

Fostering **creativity** in **learning**
through digital **games**



Creative Emotional Reasoning Computational Tools Fostering Co-Creativity in Learning Processes

www.c2learn.eu

COMPUTATIONAL TOOLS INTEROPERABILITY SPECIFICATION

C²LEARN PROJECT DELIVERABLE NO. D3.5

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EXECUTIVE SUMMARY

C²Learn at a glance

C²Learn (www.c2learn.eu) is a three-year research project supported by the European Commission through the Seventh Framework Programme (FP7), in the theme of Information and Communications Technologies (ICT) and particularly in the area of Technology-Enhanced Learning (TEL) (FP7 grant agreement no 318480). The project started on 1st November 2012 with the aim to shed new light on, and propose and test concrete ways in which our current understanding of creativity in education and creative thinking, on the one hand, and technology-enhanced learning tools and digital games, on the other hand, can be fruitfully combined to provide young learners and their teachers with innovative opportunities for creative learning. The project designs an innovative digital gaming and social networking environment incorporating diverse computational tools, the use of which can foster co-creativity in learning processes in the context of both formal and informal educational settings. The C²Learn environment is envisioned as an open-world 'sandbox' (non-linear) virtual space enabling learners to freely explore ideas, concepts, and the shared knowledge available on the semantic web and the communities that they are part of. This innovation is co-designed, implemented and tested in systematic interaction and exchange with stakeholders following participatory design and participative evaluation principles. This happens in and around school communities covering a learner age spectrum from 10 to 18+ years.

About this document

Deliverable D3.5 provides details on the Interoperability Specification for the exchange of information between the C2Learn Games and the Creativity Profiling Server, and more specifically the submission of creativity exhibits produced by these games.

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1. INTRODUCTION

The activities supported by C2Learn are centred on Game Sessions, which involve the invocation of one or more C2Learn Games. The following figure depicts the core components of the architecture serving the C2Learn activities, along with their interrelations. The components comprising the architecture are the following:

C2Space is the overall environment serving the different distinct C2Learn Games

- The Game Registry is part of C2Space and contains and delivers information for the games that are available for usage in game sessions. The Game Registry relies on metadata for describing the games, which are located in a relevant *Game Repository*.
- The Game Session Registry is part of C2Space and stores the information for the game sessions. It is used by the relevant games in order to determine the appropriate enrolment process and setup.
- The C2Learn Games are the actual games used by the game session. They are responsible for the enrolment process of the users playing the game either as group members or as single players.
- The Creativity Profiling Server communicates with the C2Learn Games and collects the artefacts created by the players, in order to (a) calculate the Computational Creativity Metrics for these artefacts and (b) update the user's creativity profiles.

The described architecture poses the representation and communication requirements that must be satisfied in order to integrate the distinct architectural components in a way that will ensure (a) that the platform is easily extensible with different games and class settings, and (b) that the produced content will be able to be incorporated with minimal effort in different learning environments.

