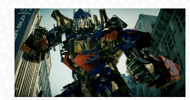
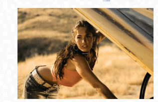
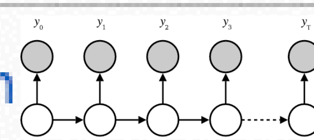
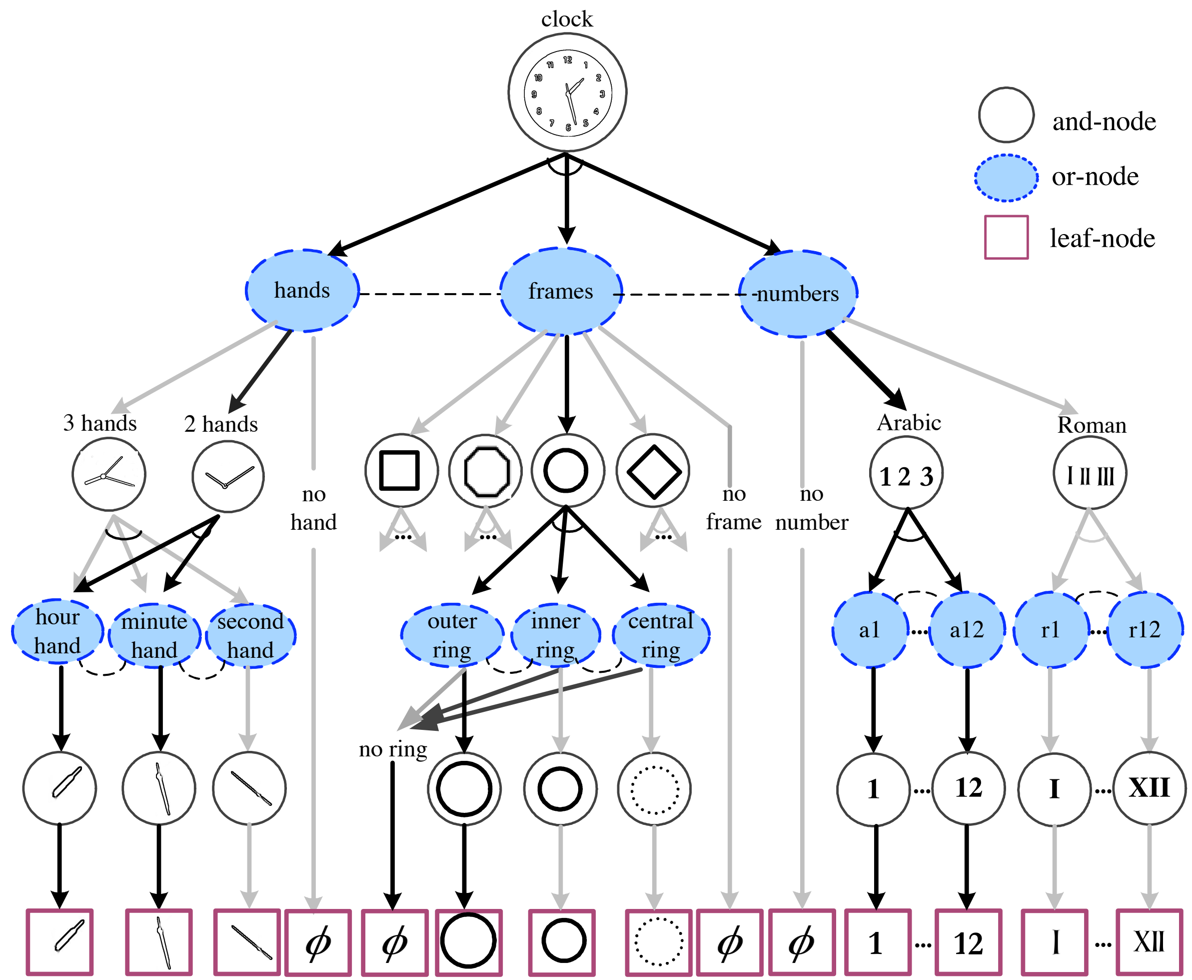
Grammars (C2)

Grammar	Languages	Automaton	Production rules
Type-0	Recursively enumerable	Turing machine 	$\alpha \rightarrow \beta$ (no restrictions)
Type-1	Context-sensitive	Linear-bounded non-deterministic Turing machine  	$\alpha A \beta \rightarrow \alpha \gamma \beta$
Type-2	Context-free 	Non-deterministic pushdown automaton 	$A \rightarrow \gamma$
Type-3	Regular	Finite state automaton 	$A \rightarrow a$ and $A \rightarrow aB$

- Stochastic Grammars (2.4) (Bayes Net w/ dynamic structure)
- Polytime for Types 2-3*
- Wikipedia says most natural languages generated by Type-1
- Intermediate between 1 and 2: Tree-adjoining/Attribute Grammars
- Type-0 includes innate universal grammar shared by all humans*

Why Grammars?

