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PRESENTATION ON VISUAL REASONING

Presenter:

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INTRODUCTION

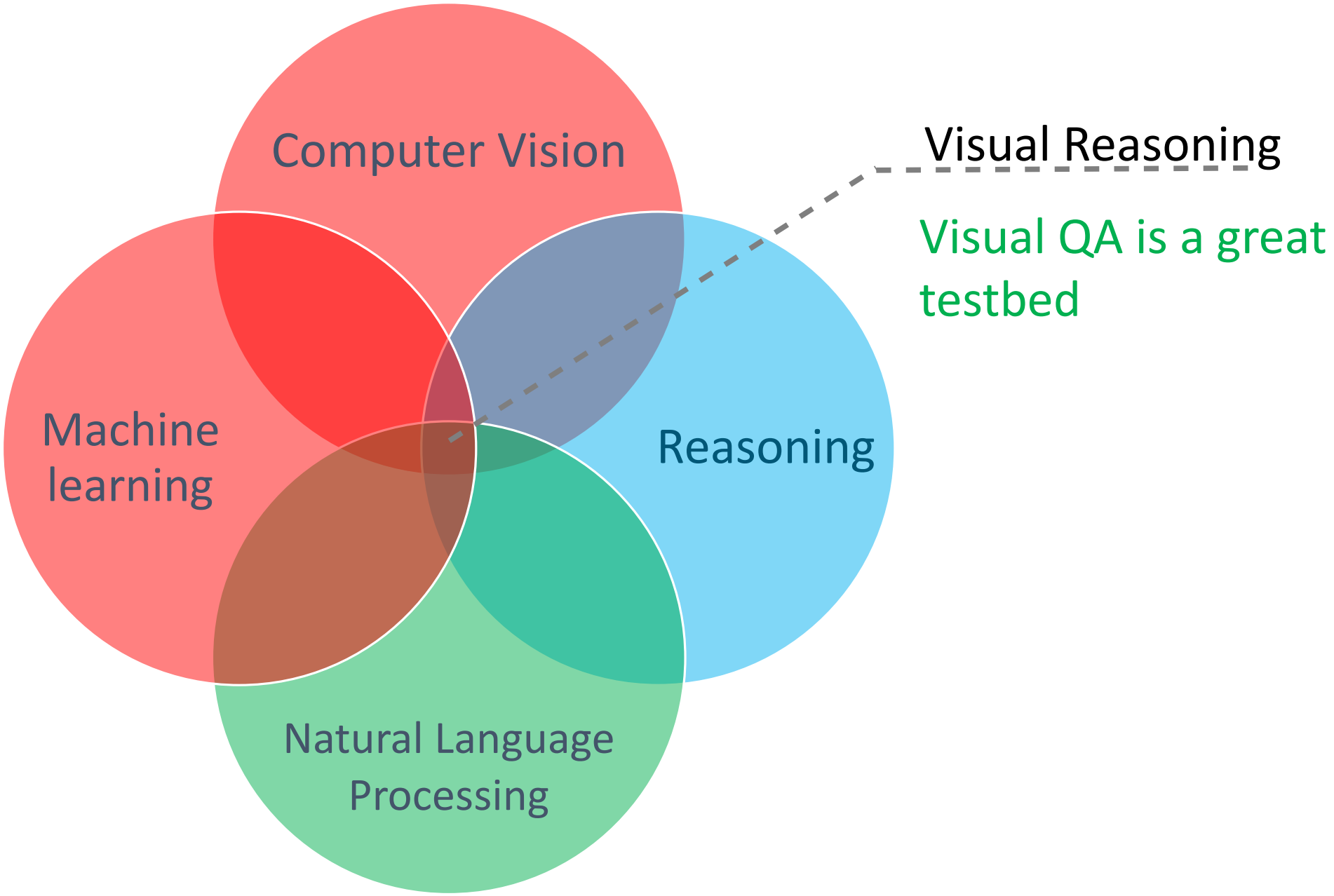
Visual reasoning is the process of analyzing visual information and being able to solve problems based upon it. A person's visual reasoning abilities are related to overall intelligence. It is a component of nonverbal intelligence, meaning that a person does not have to use language in order to solve visual problems.