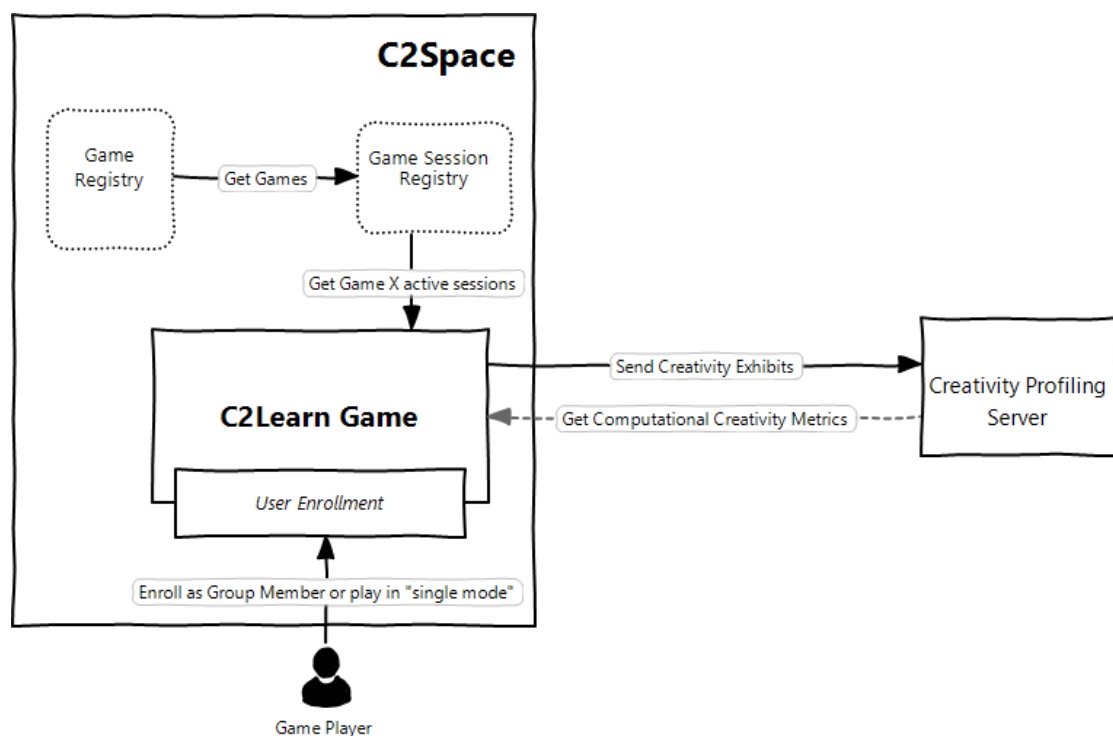


Figure 1: Overall Architecture

More specifically, in order for a game to become available in C²Learn Game Sessions, it has to be declared in the *Game Registry*. To this end, the game should provide metadata regarding its usage and requirements. The metadata also include a pointer to the *Game Repository*, where the actual game is available.

The next step is to define a Game Session, i.e. define the game to be used and the participating players. The produced game session definition is stored in the *Game Session Registry*.

As the players participating in a Game Session proceed with their creations, the latter are sent to the Creativity Profiling Server (CPS). As the provided C2Learn Games are not designed to be adaptive with respect to user characteristics, but they adapt the game progress based on the evolution of the users' creation at hand, the updated version of the C2Learn Creativity Profiling Server aims to identify patterns of creativity by analysing the produced artefacts using machine learning and data mining techniques. Towards this, it collects and processes information pertaining to all CER techniques, expressed in different modalities (for further details, cf. D3.4.2b).

In deliverable D4.2b, C2Learn Content Representation, we analysed the content representation requirements for the Game Registry and Game Repository components, and the respective choices of standards and formats that will be used within C2Learn. In the present deliverable, we report on the interoperability specification for the exchange of information between the C2Learn games and the Creativity Profiling Server (CPS), for all the supported types of Creativity Exhibits handled by the CPS. The specification relies on widely used and supported standards and aims to facilitate the connectivity of CPS with all existing and future applications.

2. CPS INTEROPERABILITY SPECIFICATION

The type of creativity exhibits that CPS can handle are divided into three categories:

1. Semantic Reasoning Exhibits (SRE): This category concerns textual exhibits, such as stories.
2. Diagrammatic Reasoning Exhibits (DRE): This category concerns diagrams and image creations as exhibits
3. Emotive Reasoning Exhibits (ERE): This category concerns the behavioural actions of a user and will be further analysed in the next version of CPS and reported in the relevant deliverable (D3.4.3).

As described in deliverable D3.4.2b, User Profiling & Behaviour Detection, the CPS exposes an API based on the REST architectural paradigm. REST was developed by W3C Technical Architecture Group (TAG) in parallel with HTTP 1.1, and aims to pose a set of architectural constraints applied over components, connectors, and data elements coordinated under a distributed hypermedia system (such as the World Wide Web). For the exchange of data elements, the CPS uses JavaScript Object Notation (JSON), an open standard format understandable by humans, used to transmit data objects consisting of attribute–value pairs. JSON is widely used by numerous applications, as it is light-weight, easily understandable and easy to manipulate.

