

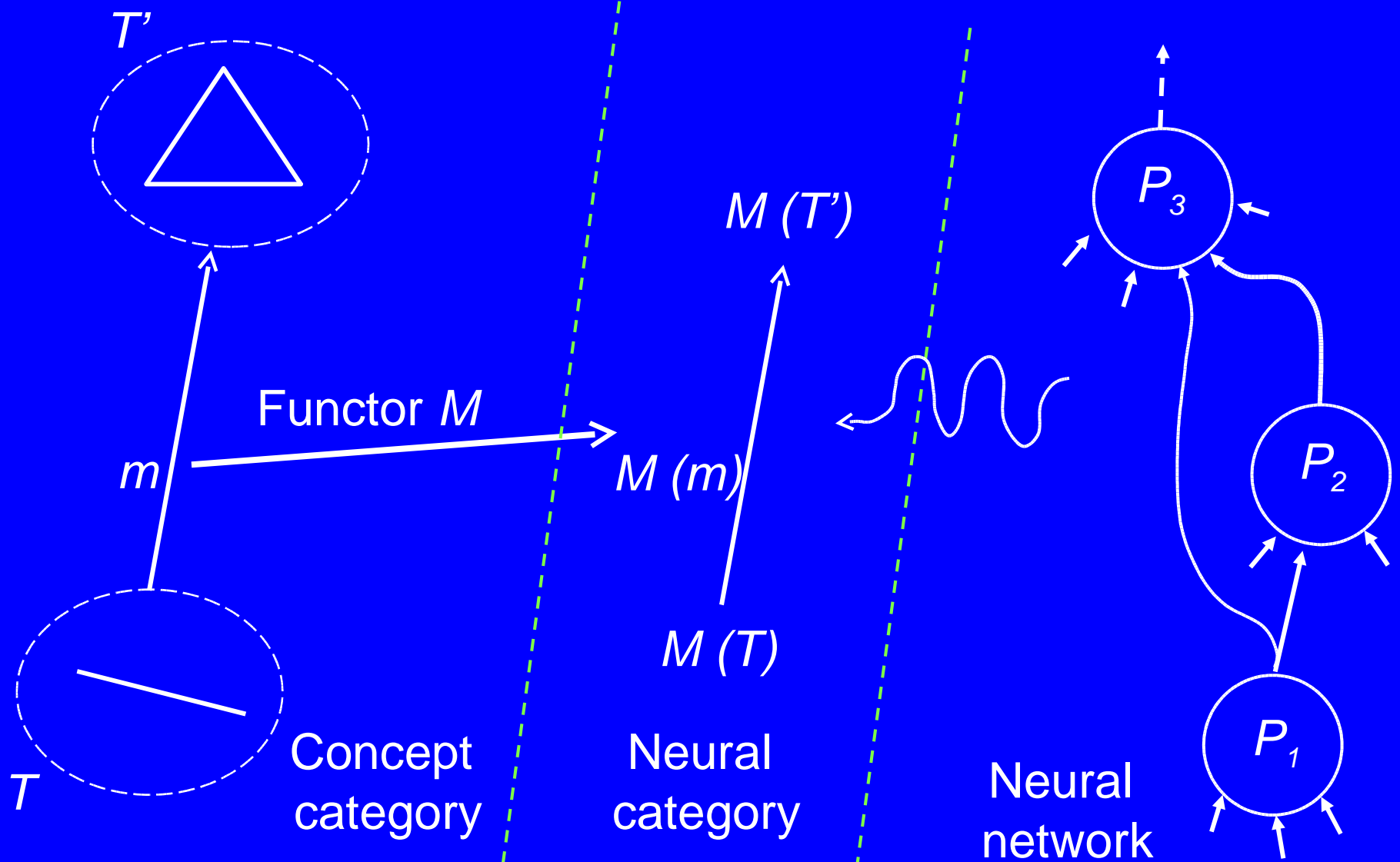
Applying Category Theory to Improve the Performance of a Neural Architecture

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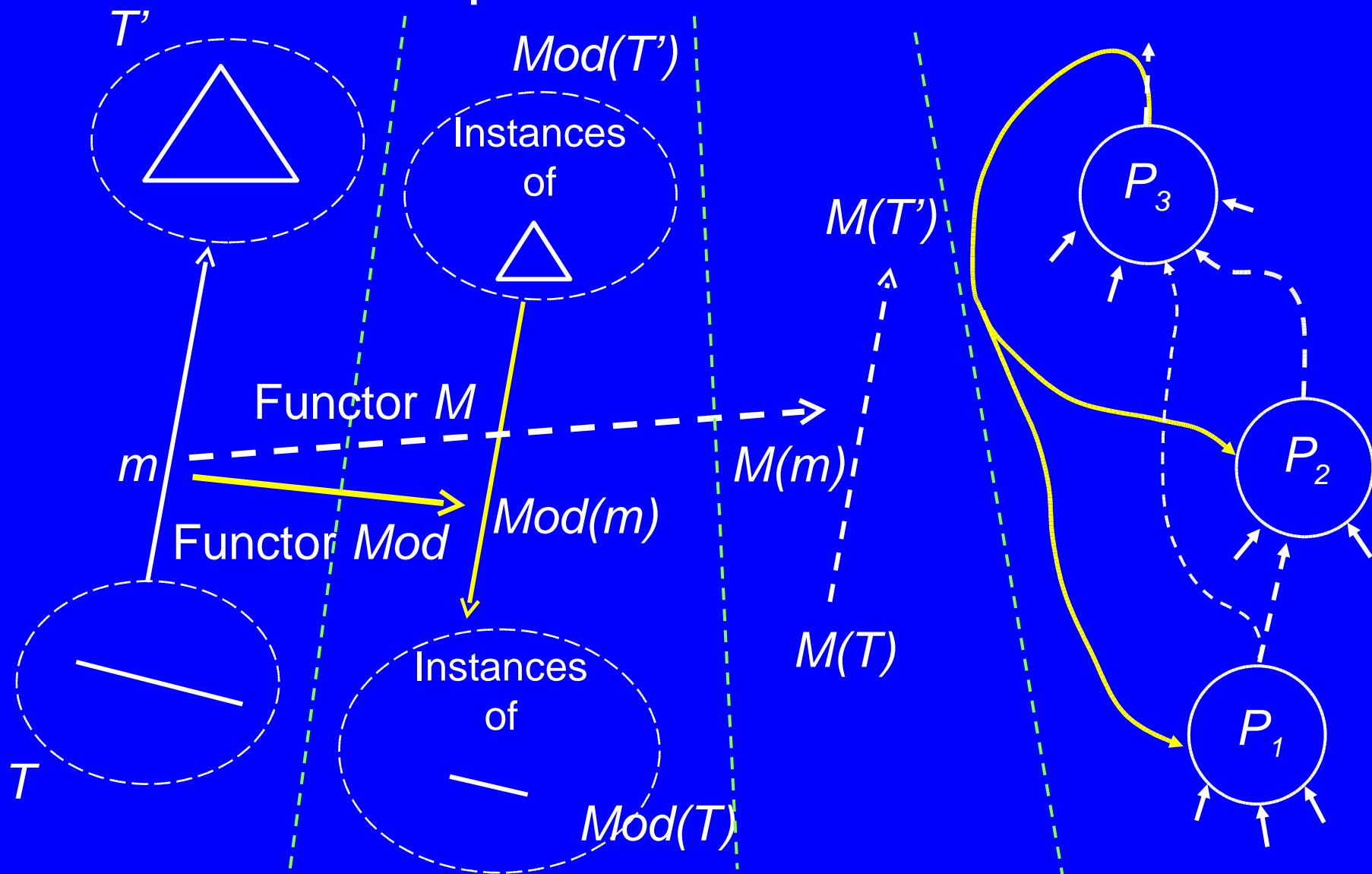
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Semantic Representation

