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Visual Storytelling by *Novelette*

Agnese Addone, Renato De Donato, Giuseppina Palmieri, Maria Angela Pellegrino,
Andrea Petta, Vittorio Scarano, Luigi Serra
ISISLab, Dipartimento di Informatica
Università di Salerno
Fisciano, Salerno, Italy
addone@unisa.it, rended83@gmail.com, pinapalmieri@gmail.com, mapellegrino@unisa.it,
andrpet@gmail.com, vitsca@unisa.it, luigser@gmail.com

***Abstract*—Storytelling is an effective way of communicating information and knowledge, and it is widely adopted in heterogeneous contexts, from education by improving critical thinking and enhancing learning practice, to journalism by encouraging coherent stories of news supported by graphical representations. However, storytelling platforms seem to be targeted to a specific audience without showing how they can be adapted to heterogeneous needs, from class support in education to mechanisms to overcome the syndrome of the white page. In this article, we propose *Novelette*, a digital storytelling environment, and we show how it can be applied in heterogeneous contexts and by the different target audience. We present *Novelette* operating mechanisms, its architecture, and we overview different use cases, from tales creation Rodari style to data- and media-stories. By use-cases, we desire to make evident that the same platform can generate stories engaging for any target audience.**

***Keywords*-Storytelling, Digital environment, Authoring stories, Narrative visualization**

I. Introduction

Storytelling is an effective way of conveying information and knowledge [1], and it improves knowledge sharing, enhances learning practices, and improves communication, critical thinking and technical skills [2]. Creating stories implies a process of context definition, data and information selection, and the elicitation of an order to narrate the story [3]. A story is a tale that people tell by exploiting narratives, i.e., scaffolding resource to build stories

Storytelling is widely popular in many fields, from media [4] to data visualization [1], from entertainment [5] to education [6]. The common factor is the creation of a consistent sequence of visualizations to discuss and present important aspects represented by images, data and characters. However, we observed that storytelling tools are usually bounded to their target audience, and it is rare to note the versatility of a platform while being used in different contexts by a heterogeneous audience.

Our contribution. We aim to propose a single and unified workflow to create stories able to support users in storytelling in different contexts. Moreover, we aim to provide this workflow in a fully-fledged *digital environment*, i.e., one that supports end-users in all the activities related to the creation of stories, their refinement and publication, and the management of groups of workers. Moreover, we plan to create a community around the platform to encourage collaborative design and to address real user needs. In this article, we describe the proposed workflow, the architecture of *Novelette* and its interface, and we show its applicability in context heterogeneous for the audience and topic.

The paper is structured as follows: in Section II, we overview storytelling platforms proposed in the literature and their applicability; in Section III, we overview the features proposed in *Novelette*, its interface, architecture, and its operating mechanism; in Section IV, we present three different use cases to present how *Novelette* can be used in i) education settings, for instance, to create tales for children, ii) in media content creation to disseminate information on social media, iii) in journalism to create a coherent representation of data stories within their context; then, we conclude with some final remarks and future directions.

II. Related work

In this section, we consider digital storytelling platforms by focusing on tools devoted to educational activities, media-stories and data-driven storytelling.

Table I provides an overview of analyzed tools and the comparison with *Novelette*. By the *Education*, *Media* and *Journalism* columns, we identify the applicability context. In particular, we classify tools in digital learning platforms [18] (Education column), tools to create media-stories and enable their sharing by social media (Media column), and data-driven storytelling [19] (Journalism column). We distinguish i) *Tool creators (Tc)*, i.e., web-based storyboard creators that scaffold users in creating stories, and ii) *Digital environments (Mng)* that enhance tool creators by the management of groups of workers. According to the analyzed platforms, we identified the following groups of features (GF):

GF1 *sharing and export*, corresponding to the possibility of sharing either stories or the story content out of the creator. By sharing, we mainly consider the possibility to share them on social networks. By exporting, we mean the possibility to freely export them as images or web components that can be embedded in a web page;