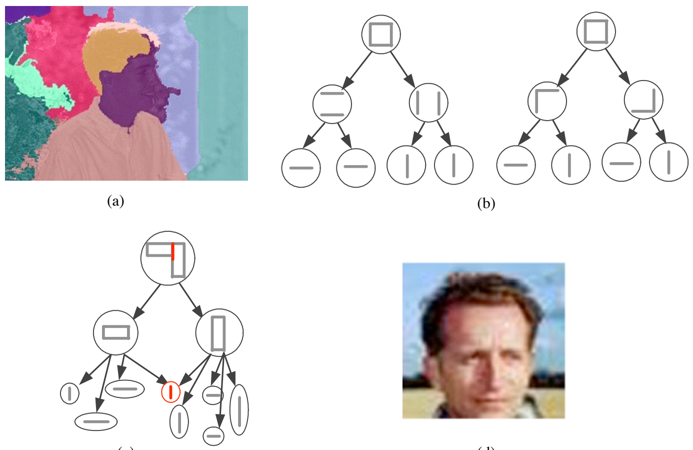
- Composition and Reusability
- Productivity



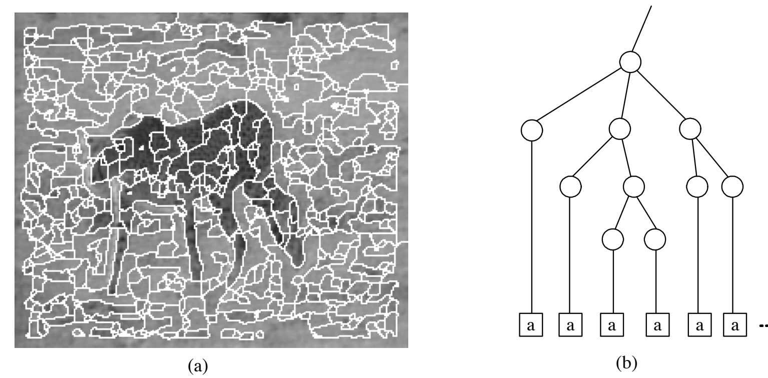
(fewer training examples, represent large intra-class variation)

Image Grammar Challenges (2.3 + 2.6)

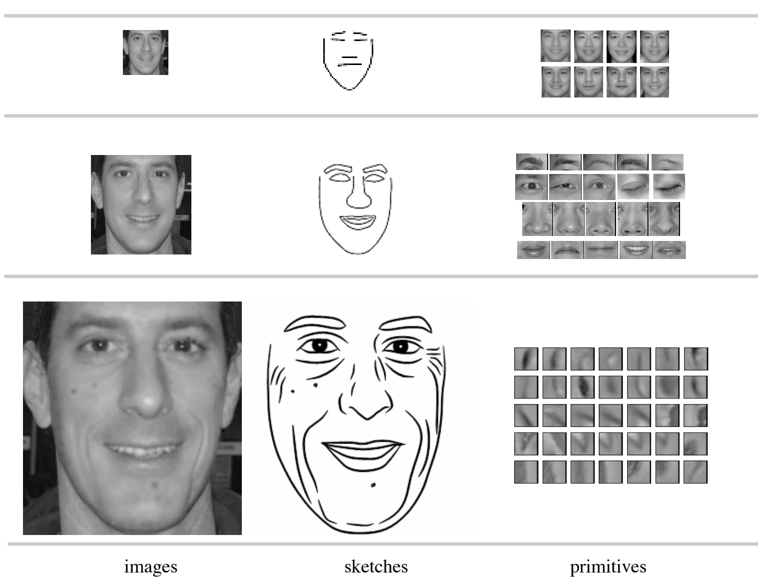
Ambiguity (2.3)