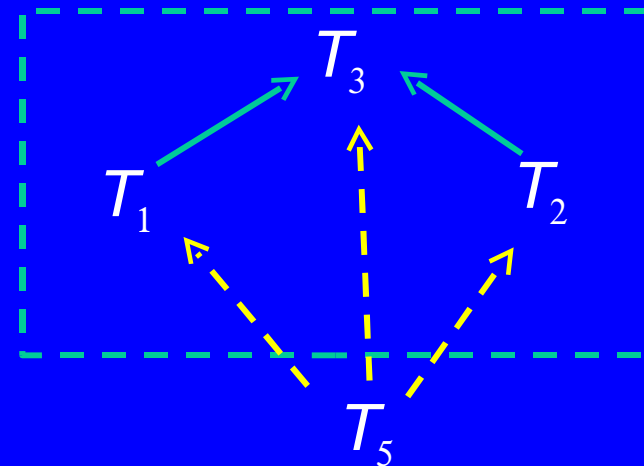
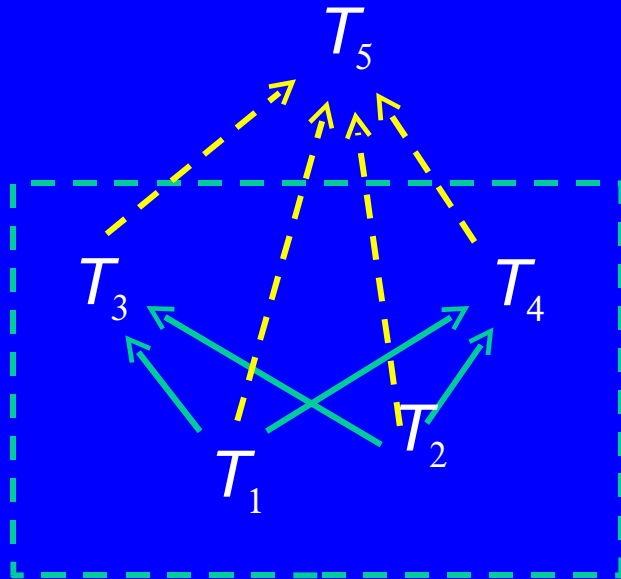


Model-Space Morphisms \implies Reciprocal Connections



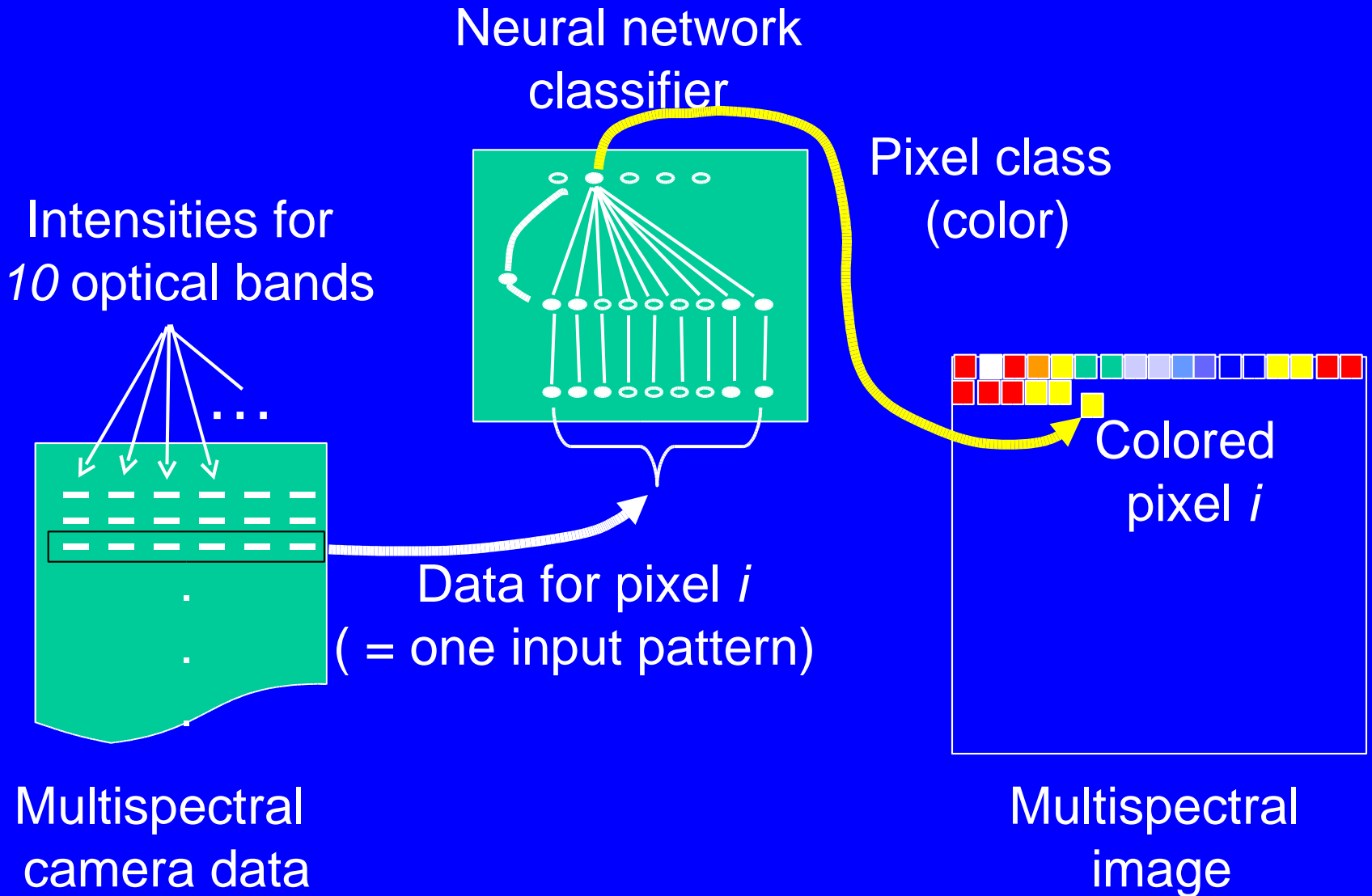
Colimits Express Specialization - Limits Express Abstraction