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Table I: Features synthesis of reviewed tools. *Edu.*= Education*, *Journ.*= Journalism*, *Tool VS Environment= Tool creator (Tc) or Management support (Mng)*, *Storytelling support= Full (●), Partial (◖) or Basic (◢).*

	Year	Edu.*	Media	Journ.*	Tool VS Environment	Storytelling Support*	Language Support	Licence Type
SPOD [7]	2017	-	✓	✓	-	◢	5 EU lan.	Free & Open Source
Socrata [8]	2018	-	✓	✓	-	◢	5 EU lan.	Commercial
Opendatasoft [9]	2019	-	✓	✓	-	◢	8 EU lan,ar	Commercial
StoryWeb [10]	2020	✓	-	-	Tc	◖	en	-
Communics [11]	2020	✓	-	-	Tc	◖	en	-
iStory [12]	2020	-	✓	✓	Tc	◖	en	-
Gravity [13]	2020	-	-	✓	Tc	◖	en	-
Tableau-Stories [14]	2020	-	✓	✓	Tc	◖	6 EU lan., ja-jp, ko-kr, zh-tw	Commercial
UTellStory [15]	2020	✓	✓	✓	Mng	●	en	Free
StoryJumper [16]	2020	✓	✓	✓	Mng	●	en	Free *(Paid book)*
Wakelet [17]	2020	✓	✓	✓	Mng	●	en	Free
Novelette	*2020*	✓	✓	✓	Mng	●	en,it	Free & Open Source

GF2 *story creation features* that support and scaffold users in creating textual or visual stories;

GF3 *group management features* to support users in managing and supervising work at a group level (such as within a class).

We classify tools by (◢, *Basic storytelling support*) symbol representing tools that meet *GF1*, mainly by enabling the sharing and the export of story content by asking users for the burden of assembling the story without the tool support; (◖, *Partial storytelling support*) symbol represents tools that meet at least *GF2*; (●, *Full storytelling support*) symbol tools that have all these features.

SPOD [20] is a free and open-source multi-language online Social Platform for Open Data. It introduces the datalet concept for data visualization using several types of charts. Datalets can be shared on social media and embedded as dynamic web components in web pages (GF1) providing the material for media and data story creation [7], [21].
Socrata [22] and *Opendatasoft* [8], [9], [23], [24] are commercial Open Data platforms [25] with similar features, i.e., data representation, their sharing on social networks and embedding in external blogs (GF1), delegating final users the creation of the overall story.

StoryWeb [10] is storytelling-based knowledge sharing application. It supports the story creation (GF2) and their sharing within the context of digital learning (i.e., education settings) by mainly focusing on the primary school.
Communics [11] is a web-based digital tool designed for supporting the creation of comics stories (GF2). The system provides a library of pre-defined sentences as a support to overcome the "blank page syndrome", extremely useful in education settings. A particular incipit is provided as a guide for the co-creation process [26].
iStory is an interactive storytelling dashboard (GF2) focused on interactive exploration and visualization of social data. It addresses journalists' needs mainly [12].

Gravity [13] is a web-based prototype and is a visual graph-based narrative (GF2). It supports visualizations from raw data, the export of interactive artefact (GF1), and their exploitation as story pieces in the visual data story.
Tableau [27], [28] is a commercial visualization tool which enables the exploitation of many heterogeneous data sources. Tableau allows data analysis by introducing *Story Points* [14], [29] for creating visual narratives and effective ideas communication (WP2) supporting storytelling in data-rich domains, such as finance and sports journalism.

