to join instances under same tree and return such entities effectively.

```
PREFIX ASO: <http://xmlns.com/ASO/0.1/>
SELECT ?script
WHERE
 {
   ?script                    rdf:type                ASO:Script.
   ?script                    ASO:has_setting         ?Location_Setting.
   ?Location_Setting          rdfs:subClassOf         ASO:Europe.
   ?script                    ASO:has_main_character  ?Main_Character.
   ?Main_Character            ASO:  has_characteristic ASO:Robot
 }
```

Figure 4 SPARQL query for a set of scripts containing Robot as a main character and European theme setting

The query will return matching scripts to the given criteria. Student users then can find the scripts that have similar settings to learn from or to prevent being unintentionally inspired by existing works. For instructors, the use of SPARQL can assist to prevent copying works and learn the trend of script settings flavored by students to match up teaching materials suitably. However, it is difficult for a user to make a SPARQL query personally. We also design a search UI for users to easily search through the ontological instances regarding the ontology design.

4.3.3 Classification Using SWRL

One of ontology advantages is to apply rules for increasing the ontological facts. The common used rule language for ontology is semantic web rule language (SWRL). (Horrocks et al., 2004) Rules can be applied to infer new facts or categorize instance. For inferring new facts, the rule takes existing facts into consideration and logically infer the new statement such as combining '*male'* gender and '*is_parent_of*' properties to generate

the new '*is_father_of*' relation. This can help to expand relationship between animation character without the need of script owner to provide the facts redundantly. The rules can also be chained for further the relation such as grandfather-grandchild relation, and niece-uncle relation. For categorization, this can be regarded as instance classification using properties given by ontology schema. Namely, instances with same property values can be classified together under another aspect of given conceptual scope. This classification can facilitate in grouping similar animation scripts into their proper category.

For instance, the designed ontology does not contain an aspect of genre (type of story such as fantasy, romance and horror). However, we can categorize the scripts using given elements of the animation instances. For example, we can provide the rule that if main character is Robot or Divine_Being, the genre becomes 'fantasy'. With this method, a script can be categorized into more than one genre such as fantasy, fiction and romance. We then can apply more rules to forward-chain the categorization of the results for more complex category such as 'fictional fantasy romance' and 'paranormal crime suspense'. The SWRL rule for these examples from the ontology components is given below.

Table 3 The SWRL rule from the ontology components

Finding Result	SWRL rule
Assigning father relation	ASO:is_parent_of(?x, ?y) ^ ASO:has_gender(?x, 'male') → ASO:is_father_of(?x, ?y)
Classifying Fantasy genre	ASO:Script(?x) ^ ASO:has_character(?x, ?y) ^ ASO:Character(?y) ^ rdfs:subClassOf(?y, ?z) ^ ASO:Robot(?z) → ASO:fantasy(?x)
Classifying Horror genre	ASO:Script(?x) ^ ASO:has_character(?x, ?y) ^ ASO:Character(?y) ^ rdfs:subClassOf(?y, ?z) ^ ASO:Ghost(?z) → ASO:horror(?x)

With this method, a script can be categorized into more than one genre such as fantasy, fiction and romance. We then can apply more rules to forward-chain the categorization of the results for more complex category such as 'fictional fantasy romance' and 'paranormal crime suspense'.

The use of SWRL is good for keeping provided facts in an ontology to be at a minimal base to prevent ambiguity and excessive complexity. With the applied rules, hidden facts and inferred axiom can be enchanted for usage without editing and revising the ontology. However, rule criteria require domain expertise of relevant concepts to maintain

coverage and accuracy. Thus, the operation of applying rules to the ontology in this work goes to only instructors who are more experienced in the field.

5. Evaluations and Results

To show a potential of the designed ontology, we set up evaluation and experiments as follows. First, we asked experts to assess the ontology and its instance regarding design and structure. Second, the ontology in a searching application is tested with the queries made by practical users, and the query results are measured following standard automated query measurement.

5.1 Assessment of Ontology and Its instances from Experts

The ontology is evaluated by 3 ontology experts and 3 animation script experts. The criteria (Vrandečić, 2009) for evaluated are as follows:

1) Accuracy is a criterion that states if the definitions, descriptions of classes, properties, and individuals in an ontology are correct.

2) Completeness measures if the domain of interest is appropriately covered in this ontology.

3) Conciseness is the criteria that states if the ontology includes irrelevant elements with regards to the domain to be covered.

4) Adaptability measures how far the ontology anticipates its uses. An ontology should offer the conceptual foundation for a range of anticipated tasks.

5) Clarity measures how effectively the ontology communicates the intended meaning of the defined terms. Definitions should be objective and independent of the context.

6) Computational efficiency measures the ability of the used tools to work with the ontology, in particular the speed that reasoners need to fulfil the required tasks.

7) Consistency describes that the ontology does not include or allow for any contradictions.

Experts are asked to measure the ontology using Likert Scale of 1 to 5 for very poor, poor, fair, good, and excellent, respectively. We obtain the result given in Table 4.