Least specialization

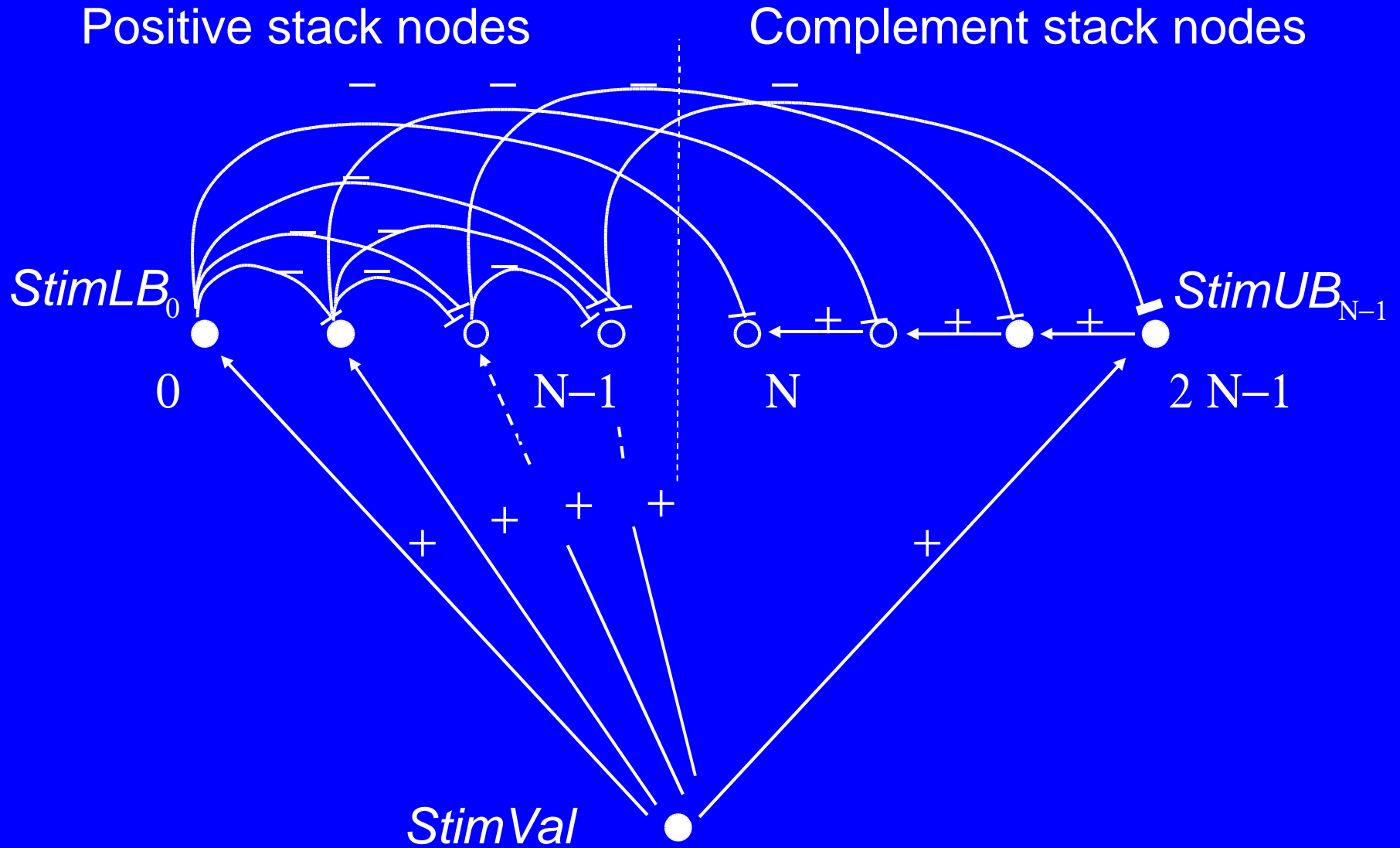


Maximally specific abstraction

Classifying Pixels by Spectral Similarity



Stack Interval Network



Stack Interval Patterns Represent Real Intervals

Positive stack

Complement

$0 < v \leq 1$



Width 1 unit

Positive stack

Complement

$1 < v \leq 2$



Width 1 unit

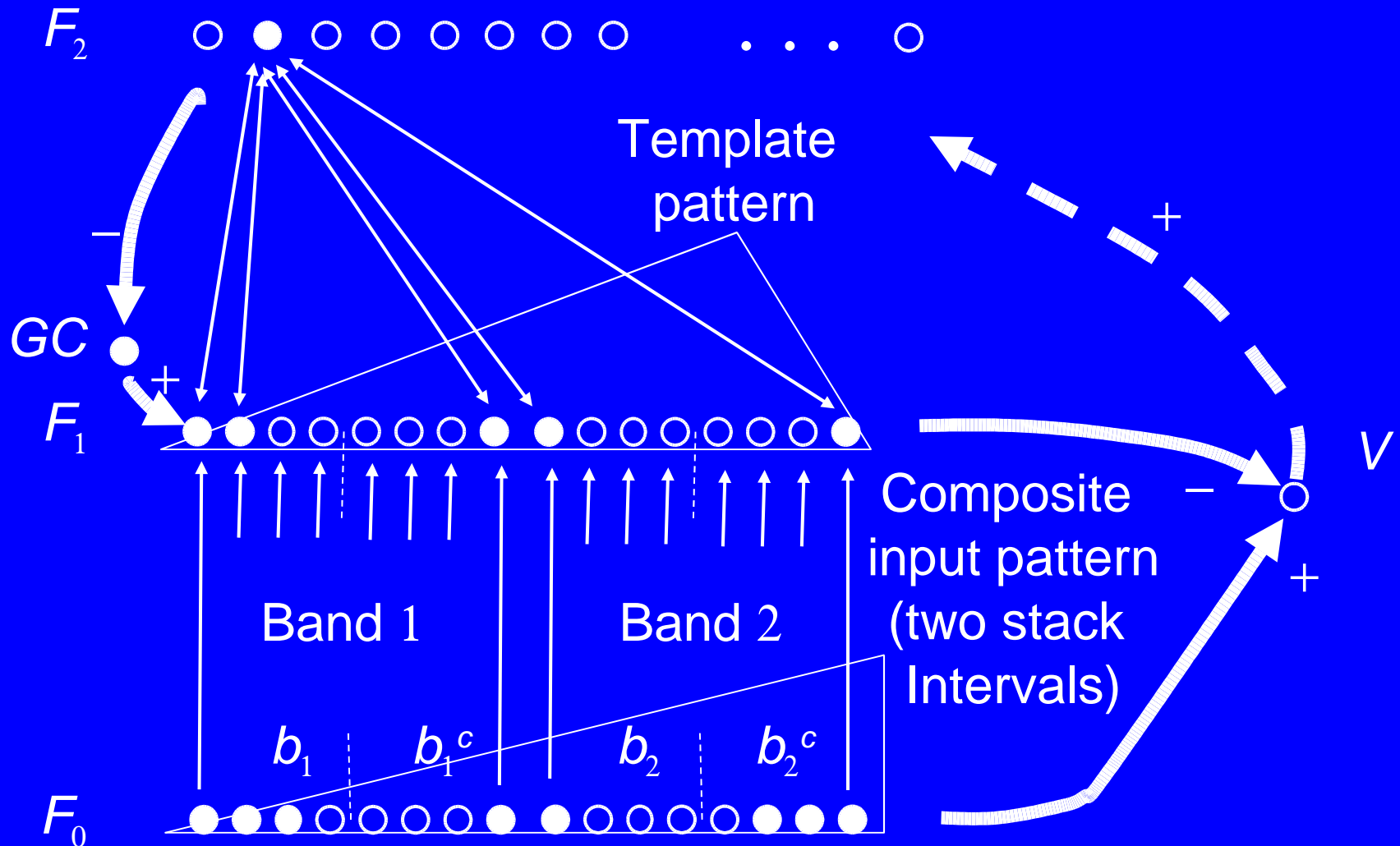
Intersection of stack patterns (in template patterns)

