Learning Topology and Geometry

Automated Grammar Induction

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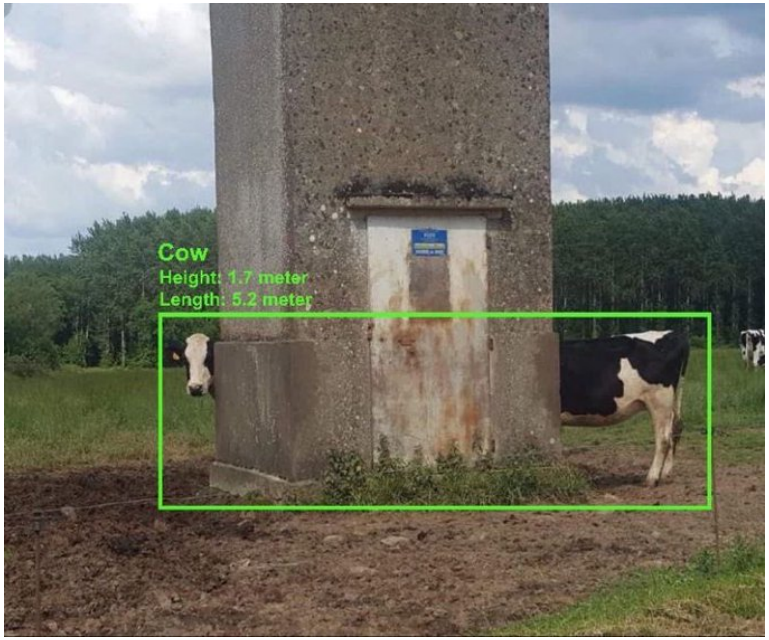
Learning Topology and Geometry

A Lack of Topological and Geometric Awareness

Critiques of DL/NN recently circulating on social media



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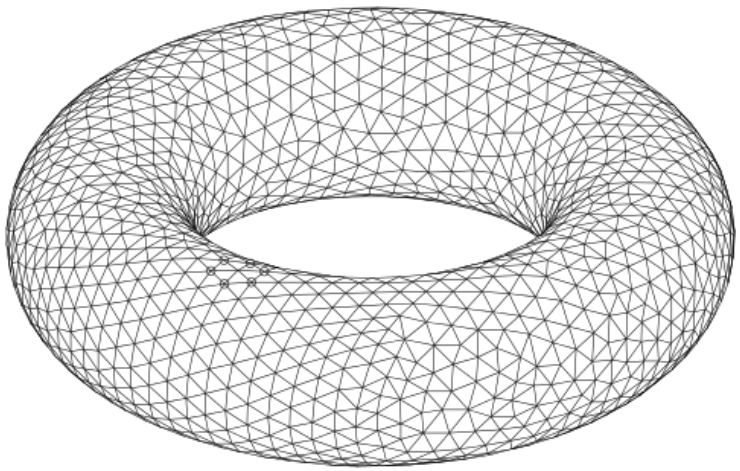
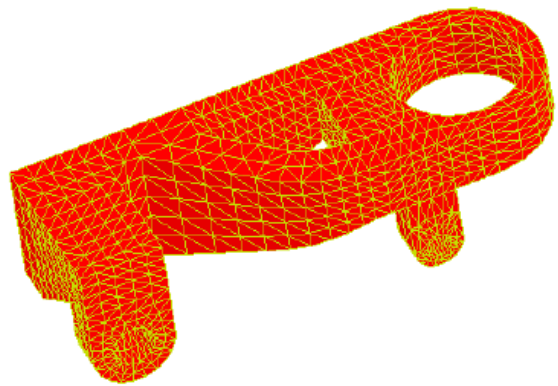
Conventional Simplical, Cellular Homology

Triangulations, cycles, cocycles, universal covering groups, metrics





Deep and broad mathemaical foundations to draw on.

