What is conceptual coherence?

- Prototype theory, exemplar theory, etc., don't really address the problem of conceptual coherence
- "Less coherent" concepts may be harder to classify

  but all sets of examples have prototypes and exemplar representations!

- But what is conceptual coherence anyway?

Simplicity

I mean he'd keep telling you to *un*ify and *sim*plify all the time. Some things you can't *do* that to.

- Holden Caulfield (J. D. Salinger)

- Occam's razor

Entities should not be multiplied without necessity - Occam

i.e. If there are multiple interpretations of the same data, choose the simplest one

- "When you hear hoofbeats, think horses not zebras" - Medical cliche

- But: Hickam's dictum: *The patient can have as many diseases as he damn well pleases*

Why simplicity?

- Simplicity or parsimony is a widely used principle of scientific inference, without which much of modern science would not exist
- Until 1963, most philosophers believed that simplicity could not be universally quantified

  - What seems simple in one "language" may seems complex in another

- But that ended in 1963 with Kolmogorov complexity

Kolmogorov complexity

- Kolmogorov, Chaitin, Solomonoff (1960s)

  The complexity (randomness) of a string *S* is the length of the shortest computer computer program that generates *S*.

  Examples:

00000000000000000000000000000000000000000000000000 = "Print 50 0s" [11 characters]

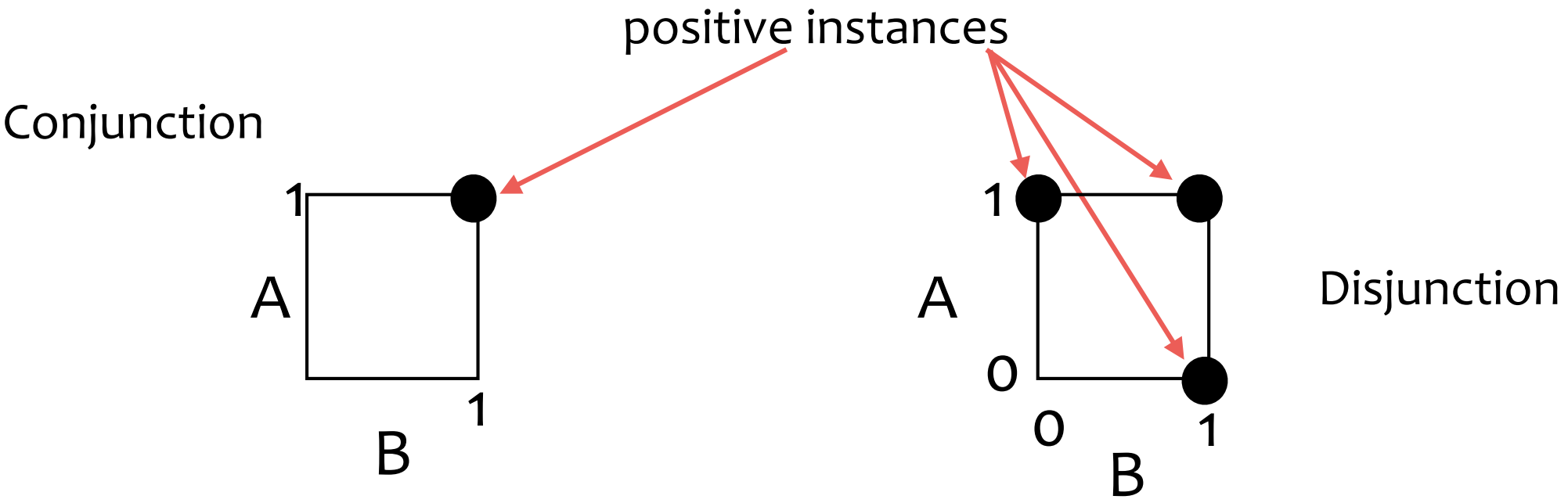
01010101010101010101010101010101010101010101010101 = "Print 25 01s" [12 characters]

