

A Minimal Model of Computational Creativity and the CSF

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Boden's (1992) hierarchy identifies the levels of Combinational, Exploratory and Transformational creativity, which Wiggins (2006) formalised into the abstract **Creative Systems Framework (CSF)**. We use the CSF to explore the question: what is the simplest computational system that one could argue is creative? We outline RegExplore that adopts the micro-world of string manipulation centred on CSF where; concepts c_i are strings, rules \mathcal{R} are regular expressions (regex) that we hope to creatively modify with some traversal strategy \mathcal{T} . Beginning with conceptual spaces such as; flight numbers, car registration plates or product codes, can a Computational Creativity (CC) system create a new space representing different forms of these data of value to some user? RegExplore is being developed as an aid to teaching (Filimowicz and Tzankova, 2017) formal aspects of CC to undergraduate computer science students while also serving as an instantiation of the CSF and as a tool for software testing and engineering.

RegExplore allows iterative interaction between strings c_i and expressions \mathcal{R} by firstly learning (Espirito Santo *et al*, 2024) the expressions that generalize across a collection of strings. It also generates random strings from an expression/rule to explore that conceptual space, showing Boden's improbable or *combinational* creativity.

The traversal strategy \mathcal{T} adopts the Blind Variation and Selective Retention (BVSr, Simonton, 2010) approach to creativity, currently using mutation to vary the rules \mathcal{R} of a space (future work may apply mutation to strings). \mathcal{T} implements syntax aware mutation that changes literals, ranges, quantifiers, special characters, *etc* via the operations; insert, delete and replace. This approach allows examination of each factor on Transformational Creativity (TC), in isolation and collectively. Mutations that focus on literals and ranges illustrate some aspects of *exploratory* creativity.

Pareto optimality selects expressions in terms of their novelty and quality. Quality assesses the range of original strings accepted by the updated expression, while novelty can identify artifacts with short descriptions that require long run times (Ventura and Brown, 2024).

A set of alternate solutions are presented to users along with their evaluations, showing the new regex and a sample of randomly generated strings for illustration that aids users in their selection. Users can explore selection based on some (unstated) pre-determined objective or can explore dynamically changing their selection criteria – from within the presented alternatives.

As well as this interactive mode, it may operate autonomously by performing a sequence of iterative updates

and displaying only the final results. This mode better explores autonomous creativity.

Evaluation. What can such a micro-model tell us about real transformational creativity? Starting with a restricted language defined by a^+ producing, a , aa , aaa *etc*, what are the likely sequence of transformations that RegExplore is likely to produce, under various selective pressures? Beginning with strings whose characters are all in alphabetical order, we might argue in favour of TC upon production of a string out of alphabetic order.

Many have suggested that modern large language models demonstrate creativity comparable to humans, with claims often resting on the temperature parameter (Peepercorn *et al*, 2024). But are much simpler models capable of creativity? One experiment started with registration plates for Irish cars, each with a 3-digit date, 1 or 2 letter location and an id-number (261-KE-12345). Three successive transformational operations yielded $\setminus\{2,3\}\setminus\{A-Z\}\{1,2\}\setminus\setminus\{2,8\}$ matching strings like 6Z-Tss1EwwBI, T38-DS-VtELc, Wfp-PT-q7n. RegExplore created a newly transformed space of interesting strings maintaining some structure from the original strings. But this new space had a balanced compression score of 0.74 when the mean of 29 alternative expression was 0.68 (SD=0.017) - indicating less compressible strings containing a greater degree of information compared to the alternatives. This resulted not from random change but from iterative, guided interventions rooted in novelty and quality metrics.

Another experiment started with $[A-Z]\{2\}\setminus\{d\}\setminus\{d[A-Z]\{2\}\}$ producing $[A-m]\{\}\setminus\{d\}\setminus\{d[A-Z]\{2\{2,5\}\}$. This was surprising because some of the original quantifier syntax, $\{$ and $\}$, was incorporated directly into the newly producible strings, creating a new space including: $Z\{49D\{222\}$. We argue these are examples of micro-TC – showing qualities such as surprise (Boden, 1991) imagination and skill (Colton *et al*, 2011)?

Future work looks at introducing more categories like vowels, consonants, odd and even numbers enabling greater exploration of constraints. We plan to explore constraints involving positive and negative lookaround expressions. Does creativity arise from uniqueness of the individual string – or diversity (Demke *et al*, 2023) of the inspiring set? Explicit comparison of rules may identify generalization or incompatibility between search spaces, allowing exploration of creative trajectories over time. How does this micro-TC relate to real TC? Can we align RegExplore with rational reconstruction (Camap, XXXX) of creative scenarios?

Does this shed any light on whether LLMs can create computational systems with power equal to themselves – what O'Donoghue *et al* (2014) called self-sustaining

creativity? Will the output of existing LLM increase or decrease the creative power of newer LLM trained on generated data?

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References

- Boden, M. 1992. *The Creative Mind*. London: Abacus.
- Carnap, Rudolf. The logical structure of the world. Open Court Publishing, 2003.
- Colton, Simon, John William Chamley, and Alison Pease. "Computational Creativity Theory: The FACE and IDEA Descriptive Models." In *ICCC*, pp. 90-95. 2011.
- Demke, Jonathan, Kazjon Grace, Francisco Ibarrola, and Dan Ventura. "Transformational Creativity Through the Lens of Quality-Diversity." In *ICCC*, pp. 304-307. 2023.
- Espírito Santo, Luís, Geraint Wiggins, and Amílcar Cardoso. "Towards a Formal Creativity Theory: Preliminary results in Novelty and Transformativeness", *arXiv* e-prints (2024): arXiv-2405.
- Filimowicz, Michael, and Veronika Tzankova, eds. *Teaching computational creativity*. Cambridge University Press, 2017.
- O'Donoghue, Diarmuid, J. Power, S. O'Briain, F. Dong, A. Mooney, D. Hurley, Y. Abgaz, C. Markham. "Can a computationally creative system create itself? Creative artefacts and creative processes" *ICCC*, 146-154, 2014.
- Peeperkorn, Max; Kouwenhoven, Tom; Brown, Dan; Jordanous, Anna; Is Temperature the Creativity Parameter of Large Language Models? , *ICCC*, 2024. arXiv:2405.00492
- Simonton, Dean Keith. "Creative thought as blind-variation and selective-retention" *Physics of life reviews* 7, no. 2 (2010): 156-179.
- Simonton, Dean Keith. "The blind-variation and selective-retention theory of creativity: Recent developments and current status of BVSR." *Creativity Research Journal* 35, no. 3 (2023): 304-323.
- Ventura, Dan, and Dan Brown. "Creativity as Search for Small and Interesting Programs." In *ICCC*, pp. 331-335. 2024.
- Wiggins, G. A. 2006. A preliminary framework for description, analysis and comparison of creative systems. *Knowledge Based Systems* 19:449–458.