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# Creativity Profiling Server: Modelling the Principal Components of Human Creativity over Texts

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- ❖ Analysis of the computational creativity theories examined
  - Computational Creativity Metrics
- ❖ Assess the theory based on experiments with humans
  - Reveal which metrics conform with the human perception of creativity.
- ❖ Transfer of the metrics to an adjacent to human intuition basis
  - Experiment with diverse datasets to show correlation between the metrics
  - Combine three metrics to form a new one, with the aim to move computational creativity space closer to human thinking
- ❖ Constructed a stable system that applies the outcomes of the above
  - Creativity Profiling Server



# Computational Creativity Metrics: Definition

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A set of well established and more novel metrics were exploited, which given a set of textual artefacts, are able to calculate their creativity.

- Novelty : The deviation from existing knowledge/ experience. It is generally measured as a difference metric between what is already known and the new content
- Surprise : The unexpectedness exhibited inside an artefact. Surprise can be derived by comparing successive segments of the artefact in terms of semantic coherence
- Impressiveness is defined by two sub metrics, prerequisite for something to be labeled as impressive
  - *Rarity*: An artefact constitutes from many properties and themes. Rarity is how rare is their combination
  - *Recreational effort*: The objective difficulty the creator of the artefact has overcome to create it. It is expressed through the variety of themes that it encloses



# Computational Creativity Metrics: Adaptation for textual artefacts

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Given a **textual artefact** and a **knowledge base of texts**, this is how we adapted each metric to characterize the artefact.

**Novelty** :The average semantic distance between the dominant terms included in a text, compared to the average semantic distance of the dominant terms in all texts.

**Surprise** :The average semantic distances between the consecutive fragments within the text.

**Rarity**: The sum of weights on the min-weight closure of the artefact, compared to the maximum sum of weights of an artefact in the set.

**Recreational effort**: The number of different clusters in the artefact (analogous to the sum of its terms semantic distances by their number), compared to the maximum number of clusters found in an artefact in the set.



# Correlation of Computational Creativity Metrics With the Human Perception of Creativity

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## Experiment

1. 40 human participants, split in 2 groups with 5 teams of 4 members each were asked to construct a story, on a specified premise, with 20 fragments produced for each story.
2. After the completion, each team rates the stories of the remaining four teams belonging to their group, using a rank-based 4-star scale.
3. Calculate the metrics for each story and identify possible correlation between the metrics and the human rankings

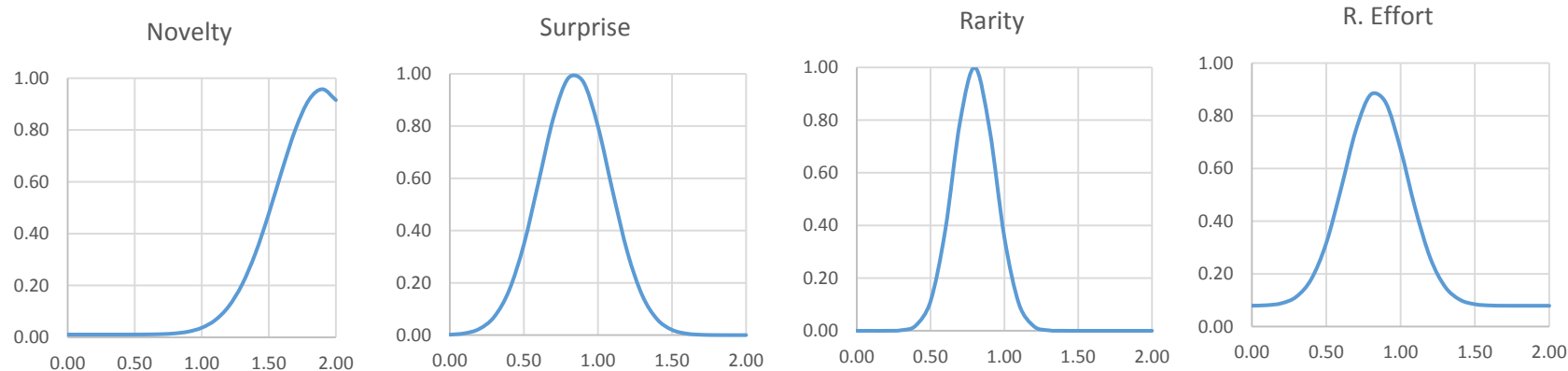


# Correlation of Computational Creativity Metrics With the Human Perception of Creativity

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## 4. Outcome:

- Novelty's increase is analogous to the increase of human's rankings.
- The rest of the metrics do not quite agree, reaching their maximum at a certain value, and then decreasing.
- As a conclusion, one can derive that the metric for novelty corresponds linearly to the human perception for novelty, while the rest of the metrics should be transformed in a way to fit human intuition.