$0 < v \leq 2$

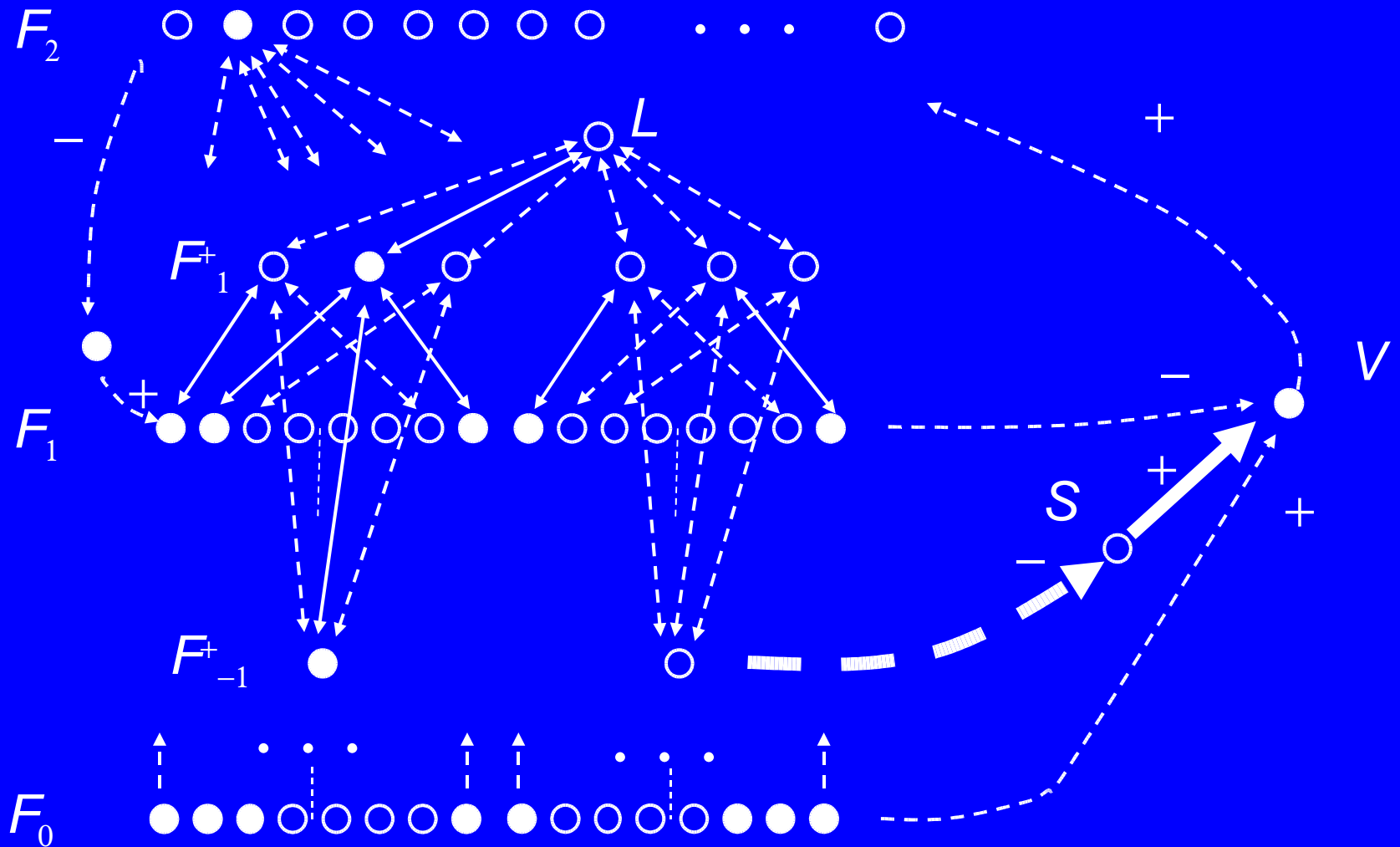


Width 2 units

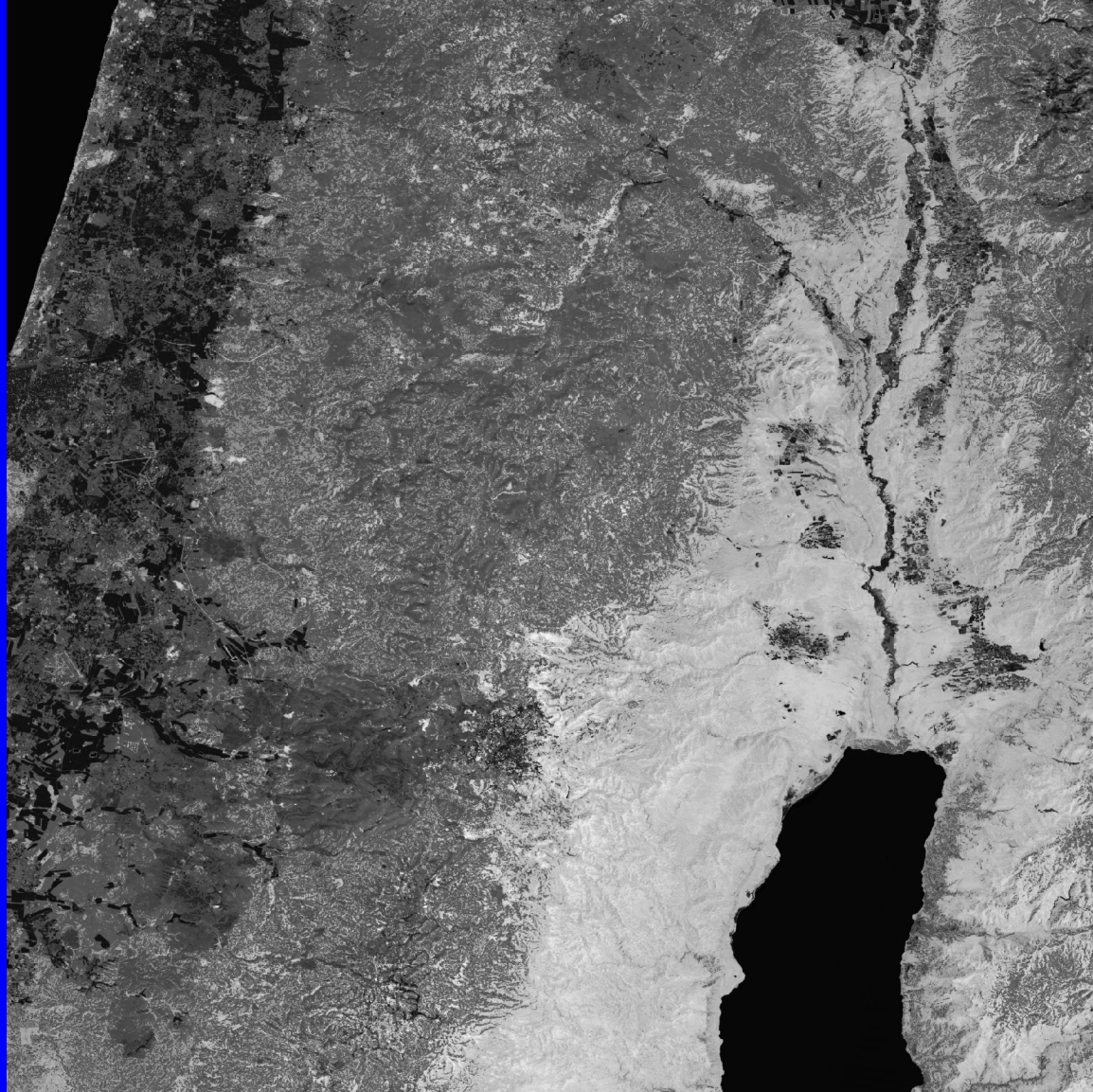
ART-1 with Stack Interval Inputs



ART-1 + F_1 Colimits, Limits

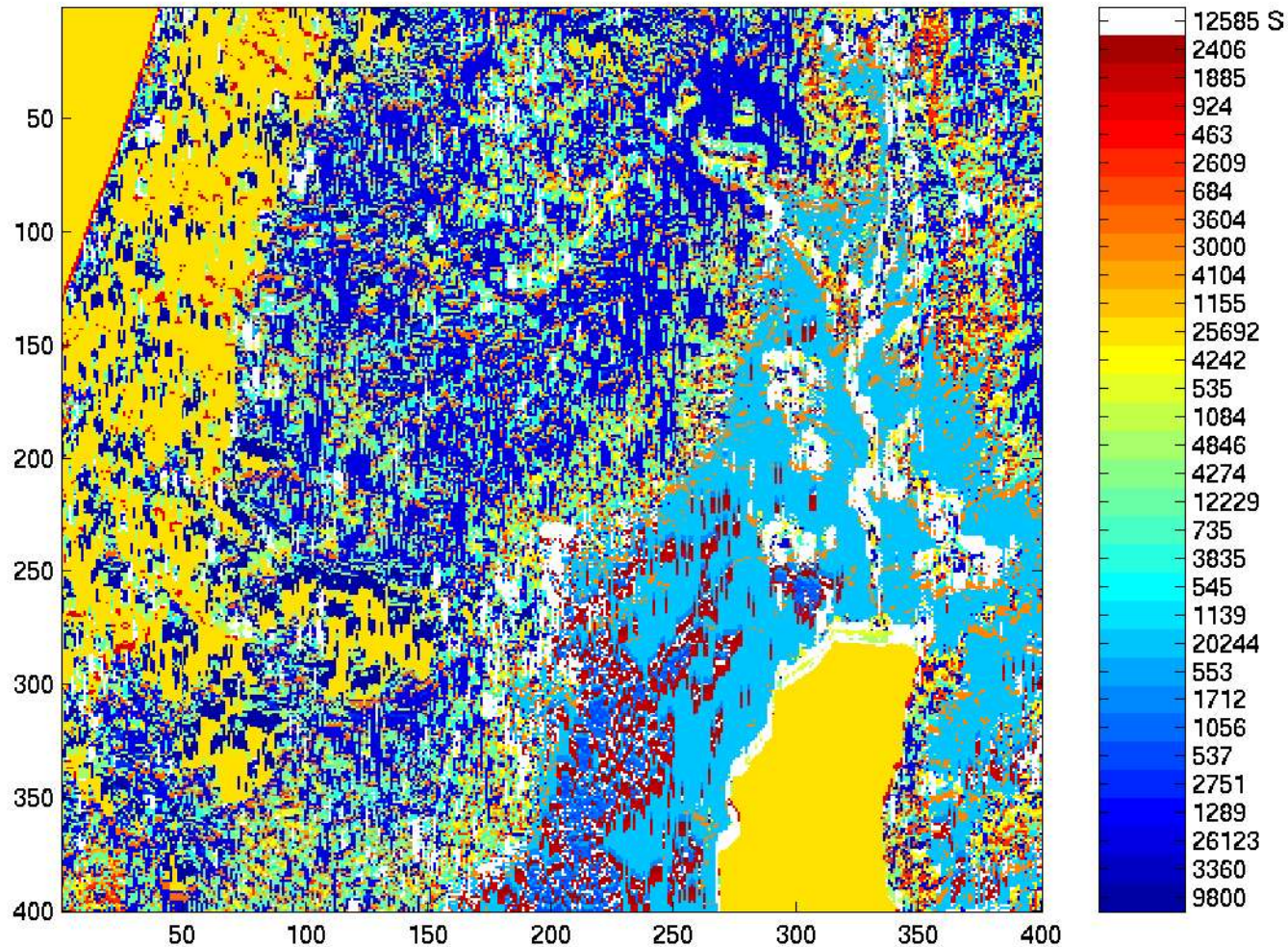


Panchromatic Image - 1 m Resolution



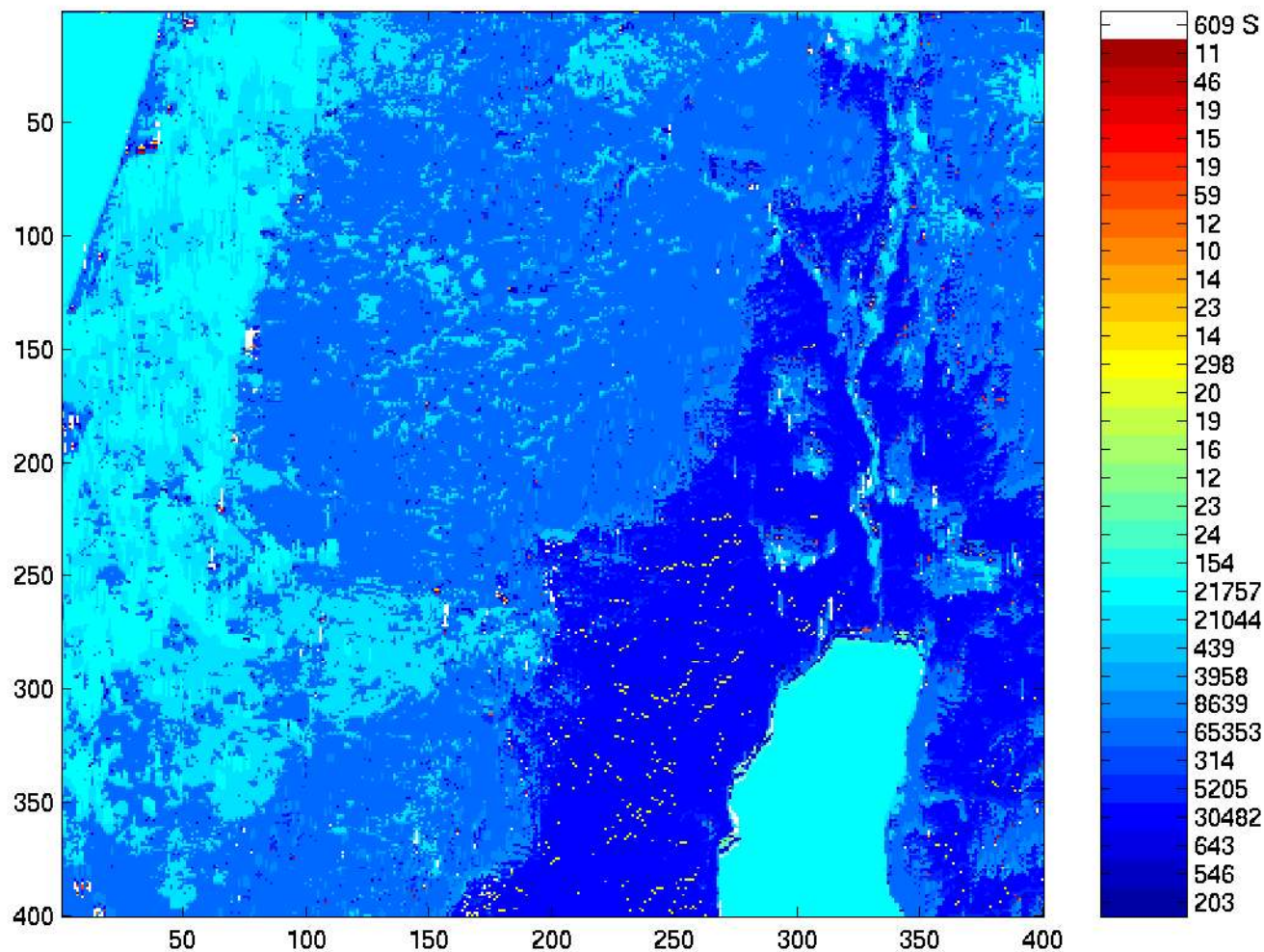
Multispectral Image - Generic ART-1