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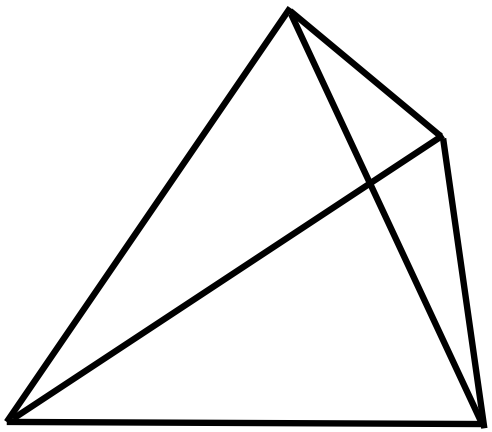
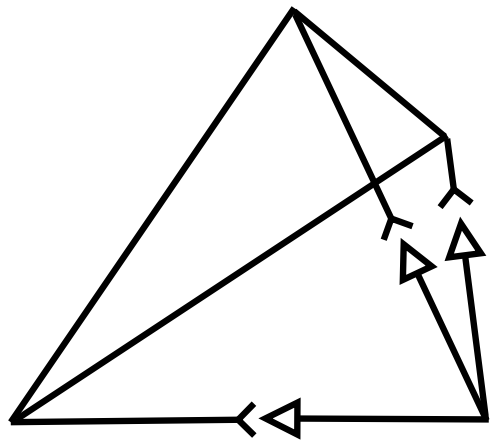
Reframe: Edge Lists -> Jigsaws with Connectors

Jigsaws, plus "global" constraints such as must-form-a-cycle





Not quite graph theory.
Not quite relational algebra.
... but almost so.

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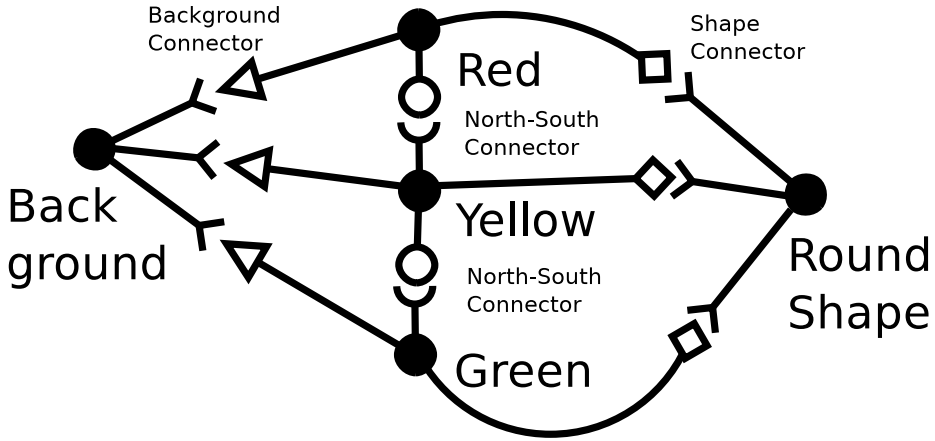
Connectors Indicate Symbolic Relationships

Image segmentation as labelled geometric relationships



Geometric syntax encodes part–whole relationships!

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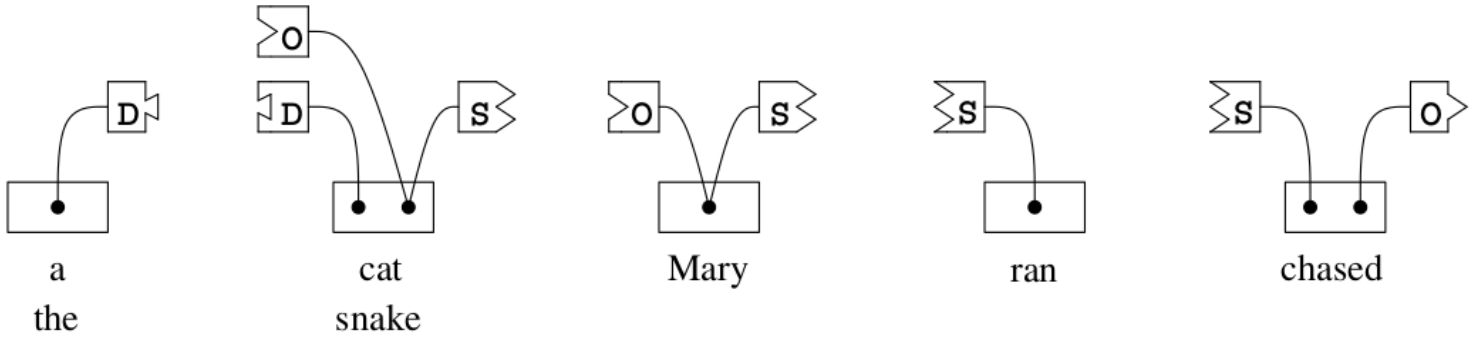
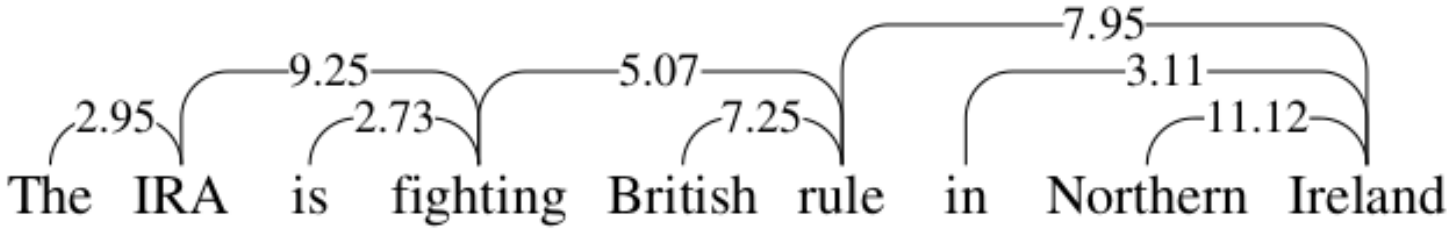
Jigsaw Paradigm Established in Linguistics