UTellStory [30] is free online multimedia storytelling (GF2) that supports the class management (GF3) and enables the sharing of artefacts within blogs and web sites to disseminate students' work (GF1). It provides basic editing features, e.g., the usage of a single image and caption or audio narration within a scene, without enabling advanced options, e.g., multiple images in the same scene.
StoryJumper [31] is a digital learning environment (GF3) that supports educators and students in authoring (GF2) and publishing stories (GF1), but the story becomes a paid book by posing a strong limitation on the use of the tool [16].
Wakelet [17], [32], [33] is an online social bookmarking site (GF2) supporting the class management (GF3). It enables the embedding of artefacts in any blog or website (GF1). The story content is limited to text and images.

Novelette scaffolds users in story creation (GF2) by overcoming the syndrome of the blank page by providing *suggestions* by navigating analogies, synonyms, and rhymes from arbitrary words and enabling the possibility to continue someone's else story by starting from a *template*. Suggestions and templates are the main novelties introduced by *Novelette*. It supports group management (see section III) (GF3) and enables the sharing of the story also out of the tool environment (GF1). For instance, the stories created by *Novelette* and presented as use cases (see Section IV) has been embedded in a WordPress site.

III. NOVELETTE

Novelette is a digital environment to support domain-agnostic storytelling. As a digital environment, it supports group activities in improving personal attitudes by telling stories. We developed *Novelette* by a collaborative design by involving educators in proposing enhancements and providing feedback on the platform features. Educators have been involved in the entire development workflow, from the design by suggesting features to solve real needs to the validation. In this article, we focus on the provision of the architectural details of *Novelette*, its interface, and the operative workflow that can be contextualised in different scenarios, as described in Sect. IV. *Novelette*[1] is freely available[2] while the source code is available on GitHub[3].

Architecture. *Novelette* is based on a client-server architecture, as represented in Figure 1.

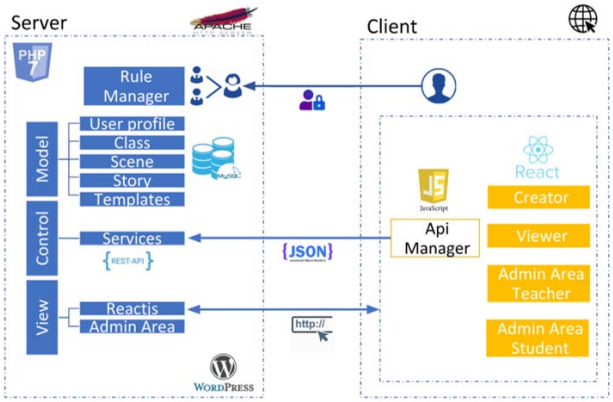

Figure 1: *Novelette* architecture

The server-side part is implemented in PHP. It is modelled by the *view model controller* pattern. The *model* represents all the persistent data, such as accounts and classes, templates, scenes and stories. Each class model is made persistent in the database by a dedicated table by avoiding the query execution. The *control* is represented by a set of RESTful services that give access to the available resources to populate the user interface by a profile access control. The *Rule Manager* is in charge of verifying the permissions according to the user role. A WordPress plugin manages data and accounts and we map WordPress roles to *Novelette* roles, i.e., `teacher` and `student`. The *view* represents the components of the interface: `Creator`, `Viewer`, `Admin teacher` and `student area`. Each client-side component is an independent ReactJs web applications by guaranteeing the *portability* and *modularity* requirements.

Internationalisation is achieved through application settings and a third-party library that dynamically loads the language resources according to the system configuration (i.e., the language set by the user). Because of its modular implementation, it is easy to integrate new languages. At the moment, *Novelette* is provided in English and in Italian, and we are working to extend the supported languages.