$\rho = 0.795$ Template density ordering



Multispectral Image - ART-1 with Limits

$\rho = 0.55$ $F_{-1} \text{ tol} = 0.55$ Template density ordering



Information Theoretic Measure

$$I(X, Y) = \sum_j \sum_k p_{jk} \log (p_{jk} / p_j q_k)$$

Mutual information between random variables X and Y

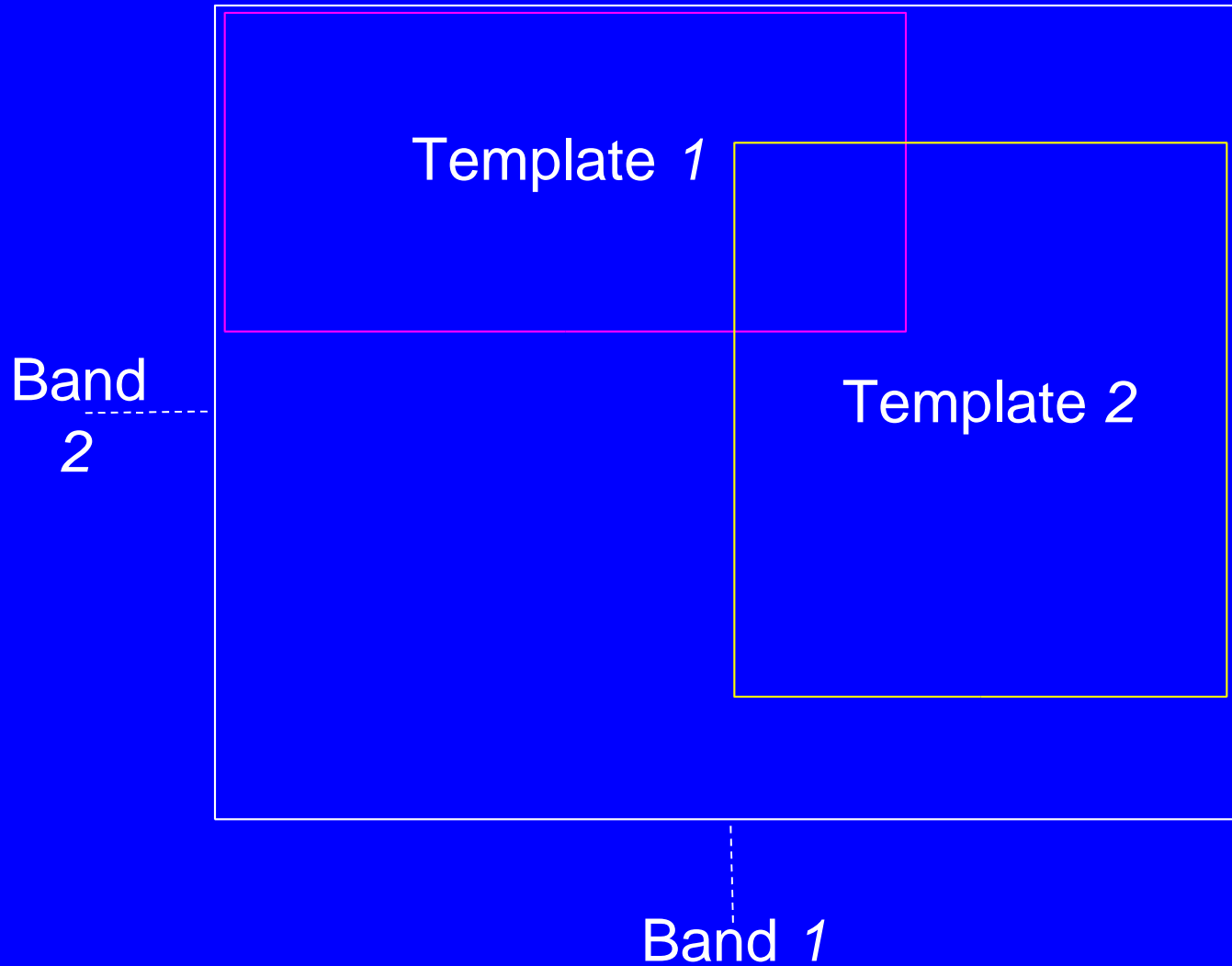
Cluster images vs. panchromatic images