Syntax in Link Grammar (1991) and earlier (Marcus, 1967)





Maximum Spanning Tree parse from Word-Pair MI (1998)

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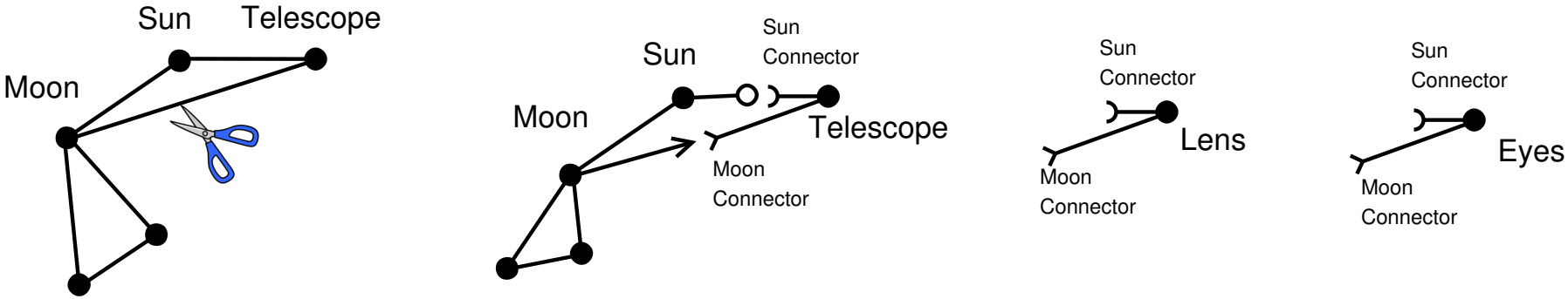
Applicable to Symbolic AI

Abstract (GOFAI) domains can be re-expressed this way too



Syntax extending into shallow semantics

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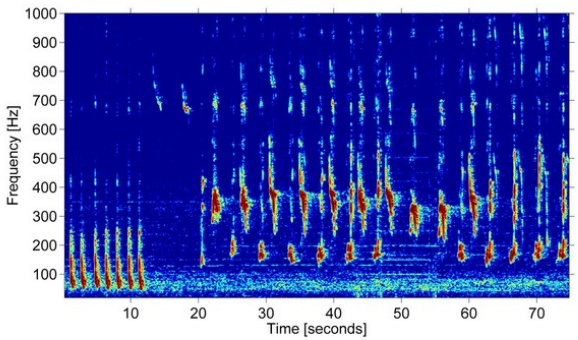
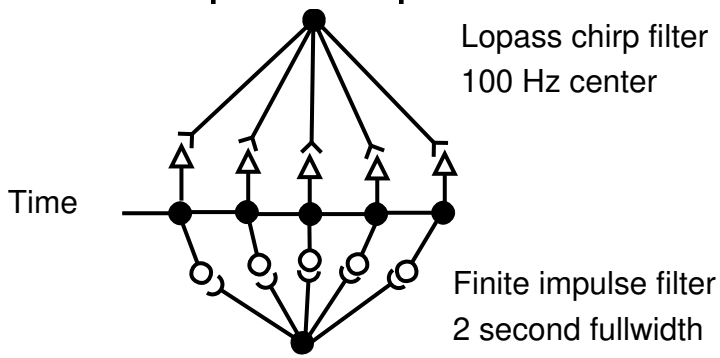
Not Just 1D, 2D, 3D, but also Abstract Sensory Domains