Interface. The *Novelette* creator interface is visible in Fig. 2 and it is composed of three components: the scenes overview (left panel), the visual story editor (centre panel), and a panel with details related to the focused element in the scene (right panel). For instance, if the user selects an image, he/she can flip it, change dimensions, sorting elements and their priorities; if a text is focused, the user can change text content, its formatting and layout (as in Fig. 2). In the top left corner, there is the menu button to save the story, change settings, such as the interface language, and move back to the user management panel. The lamp icon provides access to the suggestion mechanism. If users experience the *writer's block*, *Novelette* is provided with a suggestion provision mechanism based on analogies, synonyms, and rhymes starting from a word given by the user. For generating suggestions, we rely on external services. We exploit BabelNet [34] for looking for synonyms, WordAssociations[4] for analogies, while we adopt RhymeBrain[5] for retrieving rhymes. For what concerns synonyms, given a word, we retrieve all its senses and the related synonyms. For instance, `heart` has `love`, `organ`, `center`, `the card seed` as senses. For what concerns analogies, WordAssociation enables the possibility to start from a stimulus and look for the associated words. Associations are sorted by weights: the higher weight corresponds to the stronger association. Analogies are navigable. Therefore, starting from a word, the user can move from one word to another until the word suggestion inspired him/her. The word size reflects the association weight, while colours distinguish different parts of

[1] A clarification about the name is needed: while in the article we refer to our proposal as *Novelette*, on the homepage and on GitHub it is referred to as Storylet. The original name was Storylet, and we are now moving to *Novelette*. We will definitely move to the new name as soon as we finish some evaluations that involve end-users that might be confused by a name change in the meanwhile.

[2] *Novelette* homepage: http://www.isislab.it:19984/en/home-page-2/

[3] *Novelette* source code: https://github.com/routetopa/storylet

[4] https://wordassociations.net/

[5] https://rhymebrain.com

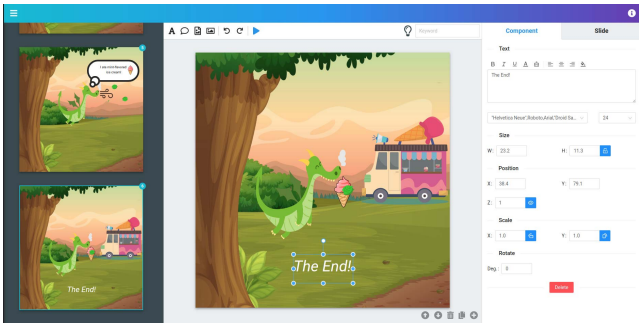

Figure 2: The *Novelette* interface.

the speech (i.e., words, adjectives and verbs). About rhymes, the returned rhymes are attached to a score, where 300 or above stands for perfect rhymes, while scores between 0 and 300 are near rhymes. We sort them according to the score. The *responsiveness* of the suggestion provision feature is strictly dependent on the responsiveness and efficiency of these external services.

Workflow. We create a general workflow that can be adapted to any use case (see Fig. 3). *Novelette* supports two roles, i.e., *teacher* and *student*. While the role names recall education settings, their responsibilities and activities can be adapted to any context, such as media stories provision to data stories.

Teacher role features and responsibilities. The teacher plays the role of the manager. He/She can create an arbitrary number of group of works. In each group, he/she has to provide access to the desired students. *Novelette* supports teachers by creating a set of accounts, whose amount can be arbitrarily chosen by the teacher, to overcome the issue of user accounts for minors and breach their *privacy*. Furthermore, this feature is also useful when the anonymity requirement must be met. These anonymous accounts can be used by students to access the creator. Class management helps in distinguishing groups of workers and in keeping their artefacts clearly separated. All the artworks saved by a student are visible from the educator panel. He/She can supervise the students' work, and he/she is in charge of revising and publishing artworks realized by students. Therefore, the educator can visualize a student story by the story viewer, modify it if needed and publish it to make it visible also out the class sandbox.

To guarantee *guidance* and support, the educator can scaffold students by creating templates at the class level. Templates are incomplete stories that can be used to bound the usage of specific scenes in a story. For instance, the teacher can provide the initiation of the story and ask the student to continue it. Furthermore, the educator can upload in *Novelette* a set of suggested images and inspire students.