No LR Order



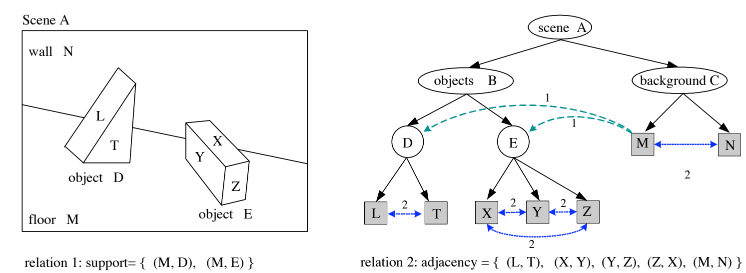
Continuous Image Scaling

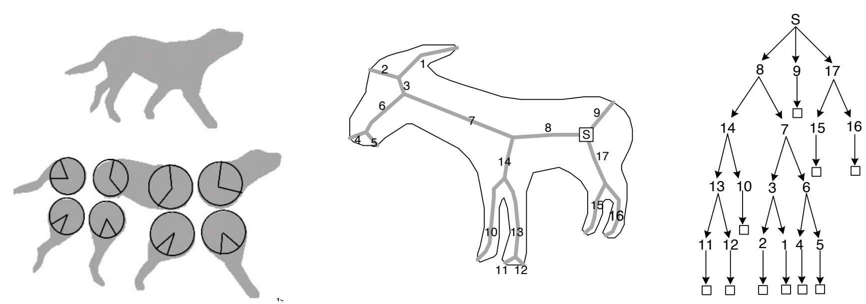


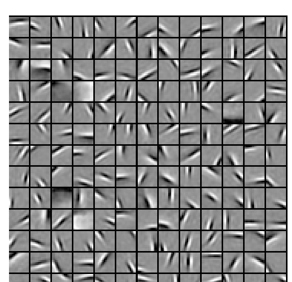
Continuous Spectrum of Texture/Clutter

Previous Work on Image Grammars (2.7)

- Syntactic Pattern Recognition
- Medial Axis, Shock Graphs
- Pattern Theory
- Sparse Coding

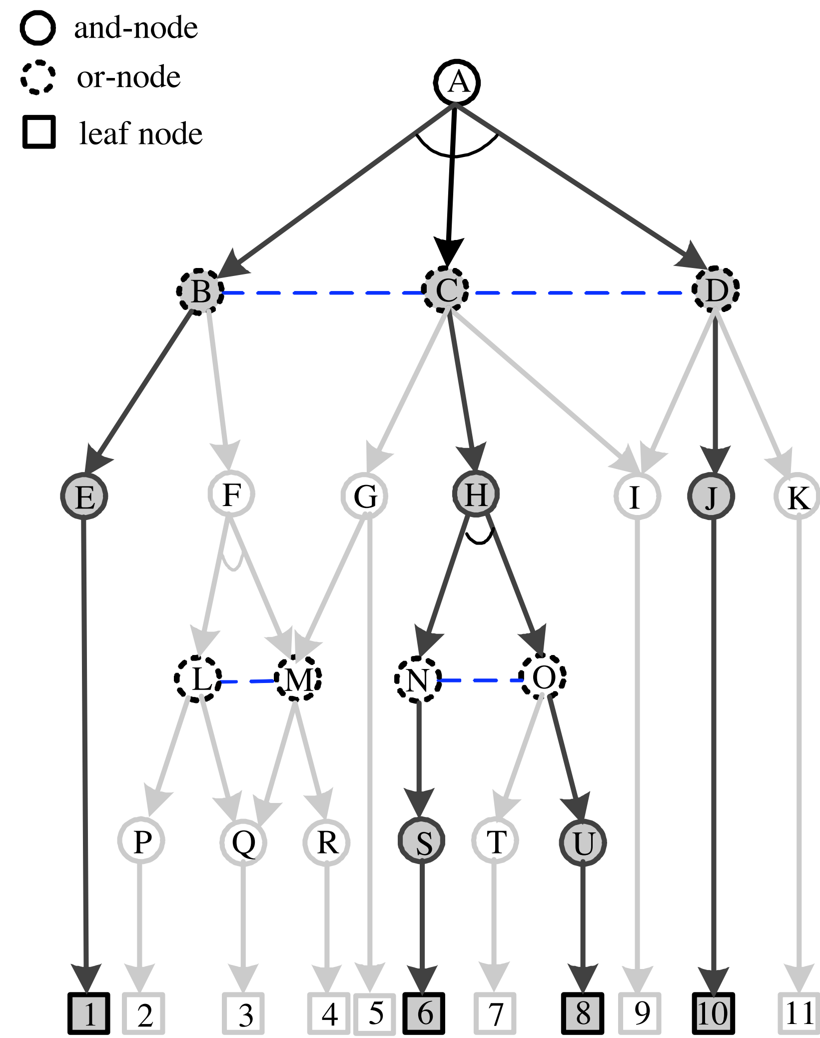



(a) (b) (c)