Table 4 Ontology Evaluation Results from Experts

Evaluation Aspect	Ontology Experts	Animation Script Writing Expert	Sum
Accuracy	4.3	4.6	4.5
Completeness	4.0	4.0	4.0
Conciseness	4.6	4.6	4.6
Adaptability	4.6	4.0	4.3
Clarity	4.0	4.6	4.3
Computational efficiency	4.6	4.0	4.3
Consistency	4.3	4.0	4.1

From the evaluation results, the conciseness and accuracy obtained the highest assessment for 4.67 and 4.5 respectively while the lowest score is given to the completeness. In overall, the evaluation is in good results. For the completeness aspect which got the lowest score, the suggestion from experts from both ontology and animation script writing fields is the same as more aspects of the knowledge can be added to further represent more depth of relevant concepts such as relation between character actions and conversations; however, such information is yet too difficult for novice students hence it is not included in the current work.

5.2 Usage Results using SPARQL

In this part, we asked 4 instructors to make queries for testing the potential of the application. There were 16 queries made to test the searching application. For data, information of 350 animation scripts made by students was stored as instances for querying. The examples of the queries are as follows.

1) scripts containing a setting on future and divine power
2) main characters who are an alien
3) scripts containing a plot of fight between main character and villain who are sibling
4) villains who are a legendary beast
5) scripts containing a setting on revenge of a villain towards a murder of his parent by an Asian main character

Then we calculate the query results for measurement of accuracy (A), precision (P), recall (R), and F-measure (F1). The obtained measurements are provided in Table 5.

Table 5 Evaluation Results from SPARQL

	Q#1	Q#2	Q#3	Q#4	Q#5	Q#6	Q#7	Q#8	Q#9	Q#10	Q#11	Q#12	Q#13	Q#14	Q#15	Q#16
A	0.88	1.00	0.94	0.92	1.00	1.00	1.00	1.00	0.95	1.00	0.94	0.89	1.00	0.94	0.93	1.00
P	0.88	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.89	1.00	0.94	0.96	1.00
R	1.00	1.00	1.00	0.92	1.00	1.00	1.00	1.00	0.95	1.00	0.94	1.00	1.00	1.00	0.96	1.00
F1	0.93	1.00	0.97	0.96	1.00	1.00	1.00	1.00	0.98	1.00	0.97	0.94	1.00	0.97	0.96	1.00

The results of 1.0 F1 score were 8 queries out of a total of 16 queries in which are 50% of the results. Furthermore, the lowest F1 score was 0.93. The average scores of accuracy, precision, recall and F1 are 0.96, 0.98, 0.99, and 0.98 respectively. The results show that the ontology and its instances are useful for querying essential information of the scripts made by students. The performance signifies that the property design and instance values of them can help to distinguish information rationally and serves as a good indication to differentiate script contents.

From the results, there are few incorrect queries. Upon analysis, we found that the incorrect query results were from missing and uncleared information in the instance assigning process. Since this work asked authors of the scripts to provide instances by themselves, some may forget to fill in some information or made a mistake in filling process such as misspelling and skipping some instance slots. This though affected the query results and classification result from rule, relatively.

6. Conclusions

This paper presents an ontology as a schema for designing an animation script. The ontology gathers necessary elements for designing a story in several aspects including character details in terms of setting and relationship, events based on screenplay acts for linking the story into desired direction, and overall settings such as time, location, fictionality, and condition. With explicit concept and relation, students are asked to provide their designed story for an animation script writing as instances to the ontology schema. These conceptualizing elements can assist the students to realize their own thought and become aware of what they are designing (metacognition). Moreover, the instances from students can be visualized as knowledge graph to help on easier understanding for instructors and sharing between fellow students. Furthermore, the ontological instances can be queried for retrieval and classified using ontology-supporting languages including SPARQL and SWRL, respectively.

From testing with 16 queries made by class instructors, the average scores regarding Accuracy, Precision, Recall and F1 from query results were 0.96, 0.98, 0.99, and 0.98 respectively. The scores indicate that the property design is able to distinguish information clearly and shows a good indication to differentiate script contents.

To improve further, we plan to develop a tool for students to read and analyze the existing good animation and movie screenplays following the designed ontology schema. The students then can learn how to design a good screenplay by seeing how the good authors compose their work as good examples. Furthermore, additional aspects in script writing such as relation between action and dialogue will be analyzed and added into the ontology to enhance the scope of knowledge representation. Moreover, the components designed for animation script ontology can be reused for other knowledge representations such as human characteristics to classify humans based on unique character or personality, character relations to define relations of people in a community, and genre categorization of movies and books.

7. Discussion

The designed ontology is crafted to capture core elements of the animation scripts including story setting, events, and character relation. Since the elements are abstract concepts, instances of this ontology require an owner of the animation script to provide the information for ensuring the accurate data. We thus provide a simple form using commonly-used spreadsheet for instance providing to a user. In fact, students who are the main data provider in this work may still be confused in their thought; hence, some provided data need to be verified, and this increases the burden to the instructor. This occurrence however causes the students to be more thoroughly thoughtful to their own work resulting in clearer and more organized thought.

Furthermore, the ontology helps instructors to find the trend of the class which can compare to those of the previous year and well-known stories stored in the database. This can help instructors to understand their students in terms of cognition process and preference. By conceptualization of necessary script elements, instructors can also observe common mistakes from their students; thus, can prepare the teaching materials specifically to improve the issue as well as develop a guideline to prevent the common mistakes made by student. From the testing, the found common mistakes in student script writing include the lack of

events leading to the main events (solving the issue), a relationship between main protagonist and villain, and the non-conformed setting regarding year of the event and used items in the story leading to unsound story. These mistakes however are a major mistake that may cause the entire script requiring rewritten if not noticed initially. Hence, by making the idea of the story and setting clearer, it can prevent the worst outcome and demoralize the students.

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