Student role features and responsibilities. Students play the role of story creator and editor. Once authenticated and asked for new story creation, students can start from the templates provided by the platform (such as the empty template) or by the teacher. In both cases, the students will be provided with the same interface to continue the story starting from the selected template. *Novelette* is provided with a clear and concise interface where all the performable actions are clarified by icons and tooltips to meet the requirement of the *intuitiveness*. The massive usage of icons partially overcomes the issue of the *internationalisation* and provides an interface that can be used by students of any school level.

As a story editor, *Novelette* provides access to a library of images, including characters and backgrounds. The educator's proposals can enhance image suggestions. Moreover, the student can freely upload images from the local storage. While the image size, rotation or orientation can be changed within *Novelette*, we decide to leave the colour modification out of the provided features. Users can choose the tool they prefer to modify images before importing them in *Novelette*.

The possibility to import images of any style, both downloaded by Internet or hand made by students, clarifies the absence of constraints of the *Novelette applicability*: it can be used to narrate tales or deeds, to demonstrate theorems or to represent procedures, to make presentations or discuss topics heterogeneous in content and format.

Once students have realized their stories, they can be attached to a *rendering template* that determines the visualization approach in the *Novelette* viewer. For instance, the student can opt for a linear layout to show the scenes in sequence; the circular layout or the cube. Some of the rendering templates pose a constraint on the minimum or the maximum number of scenes that can be visualized.

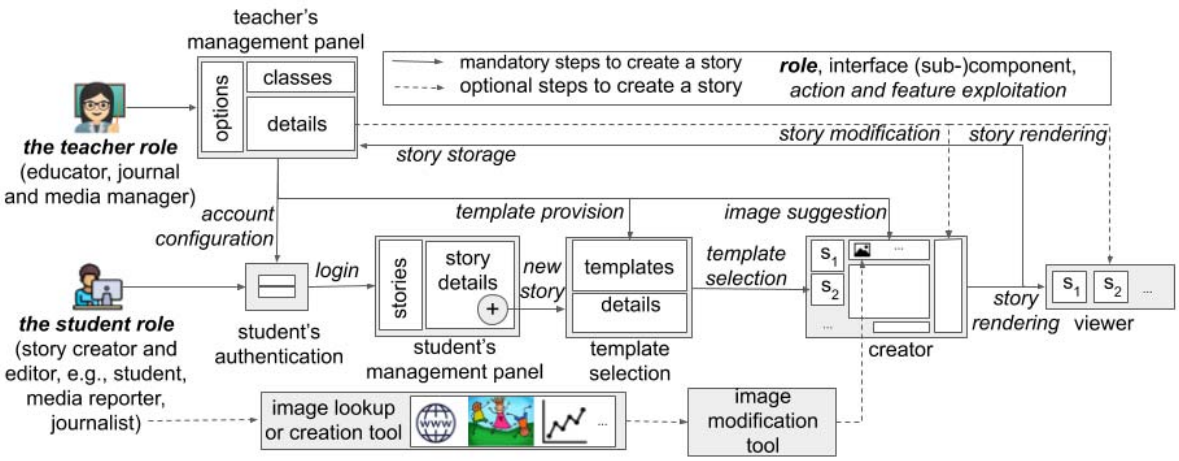

Figure 3: The *Novelette* general-purpose and domain-agnostic workflow.

IV. Use cases

The uses cases are freely accessible[6]. We enrich *Novelette* with English and Italian sources (tutorials, showcases, scenarios) to exploit the platform in practical use cases.

***Novelette* in Education.** *Novelette* has been designed by actively involving educators since the beginning of the project (December 2019). We presented to an audience of more than one hundred schools the proposal of the *Novelette* project and its main goals. Since the first feedback, it was clear that *Novelette* can be adopted in a wide range of subjects (literature, art, geography, history, maths, social science) and transversal topics (bullying, food education, civic). Around 15 educators actively joined our project and regularly tested the *Novelette* platform by playing the role of the student. We provide access to the artefacts produced by educators involved in an online session held in June 2020[7].