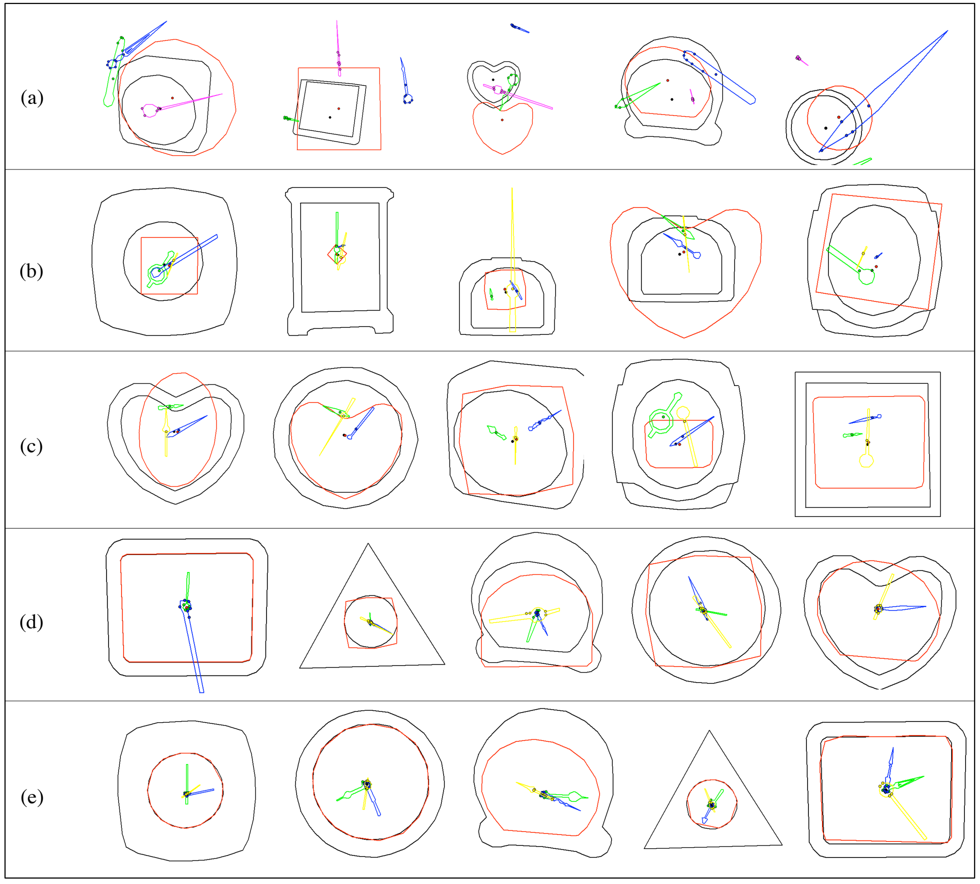
And-Or Graph (6.2)

- And-Or Tree (PCFG):
  - (Leaf Node) := a
  - (Or Node) := A (label)
  - (And Node) := γ (template)
- And-Or Graph (Eq 54-55):
  - Horizontal Or Edges (pot.)
  - *Other Relations
  - *Sharing Nodes



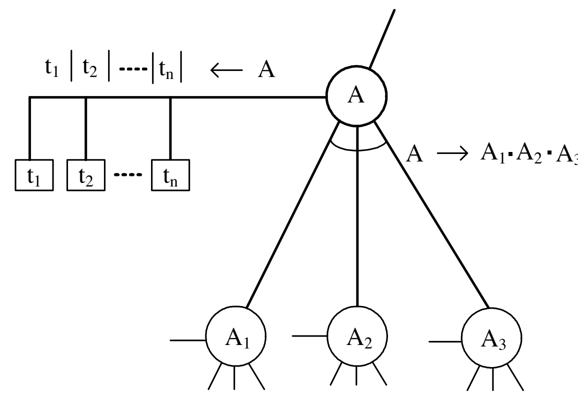
Learning (C7)