ART-1 with Limits $\rho = 0.55$	F_{-1} tol = 0.55	11.1523 bits
Generic ART-1 $\rho = 0.795$		4.7116 bits

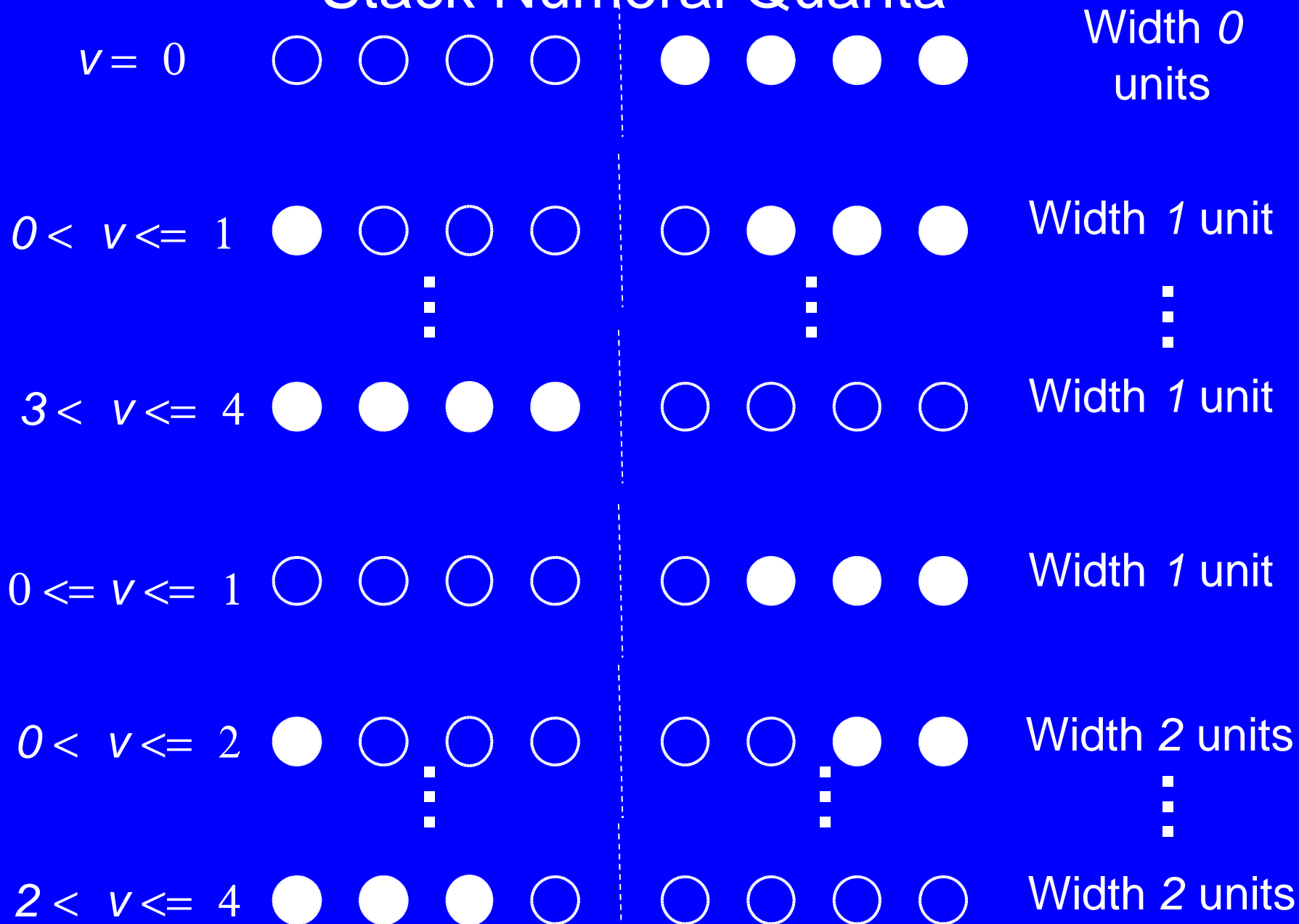
References

- M. J. Healy, R. D. Olinger, R. J. Young, T. P. Caudell, and K. W. Larson, “Applying Category Theory to Improve the Performance of a Neural Architecture” (under review).
- M. J. Healy and T. P. Caudell (2006) “Ontologies and Worlds in Category Theory: Implications for Neural Systems”, *Axiomathes*, 16 (1), pp. 165-214.
- M. J. Healy and T, P. Caudell (2004) “Neural Networks, Knowledge, and Cognition: A Mathematical Semantic Model Based upon Category Theory”, *UNM Technical Report EECE-TR-04-020*, University of New Mexico, Albuquerque, NM, USA .