# Transferring Computational Creativity Metrics to the Human Perspective

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An **experiment** was conducted to evaluate the correlation between the metrics, under which two conceptually different corpuses were gathered:

- Transcriptions of European Parliament Proceedings (Formal Verbal Transcription)
- Stories from Northern Myths, by E.K. Baker, available via the Project Gutenberg collection (Literary Work)

Creativity metrics were calculated for both datasets, and their respective covariance matrixes were examined.

As expected, novelty was found fairly uncorrelated with the other three.

The conclusion is that the 4 dimensional space of creativity should be transformed, while keeping the one dimension (novelty) intact.

To achieve this any new metric produced should be as uncorrelated as possible to Novelty.



# Metrics orthogonality and Atypicality

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Claim: Identify the principal components of creativity

Task: Find a creativity space that captures human creativity in a sufficient manner. Novelty is one of the dimensions. The others should be independent to it so we aim to minimize their correlation.

Solution: Atypicality is a weighted linear combination of the three other metrics (Surprise, Rarity and Recreational Effort).

$$A(t) = \frac{w_s Sur(t) + w_r Rar(t) + w_e Eff(t)}{w_s + w_r + w_e}$$

We run a **minimization** operation to reveal the coefficients of each metric such that the **orthogonality** (correlation of the two dimensions) diminishes, using values from the past experiment.

Minimise  $\sum_{i=1}^n (Correl(Novelty_i, Atypicality_i))^2$ , s.t.  $w_s, w_r, w_e \in [-1, 1]$

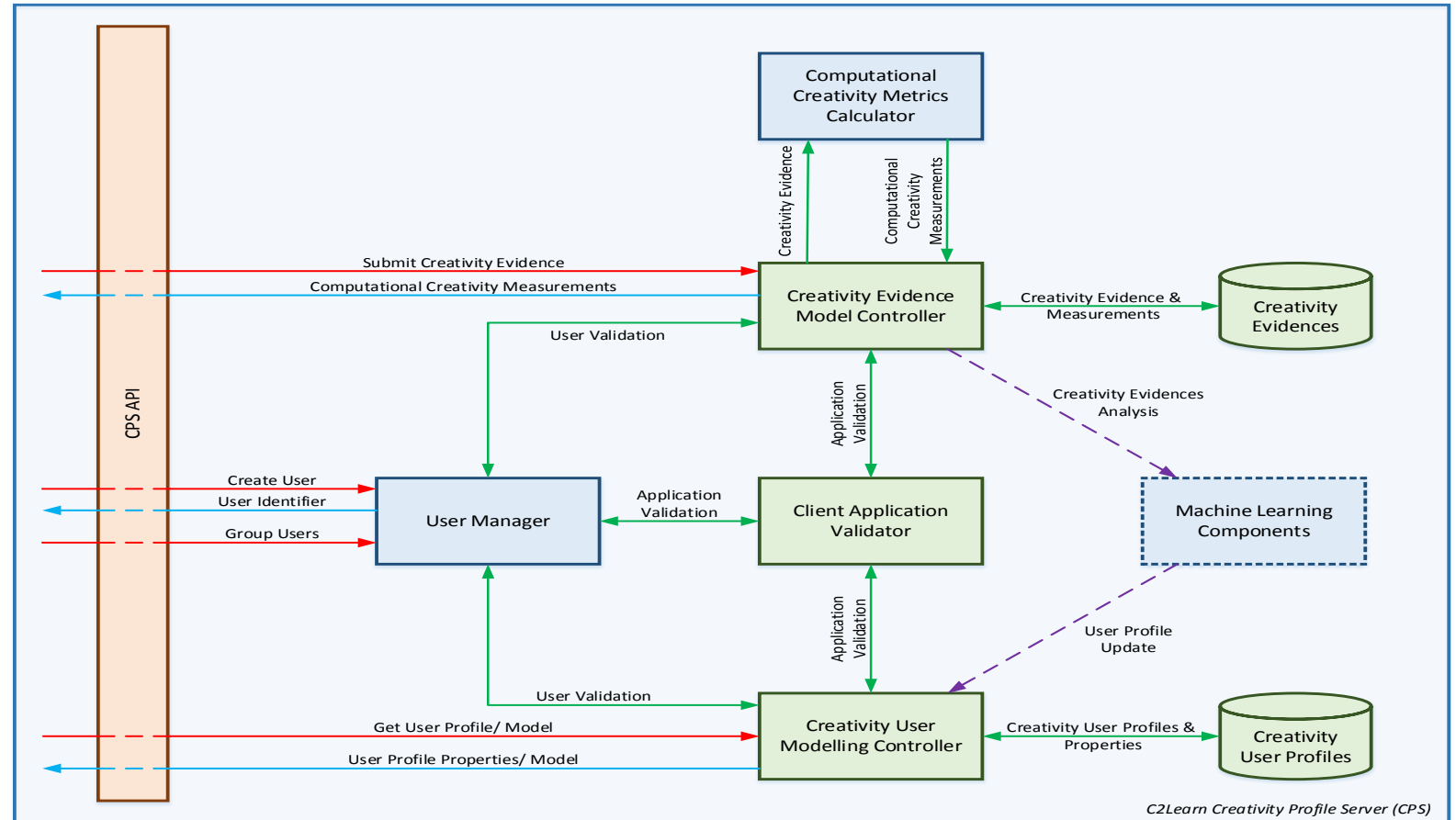
	Orthogonality
Formal Verbal Transcription	2.986E-07
Literary Work	1.436E-07