As use case in education settings, we present a digital version of a Rodari's tale from his masterpiece *Favole al telefono*. The *Ride of Cesenatico* tale tells about an elderly gentleman who joined his grandson on a carousel of horses, and he experienced travelling the world on his pony (Fig. 4).

Figure 4: **Education use case**: Gianni Rodari's tale

***Novelette* in Media.** The Hetor project[8] aims to collect and make available both the Open Heritage provided by the National Institutions and the Campania Region. The Open Heritage can be created by citizens, improving the quality and quantity of Open Data at the local and national level.

We create a media story (Fig. 5) inspired by an article[9] published by the Hetor group presenting the FAI Assets in our region: the Coastal Area of San Giovanni a Piro, the Bay of Ieranto, and the Park springs Ferrarelle at Riardo.

This use case shows how *Novelette* can be used not only to create stories for children, but it can support the creation of any narration. In particular, we show how it can support the creation of media stories to transform media content in an equivalent story that can be disseminated on social networks.

[6]*Novelette* homepage: http://www.isislab.it:19984/en/home-page-2/
[7]http://www.isislab.it:19984/en/experiment-video-conference-16-06-2020/
[8]Hetor project homepage http://www.hetor.it/site/en/
[9]Original Hetor article: http://www.hetor.it/site/beni-fai-in-campania/

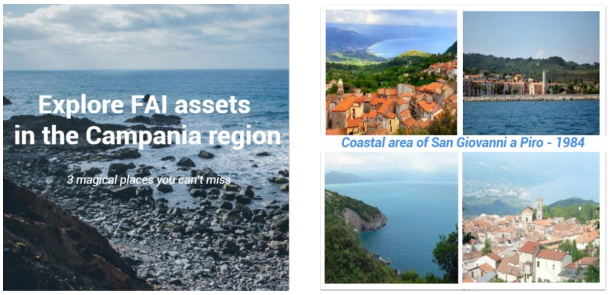

Figure 5: **Media use case**: media story on cultural heritage

***Novelette* in Journalism.** COVID 19 is a hot topic during the last months. Several datasets and charts have been shared by journalists, mass media, the government, public agencies to inform the audience about the evolution and the status of the pandemic. We propose a data story based on detailed dataset released by our Regional agency. To create this use case, we inspected the COVID-19 dataset[10], we create charts to quantify the damages caused by this pandemy, and we organize charts as a data-story by *Novelette* (Fig. 6).

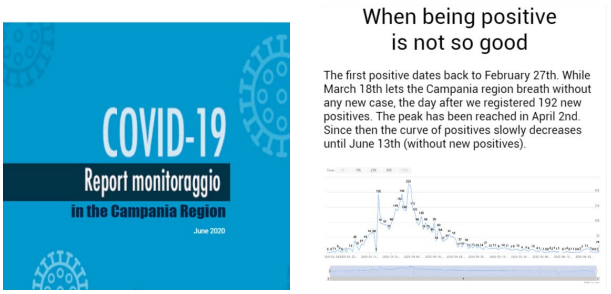

Figure 6: **Journalism use case**: data story on COVID 19

V. Conclusions and Future Works

Storytelling is an effective way of communicating, widely used in many heterogeneous settings. We show how *Novelette* and its operating mechanism can be used to create stories in the educational settings, data-stories in journalism, and media stories shareable on social networks.

Future directions. We aim to empower our environment by enabling the re-use of already published stories to create new narrations, enable stories merging, and allow the analysis of connection points among different narrations. We will follow a scaffolding approach to enable the collaboration between small, focused groups supported by the teacher guidance.

Acknowledgment

We thank the BIMED association and the educators involved in the design and evaluation process.

[10]Campania region COVID 19: https://dati.regione.campania.it/catalogo/datasetdetail/covid-19-monitoraggio-situazione-dati-di-dettaglio-relativi-alla-regione-campania

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