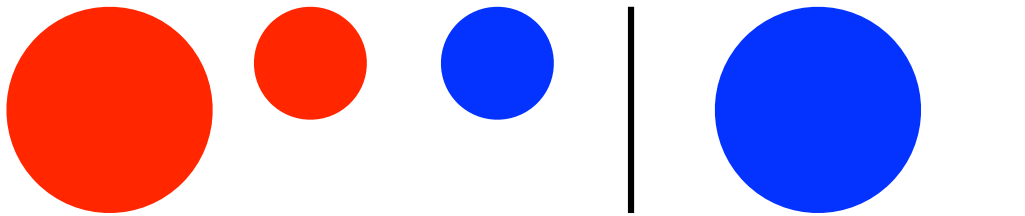
11010110100001010111011111010001010110010010010111 =

"Print '11010110100001010111011111010001010110010010010111' [58 characters]

  That is, simplicity is the degree to which something can be (faithfully, i.e. losslessly) compressed.

Conjunction and disjunction (again)



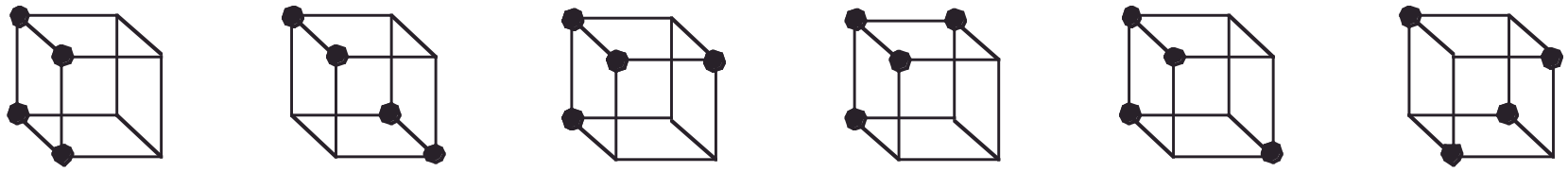


=

(red ∧ big)
∨ (red ∧ small)
∨(blue∧ small)

= (red ∨ small)

Shepard, Hovland & Jenkins (1961)

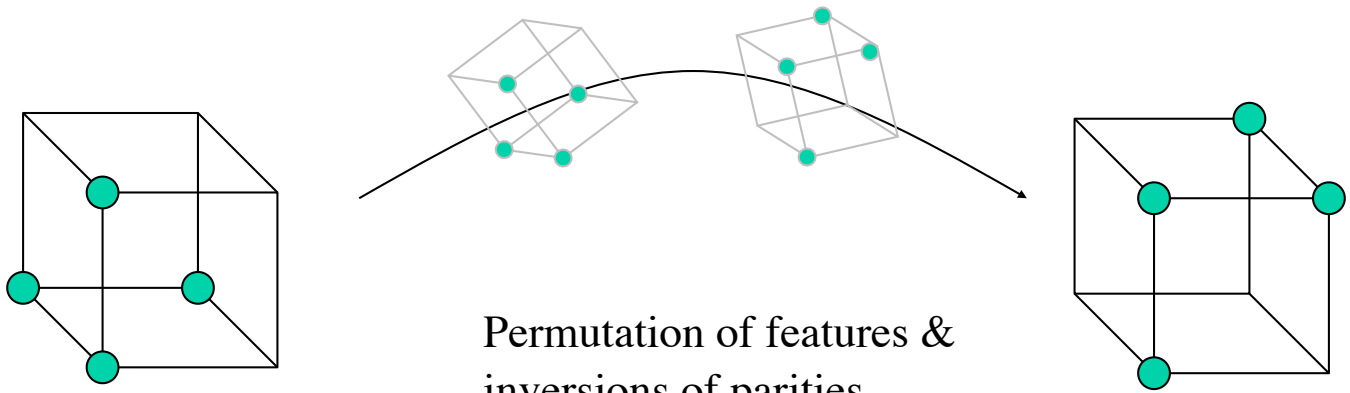


I II III IV V VI

- *<u>Complete</u> classification of concepts with 3 features and 4 positive examples*