Audio: frequency, intensity, time, shape, chirp modulation, wavelets





Syntax and structure of a whale song

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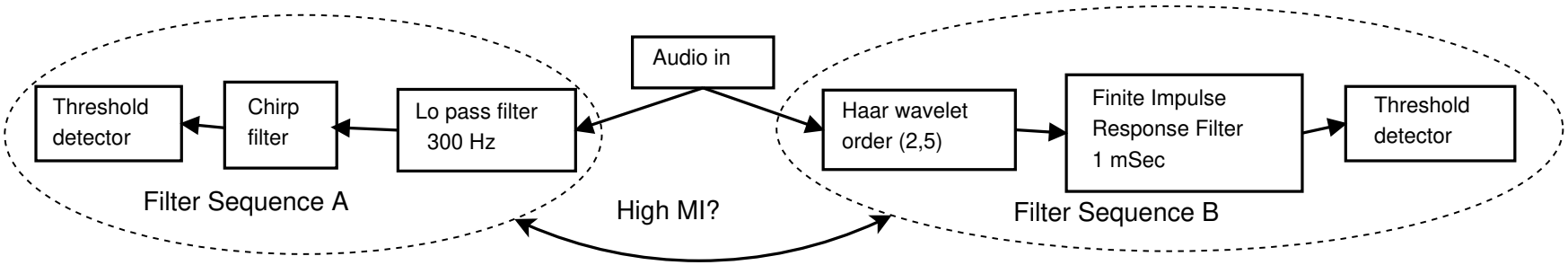
Segmentation and Tokenization as (evolutionary, ML) Program Learning

Conventional ML/AI can explore DSP filter sequences



Can DL/NN be used to generate these?
Possibly ... probably. Not been done.
Recursive... (model->syntax->model->syntax...)
... and deep ("cheap").

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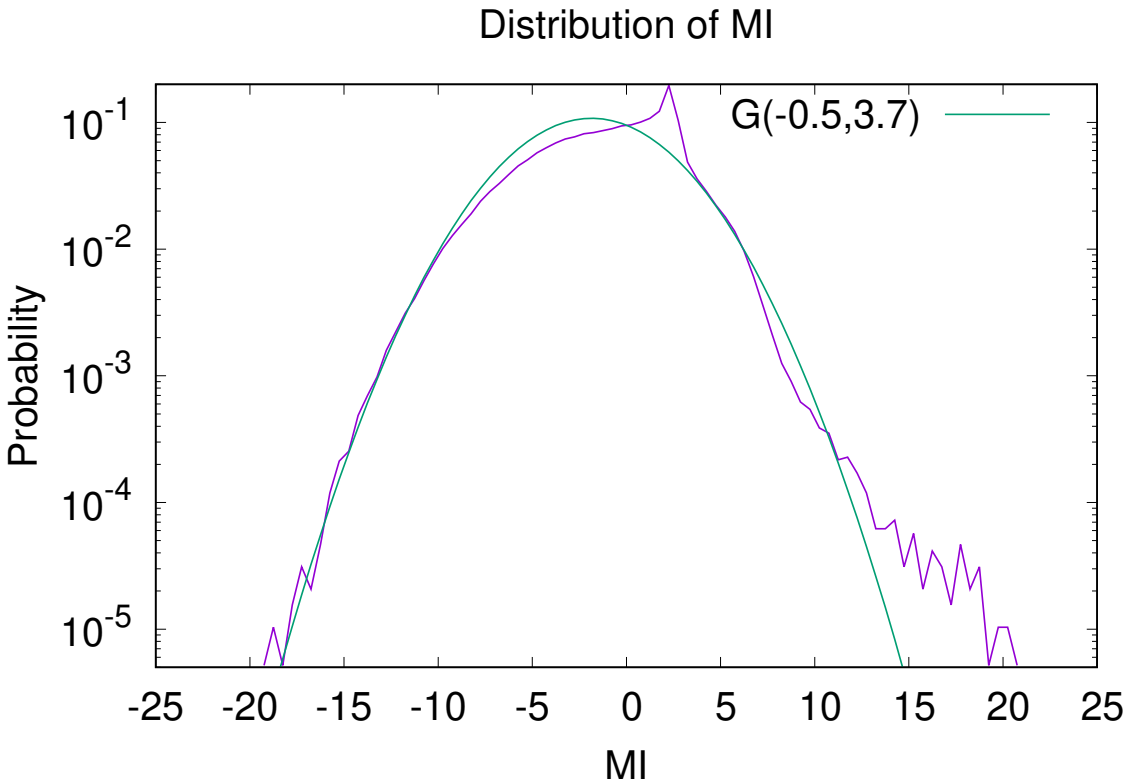
Experimental results