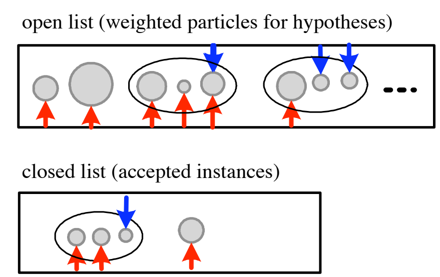
- 1. No horizontal edges, standard PCFG learning
- 2. Introduce edge w/ highest information gain (67)
- 3. Sample to approximate expectations (63,65)
- 4. Move down gradient
- Repeat 2-4



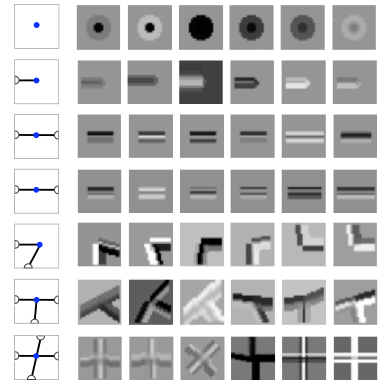
Parsing (decoding)

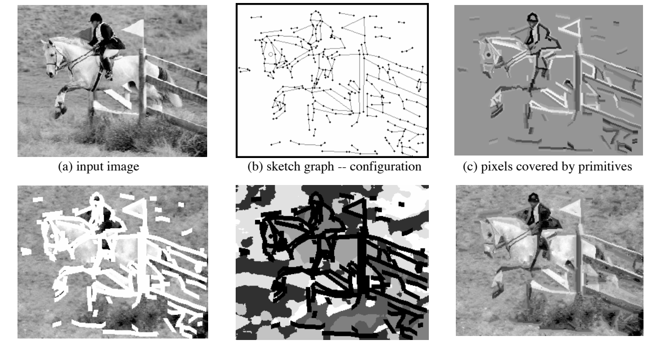
- Recursive top-down / bottom-up algorithm:
  - Bottom-up:
    - Feature Detection
    - Composition Binding
  - Top-down
    - Compute Hypothesis Posterior
    - Update Hypothesis

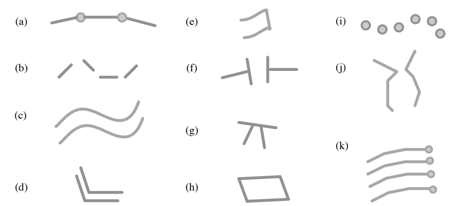


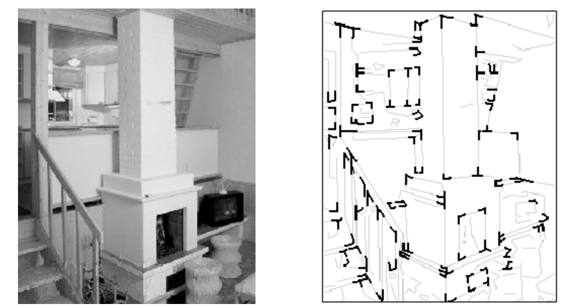


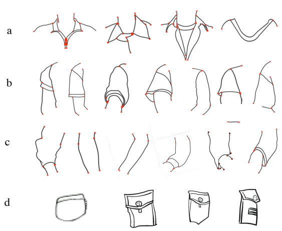
- Vocabulary (C3):
  - Image Primitives
  - Basic Geometric Groupings
  - Parts and Objects