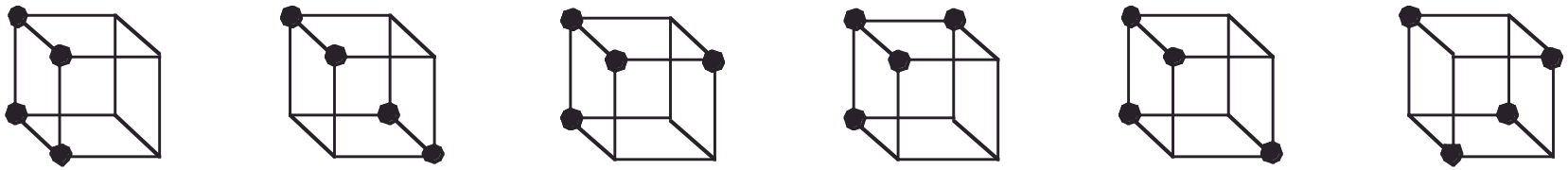
Isomorphisms between concepts

III



Two isomorphic concepts are “essentially the same” concept

Shepard, Hovland & Jenkins (1961)



I < II < III IV V < VI

Subjective difficulty ordering

- *Complete classification of concepts with 3 features and 4 positive examples*

Boolean Complexity

- The Boolean complexity of a propositional concept is the length (in variables) of the shortest propositional formula equivalent to it.
  - Simple or regular concepts have low *B*-complexity
  - Concepts with *P* objects on *D* features have *B*-complexity capped at *DP*
  - The *B*-complexity is in a sense *universal.*
- Hence, B-complexity is a measure of the intrinsic logical complexity of the concept.

Boolean Complexity (examples)

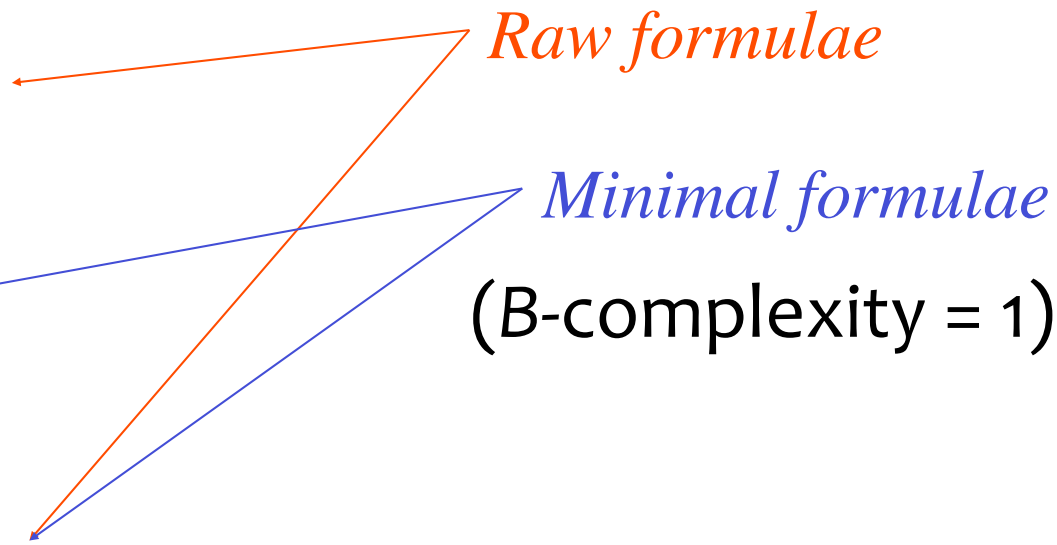
Notation: *ab* means a∧b *a+b* means a∨b

