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COINVENT

Concept Invention Theory

COINVENT is a collective effort to advance the understanding of creativity and its computational realisation.

COINVENT investigates mathematical models of general cognitive principles that operate when new concepts are invented, so as to be able to engineer computer systems that effectively support humans in their creative thinking.

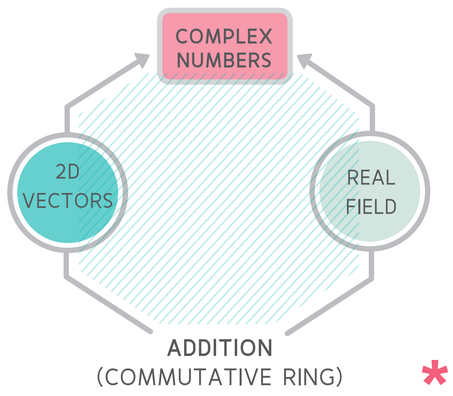
COINVENT focuses on the mathematical formalisation and the computational implementation of conceptual blending, a fundamental cognitive operation intrinsic to everyday thought and language. By conceptual blending humans combine particular elements and their relations of originally separate mental spaces into a unified space, in which new elements and relations emerge and new inferences are drawn.

COINVENT brings together a team of scientists of Europe's leading universities and research centres in formal systems, cognitive science, artificial intelligence, computational creativity, mathematical reasoning and cognitive musicology, with the objective of bringing about a computational creative system to be deployed in two representative working domains of creativity: mathematics and music.

COINVENTing MATHEMATICS

The creative act of providing novel definitions, conjectures, theorems, examples, counter-examples, or proofs are cases of concept invention in mathematics.

COMPLEX NUMBERS AND QUATERNIONS



The complex numbers can be looked at as a conceptual blend between the real numbers as a field (with addition, multiplication, and division) and vectors in two dimensions (with addition and scalar multiplication by a real). COINVENT-based technology enables us to find the complex numbers as a conceptual blend, by recognising the strong similarity between the addition operation on reals and addition of vectors. This suggests looking for multiplication and division operations on the complex numbers.
By looking at 4-dimensional vectors, this can be extended further to the case of quaternions, but leaving out commutativity to obtain a consistent blend.

* Conceptual blends of mathematical structures yielding the complex numbers.

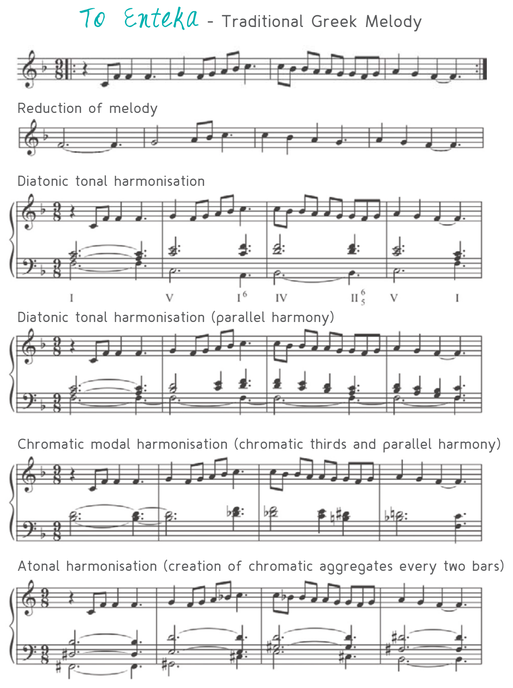
By deploying COINVENT-based technology in mathematics we shall go beyond the capabilities of current state-of-the-art automated reasoning support tools, so as to be perceived as facilitators of creative thinking.

COINVENTing MUSIC

The generation of new melodies, harmonies, rhythms, counterpoints (and their combination) in diverse musical contexts, and the integration of musical and textual/gestural spaces to achieve novel musical metaphors are cases of concept invention in music.

MELODIC HARMONISATION ACROSS IDIOMS

We should be capable of devising appropriate chordal harmonisations for tunes derived from diverse music idioms/cultures (e.g. tonal, modal, contemporary, traditional) with COINVENT-based technology. A computational system could autonomously explore different chordal spaces generating novel harmonic combinations appropriate for the melodies at hand. This could be applied for video-game design and programming, by endowing game creations with the capacity of generating new dynamic harmonisations on-the-fly; COINVENT-based technology could provide appropriate harmonisations following mood changes or activity or gestural patterns emerging as the game unfolds.



* A traditional melody is harmonised in radically different ways corresponding to individual harmonic spaces. COINVENT-based technology may generate such original harmonisations or enable the emergence of new unpredicted harmonisations stemming from blends between such spaces.

By deploying COINVENT-based technology in music we shall make computer software go beyond the mere application of style-specific compositional rules, bringing creativity right into the computational process used in music composition.

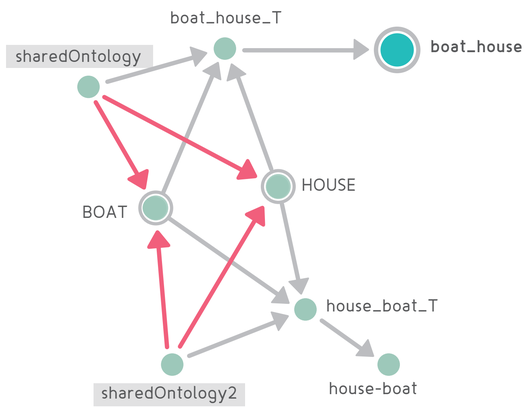
COINVENTing ONTOLOGIES

The specification of ontological information is part of any high-level description of a domain. The creation of novel concept definitions and ontological axioms from existing ontologies is therefore at the heart of concept invention.

BLENDING HOUSE AND BOAT

COINVENTing ontologies means to creatively generate new, ontologically meaningful concepts based on the definitions of two or more concepts taken from thematically distinct input ontologies whose specifications share certain structure. An example for this kind of structure-sharing is a 'hidden' axiomatisation of an image schema, such as the notion of a container found in the definitions of the concepts 'house' and 'boat'. This generates (among thousands of possibilities) the concepts of 'boathouse' and 'houseboat'.

Central COINVENT technologies to support concept blending are the Distributed Ontology Language DOL (standardised within the OntoIOp 'Ontology Integration and Interoperability' activity of OMG) to declaratively specify blending diagrams, and the ontology repository platform Ontohub that supports computationally the workflow and creative act of generating a new, blended concept. Ontohub is a DOL-enabled semantic repository with support for a large number of ontology languages and linking constructs with formal semantics.



* Blendoid representation and colimit computation via Hets/Ontohub: the screenshot of Ontohub shows the heterogeneous ontology house+boat.dol, hosted in the Conceptportal repository. The entire double-blend of house and boat into boathouse and houseboat is shown in the Graph to the left. The red arrows denote the interpretations of the shared ontologies into the blend. The concept boat_house is selected and shown on the right: its theory can be inspected by following the link to the respective ontology specification.

By deploying COINVENT-based technology to ontology engineering, we go beyond standard alignment, modularity and combination techniques, and open the door for an exploratory integration of ontological specifications to support creativity in various application domains.

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