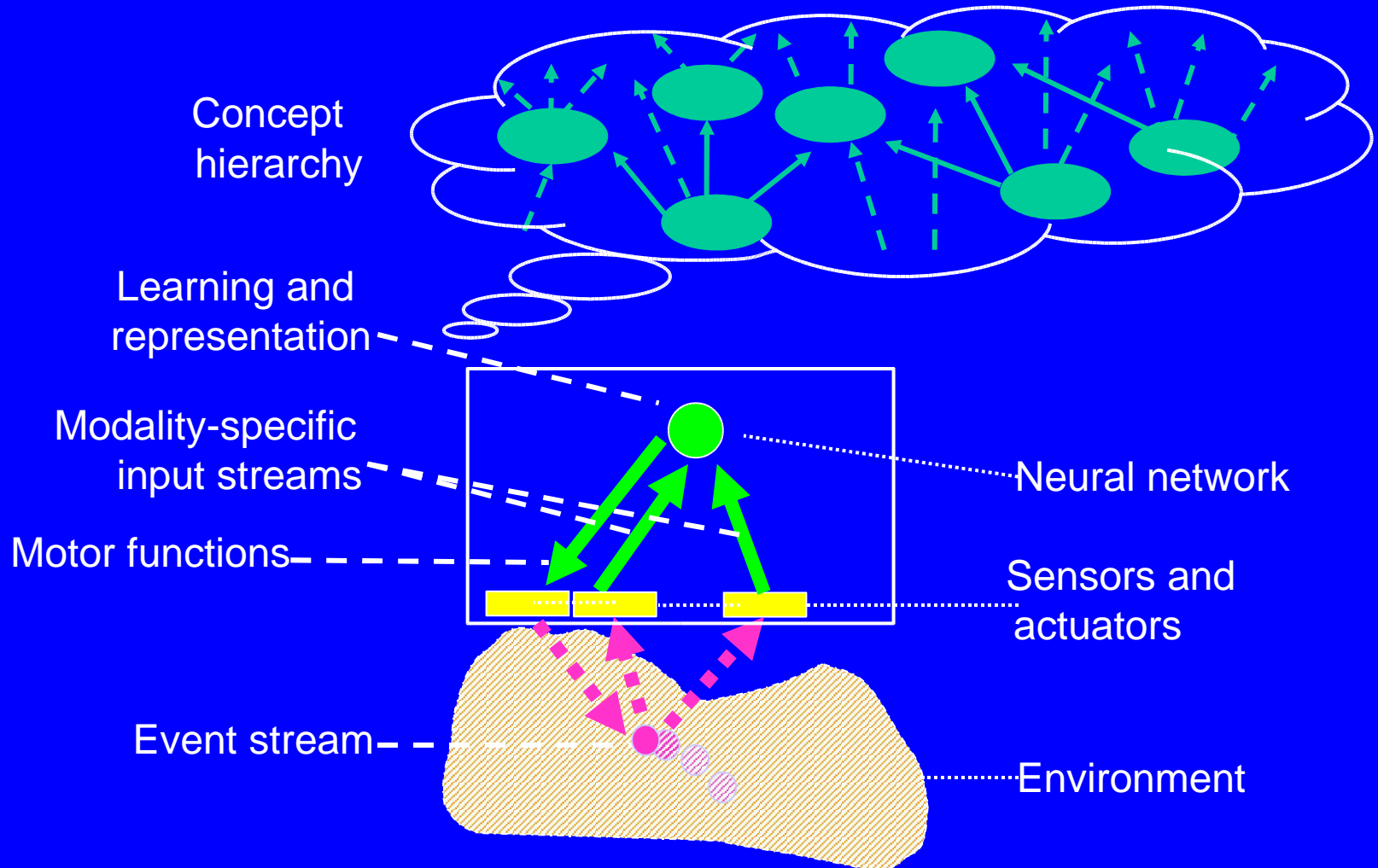
Template Patterns



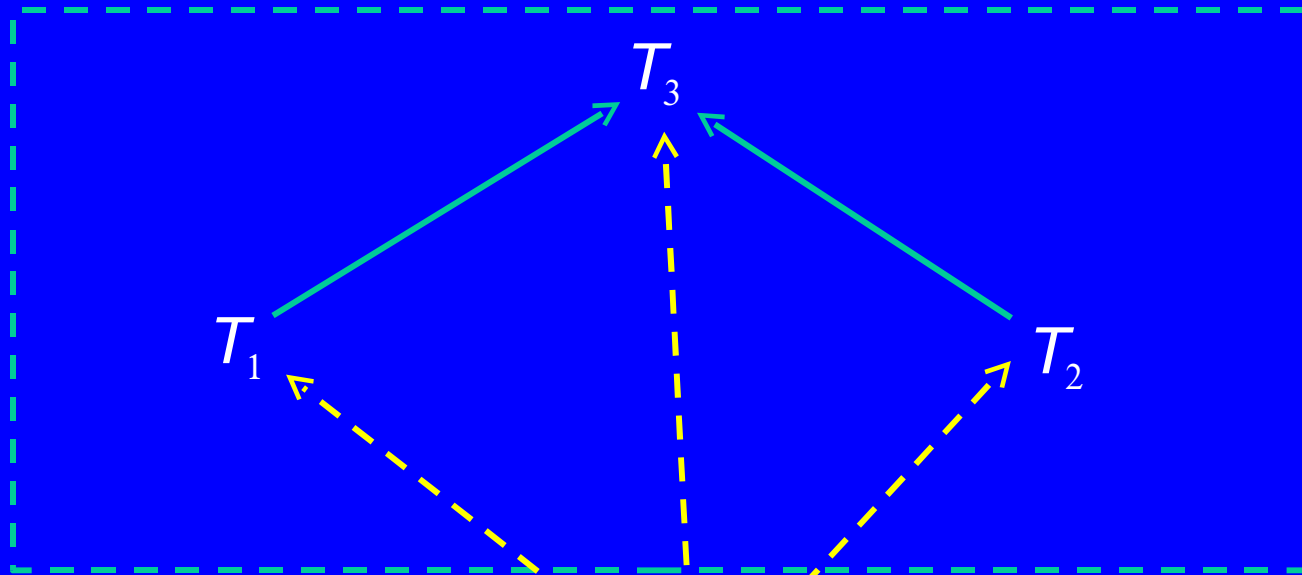
Stack Numeral Quanta



Neural Network Research Objective: Associate an Evolving Knowledge Structure with Neural Structure and Activity



Limits Express Abstraction



T_5 ... maximally specific abstraction

Colimits Express Specialization