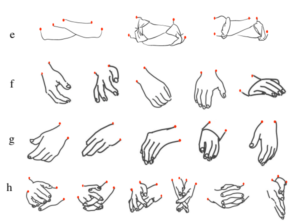


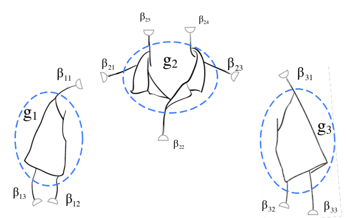




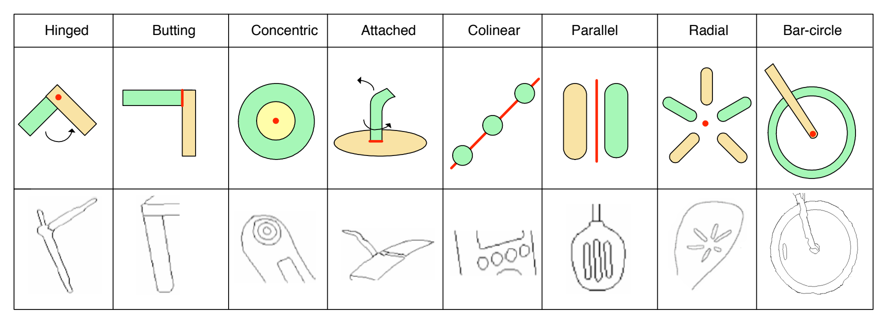


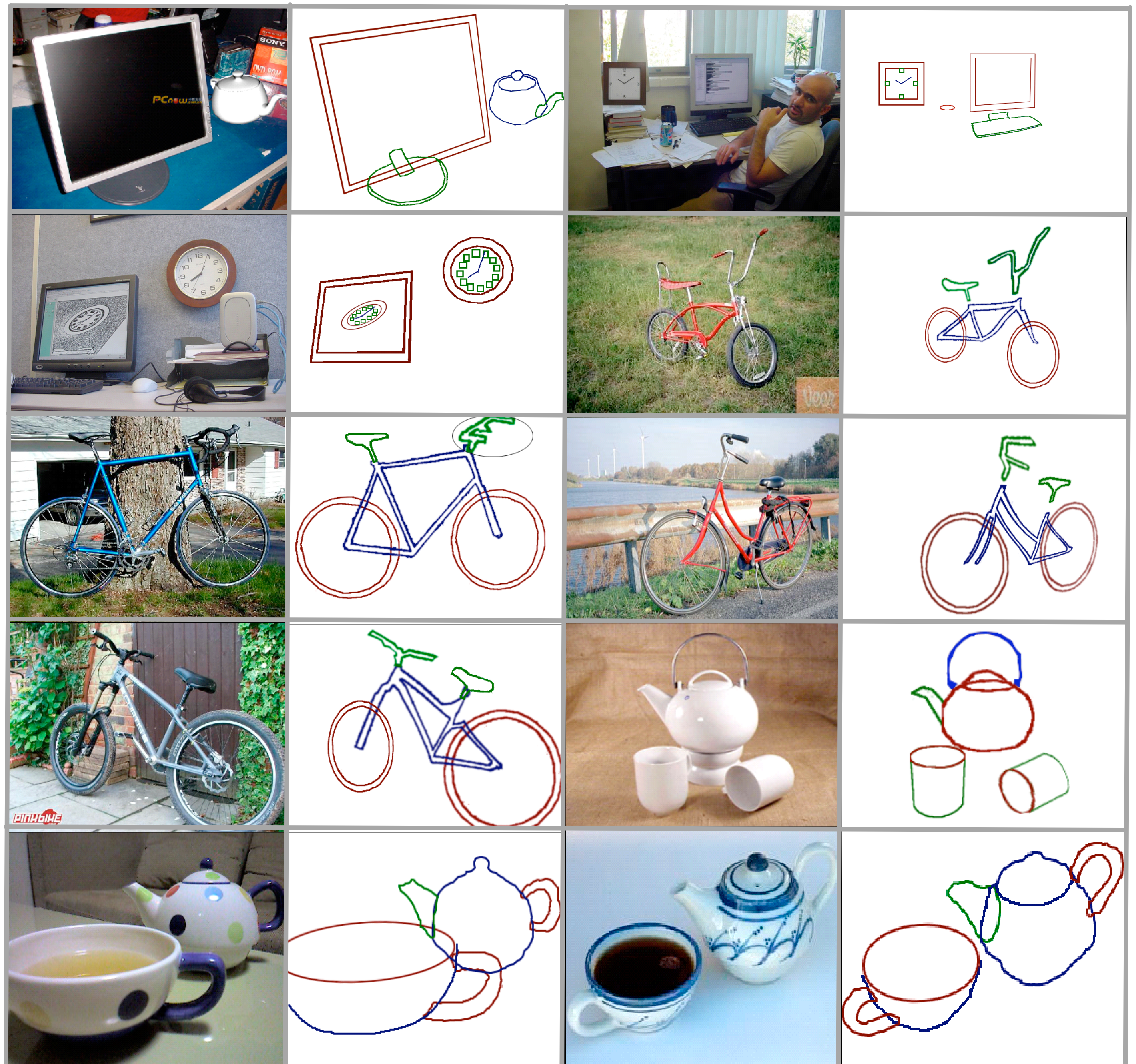






- Relations (C4):
  - Connections between primitives
  - Joints and Junctions
  - Object Interactions and Semantics





*learn graph structure, learn vocabulary, share re-usable parts

Test image

Top objects

Top object under Markov distribution

Top object under content-sensitive distribution