1. *ab + ab'*
   = a(b + b')
   = a

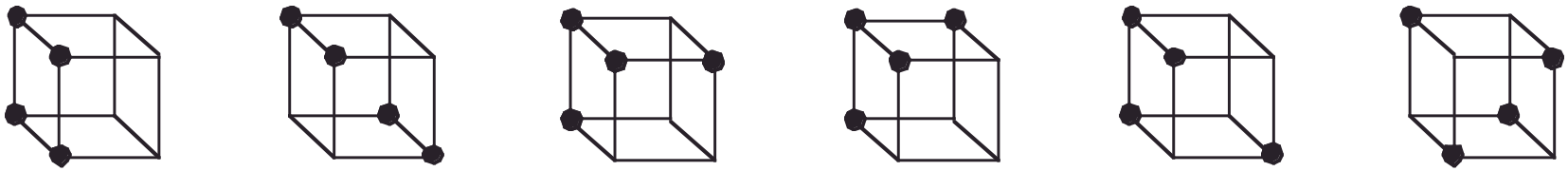
   (*B*-complexity = 1)

2. *ab + a'b'*
   (irreducible)

   (*B*-complexity = 4)



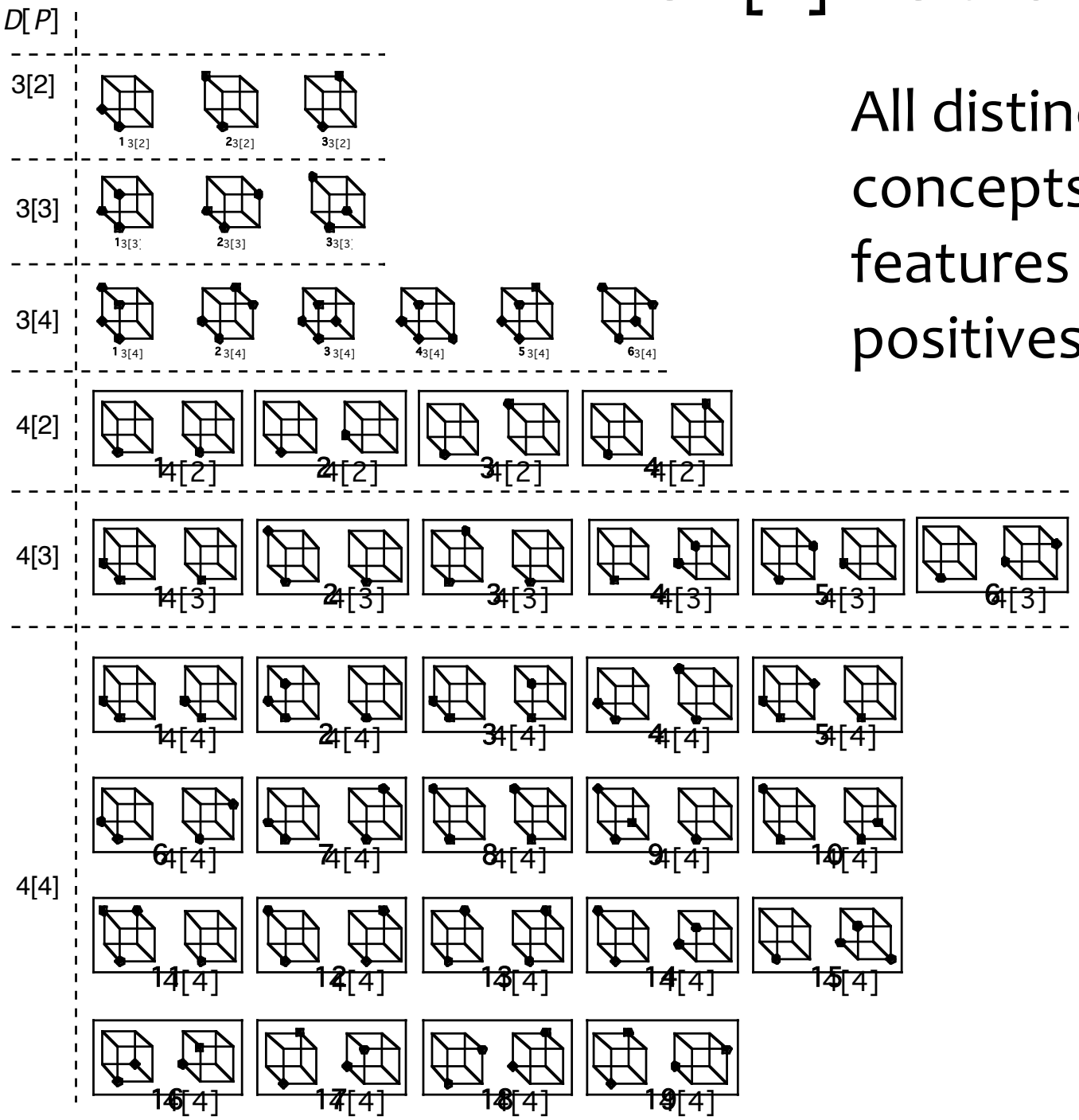
Shepard et al (1961), again



I < II < III IV V < VI

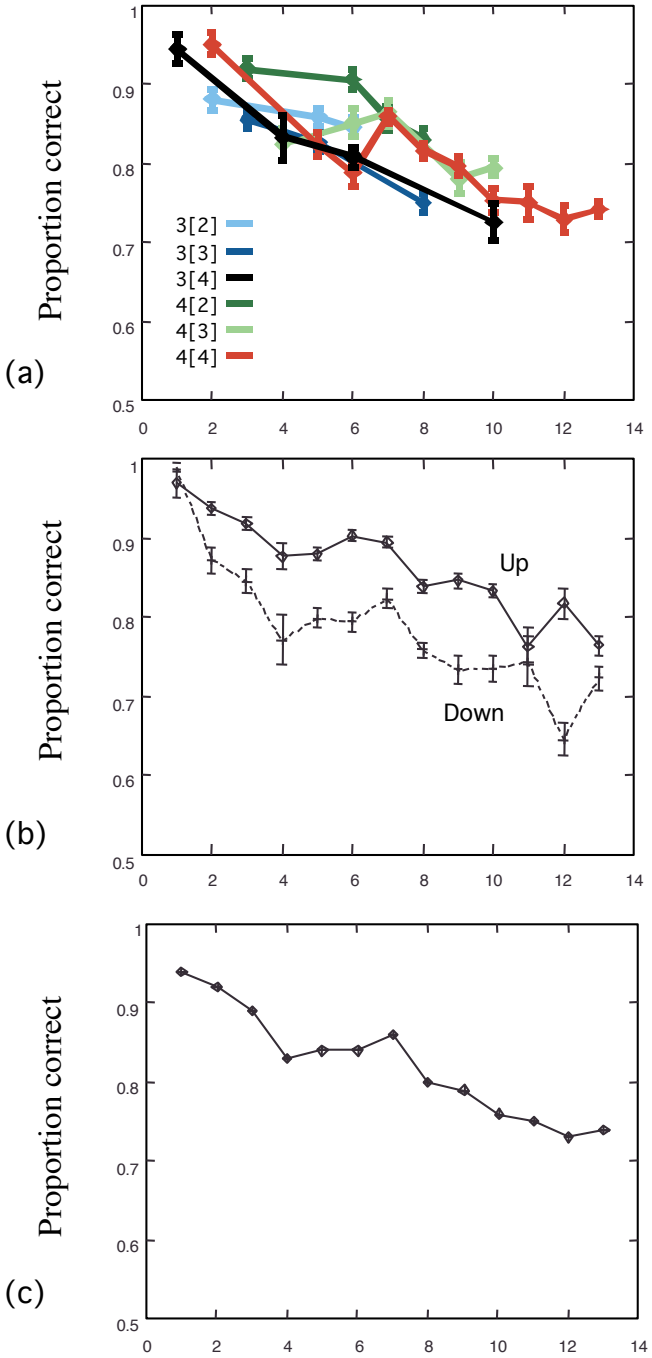
Minimal formula	*a'*	*ab+a'b'*	*a'(bc)'+ ab'c*	*a'(bc)'+ ab'c'*	*a'(bc)'+ abc*	*a(b'c+bc')+ a'(bc+b'c')*
Boolean complexity	1	4	6	6	6	10

The D[P] hierarchy



All distinct types of concepts with D features and P positives

Results



Separated by family

Separated by parity

Overall