Details on the CPS API can be found in deliverable D3.4.2b (section 6). C2Learn Games use the API to submit the created creativity exhibits to the CPS. The following subsections describe the format that the textual and pictorial artefacts created during C2Learn Games must conform to in order to be processable by the CPS.

2.1 REPRESENTATION OF SEMANTIC REASONING EXHIBITS

As stated, Semantic Reasoning Exhibits are textual artefacts, such as stories, created during C2Learn gaming activities. In order to be submitted to the CPS, the texts created during a game must be URL-encoded¹ in order to be accepted by the CPS REST API. This is a simple and straightforward process, as all major languages provide the relevant functions to URL-encode a string.

As the information transmitted is non-sensitive and anonymized there is no need for further encryption over the exchanged information.

¹ For details on URL encoding, cf. <https://dvcs.w3.org/hg/url/raw-file/default/Overview.html>

2.2 REPRESENTATION OF DIAGRAMMATIC REASONING EXHIBITS

Concerning Diagrammatic Reasoning Exhibits, we distinguish the following two cases of artefacts that can be submitted to the CPS.

- a) Images: images are actual pictorial elements created during C2Learn games. In order to submit an image to CPS, the image must be serialized in a string representation. The string representation accepted by CPS is a base64 encoding string, supported by all major languages via appropriate functions.
- b) Concept Graphs: Concept graphs are diagrams accompanied with semantic information. Concept graphs provide a textual description of the entities included in it, along with the relations between them (either taxonomical or contextual). For the purposes of C2Learn, concept graphs are serialized as JSON objects conforming to a specific structure. An edge between two entities in the concept graph is denoted by a triple of the form:

$$Edge(E1, E2) = \{ "c1": < E1 >, "c2": < E2 >, "rel": < Rel > \}$$

Which corresponds to the following graph structure:

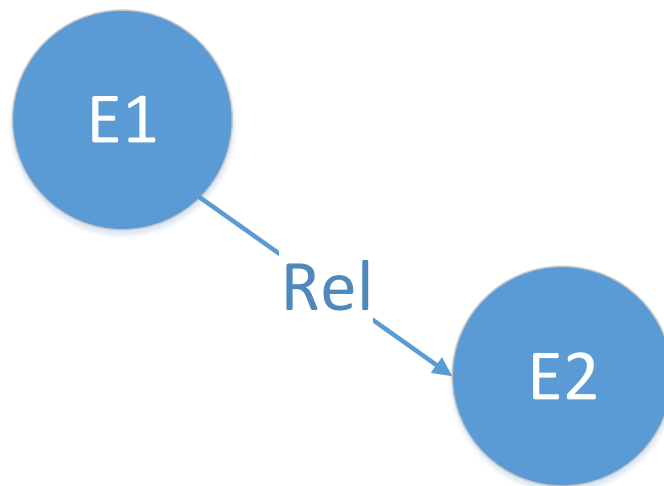


Figure 2: Relation in a Concept Graph

In the relation, E1 is the textual description for the source entity, E2 is the textual description of the target entity and Rel is the connecting relation between these two entities. For hierarchical relations, CPS accepts the “isA” relation to denote subsumption.

For representing the whole concept graph therefore, the corresponding JSON object is a table containing all the triples defined in the concept graph:

$$Graph = [Edge(E_i, E_j)], \text{ where } \exists rel(E_i, E_j)$$

An example of a concept graph and its respective representation follows:

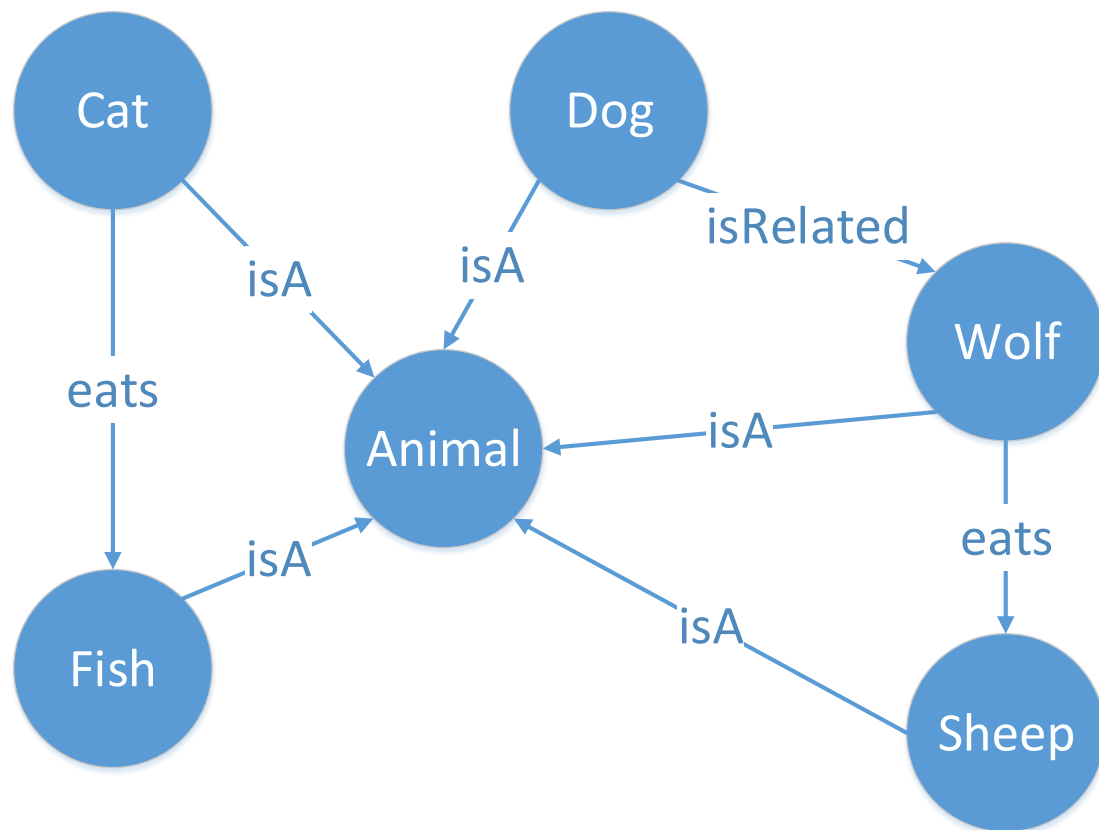


Figure 3: Exemplary Concept Graph

```
[{"c1":"cat","c2":"animal","rel":"isA"}, {"c1":"cat","c2":"fish","rel":"eats"}, {"c1":"dog","c2":"animal","rel":"isA"}, {"c1":"wolf","c2":"animal","rel":"isA"}, {"c1":"wolf","c2":"sheep","rel":"eats"}, {"c1":"fish","c2":"animal","rel":"isA"}, {"c1":"sheep","c2":"animal","rel":"isA"}, {"c1":"dog","c2":"wolf","rel":"isRelated"}]
```

Figure 4: Exemplary JSON Representation of a Concept Graph

2.3 REPRESENTATION OF EMOTIVE REASONING EXHIBITS

The representation for Emotive Reasoning Exhibits will be specified when the nature of these exhibits is further defined by the design of the C2Learn Games that produced them.

3. CONCLUSIONS

The present deliverable describes the interoperability specification for the exchange of information between the C2Learn Games and the Creativity Profiling Server, and more specifically, the standards and formats adopted for the submission of creativity exhibits to the CPS.

The current version of the specification covers the cases of Semantic Reasoning Exhibits (i.e. textual artefacts) and Diagrammatic Reasoning Exhibits (i.e. Images and Concept Graphs). The specification for the submission of Emotive Reasoning Exhibits will be reported in an additional version of the deliverable, as soon as the nature of the Emotive Reasoning Exhibits created during C2Learn Games is specified.