Gaussian Orthogonal Ensemble (Spin Glass)



Uniform distribution of English word similarities in high dimensions. Conventional (information-theoretical) metrics apply.

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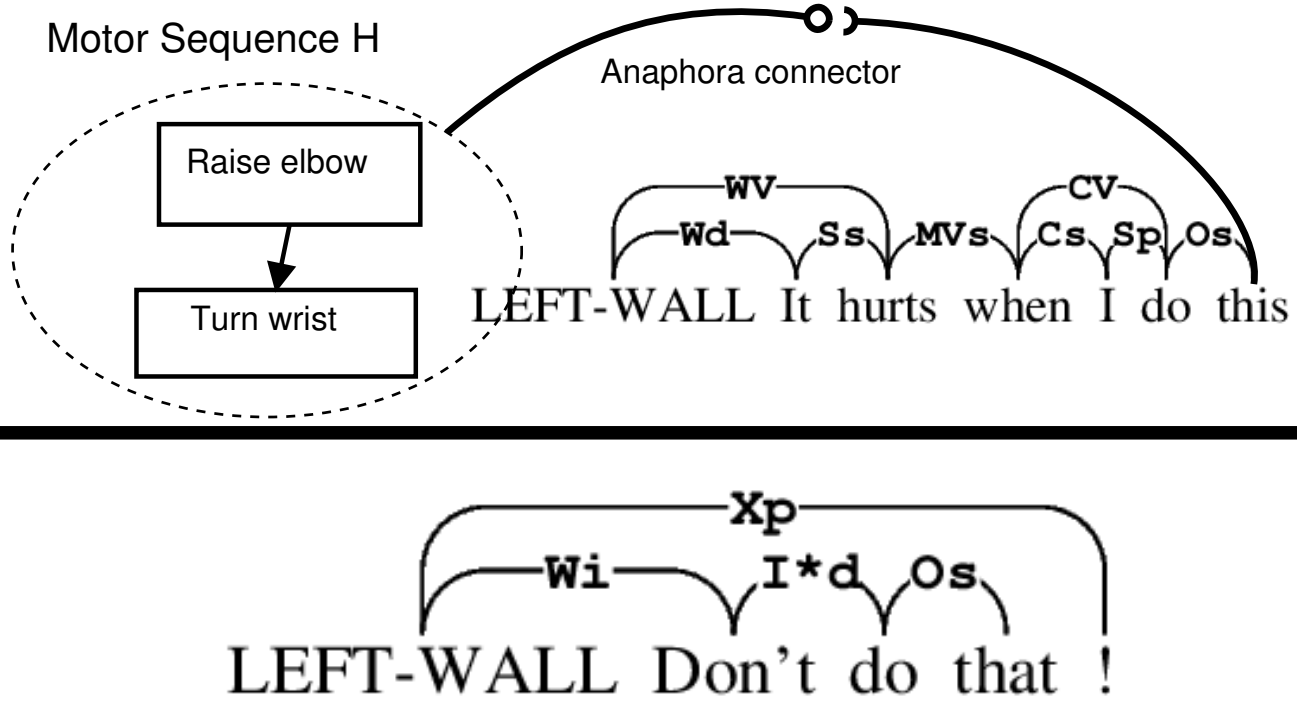
Common Sense as Inference over Symbolic Domains

Enactive AI founded on unsupervised symbolic relationships,
Learned recursively i.e. “deeply”



GOFAI failed because it depended on human-curated datasets.
This proposal doesnt.
... and it was shallow. Shallow==hard-to-learn.