# Creativity Profiling Server (CPS)

*Creativity Profiling Server (CPS)* is a system to support creativity assessment for educational application. It supports traditional features of similar servers like user tracking, group formation and includes a set of components to implement the creativity evaluation and profiling.



## CPS Testing Interface

<http://cru.iit.demokritos.gr:8500/CreativityProfileServer/>



# CPS work flow

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1. The server can create a new user through its API. (**USER MANAGER**)
2. When a user submits an artefact, the server initially checks his/her authentication. (**APPLICATION VALIDATOR**)
3. Then the system calculates and stores the artefact and its 4 Creativity Metrics (**CREATIVITY EXHIBIT MODEL CONTROLLER + COMPUTATIONAL CREATIVITY METRICS CALCULATOR**)
4. Afterwards,
  - A four dimensional vector is constructed from the metrics of the user's artefacts
  - The vector is transformed to two dimensions applying the aforementioned theory
  - The user's updated profile is analogous to the last point of this vector and the previous one, in a decay through time fashion(**MACHINE LEARNING COMPONENTS**)
5. Lastly, part of the user's group profiles are added to the profile in a balanced way, according to the group's creativity difference with the user. It is stored and can be retrieved through the API. (**CREATIVITY USER MODELLING CONTROLLER**)



# CPS Temporal adaptation and Evaluation

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## Refinement of atypicality

Every time window (predefined), the server runs the minimization process (same as in the experiment), with the current artefacts metrics, constantly checking for a better approximation of atypicality.  **As the knowledge base expands, the system becomes more effective.**

## Preliminary CPS Evaluation

We run an **experiment** with twenty students that produced five stories each to predefined topics and asked five experts to make **each one** an ordered list of the texts produced and the students based on creativity. **Success** (a measure based on Kendall's tau) was employed to find the agreement of expert rankings and the CPS creativity profile.

	Textual Exhibits	Users
Min Success	0.58	0.56
Average Success	0.74	0.71
Max Success	0.89	0.88



# Conclusions & Next Steps

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To conclude, our contribution is..

1. The derivation of a new, more efficient conceptual space of computational creativity
2. A fully functional server that applies this new theory
  - Supports group profiling and standard user management.
  - Profiles its users in terms of creativity using their exhibits with a realistic time decay factor.
  - Maintains an expandable knowledge base and refines its algorithm based on it.

Our aim for the future is to...

1. Examine the effectiveness of the model in more complex experiments
2. Test with textual exhibits from different domains and modalities (prose, poetry, speech)
3. Observe over more open-ended experiments on the subject



# Thank You!



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*([www.c2learn.eu](http://www.c2learn.eu))*