

SPECIAL ISSUE ON

MODELS OF REPRESENTATION IN COMPUTATIONAL INTELLIGENCE

Aims and Scope

Computational Intelligence (CI) provides a set of powerful tools to effectively tackle complex computational tasks: global optimization methods (e.g., evolutionary computation, swarm intelligence), machine learning (e.g., neural networks), and fuzzy reasoning.

While CI research activity generally focuses on the improvement of the algorithms (e.g., faster convergence, higher accuracy, reduced error), there is another promising research direction consisting in the modification of the *representation of solutions*. This can be in the form of *search space transformation*, that is, dilating, shrinking, stretching, collapsing, or remapping the fitness landscape, leading to simplified formulations of the optimization problem. The use of *surrogate modeling* can further reduce the complexity - or the computational effort - of a CI task, by providing to the optimization algorithm a simplified or approximated version of the fitness landscape. Moreover, in discrete domains, the simplification of the problem can be obtained by *embedding implicit or explicit assumptions into the structure of candidate solutions*, so that the feasible search space can be explored by genetic operators in a “smarter” way, reducing the overall computational effort. In the contexts of machine learning or fuzzy modeling, the focus can switch on *interpretability and explainability* issues, two open issues that currently affect the trust in AI solutions and hamper the adoption of such techniques in several disciplines (in particular, biomedical applications).

While many times problem-specific strategies have been used, there is still a general lack of *universal theories* and results for the optimal way of selecting or building a representation of a particular problem, including the possibility of *automatically generating representations*. Both theoretical and applied research can be performed in this novel field of research, driving new discoveries, novel perspectives in the context of fitness landscapes analysis, solutions representation, and generation of representation models, improving the performances and our understanding of existing algorithms. Consider the power of transcending search of a fitness landscape to generate novel fitness landscapes that transform the solubility of difficult problems.

This special issue aim at collecting research work introducing novel ideas in multiple areas:

- For evolutionary and population-based techniques, new variation operators and even new classes of global optimization meta-heuristics that might devote a part of their budget for fitness evaluations to automatically derive an optimal representation.
- New general techniques for the manipulation (e.g., shrinking, stretching, remapping) of the search space for a particular class of problems might be used to improve the performances and generality of most existing CI methods in that particular class of problems.
- Deep learning is capable of sophisticated pattern recognition using many layers of neural processing to extract more and more complex features. This suggests that deep learning could be employed to steer the process of self-organization of novel representations, abstracting the portions of the representational domain that yield better performance.
- This special issue is open to both novel directions on transforming problems (to make them easier to solve, or clear to interpret/analyse) or radically new algorithms (e.g., novel generative or implicit representations).
- From the point of view on interpretable and explainable AI, new theories about representation and communication can arise, providing domain experts with an increased level of understandability of the CI system.

Topics

Topics of interest include, but are not limited to:

- Non-conventional representations of candidate solutions
- Interpretable/explainable representations
- Surrogate models
- Graph-based representations
- Dilation functions and other functions that reshape the fitness landscape
- Fitness landscape transformation, simplification, and restriction
- Alternative semantics for candidate solutions
- Novel closed variation/evolutionary operators
- Implicit/relative representations
- Generative or developmental representations
- Self-adaptive representations
- Parameterized manifolds of representations
- State-conditioned representations

- Procedural representations
- Generative automata

Submission

The IEEE Computational Intelligence Magazine (CIM) publishes peer-reviewed high-quality articles. All manuscripts must be submitted electronically in PDF format. Manuscripts must be in standard IEEE two-column/single space format and adhere to a length of 10 pages (including figures and references) for regular papers. A mandatory page charge is imposed on all papers exceeding 10 pages in length.

More information on manuscript details and submission guidelines can be found at the following websites:

- Special Issue website: <https://cmte.ieee.org/cis-bbtc/ieee-cim-special-issue-on-models-of-representation-in-computational-intelligence/>
- IEEE CIM website: <https://cis.ieee.org/publications/ci-magazine/cim-information-for-authors>

Important Dates

- Manuscript Due: **June 1, 2022**
- First Notification: August 1, 2022
- Revision Due: September 1, 2022
- Final Notification: October 15, 2022

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