Visual Reasoning Test

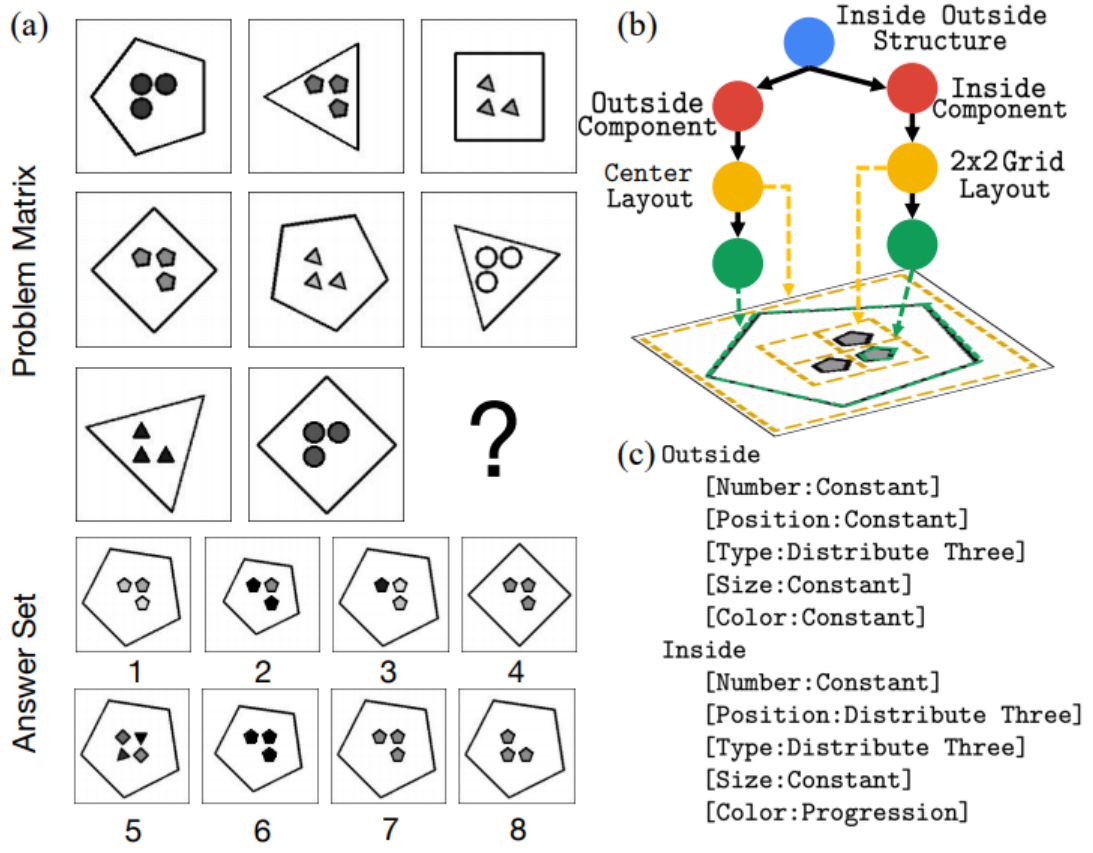
These questions may require the test taker to identify and manipulate visual patterns. They show a set of shapes and ask the test taker to identify what shapes should come next in the pattern. For example, identifying relationships, similarities and differences between shapes and patterns, recognizing visual sequences and relationships between objects and remembering these. Diagrammatic reasoning is used where the ability to cope with complexity and deal with novelty is required rather than relying on previous experience.

Visual Reasoning Test Assessment is useful for hiring

- Graphic Designers
- Computer Programmer
- Air Traffic Controllers
- Advertising Executives
- System Analysts
- System Designers


Computer Vision
Machine learning
Reasoning
Natural Language Processing
Visual Reasoning
Visual QA is a great testbed

Typical Visual Reasoning

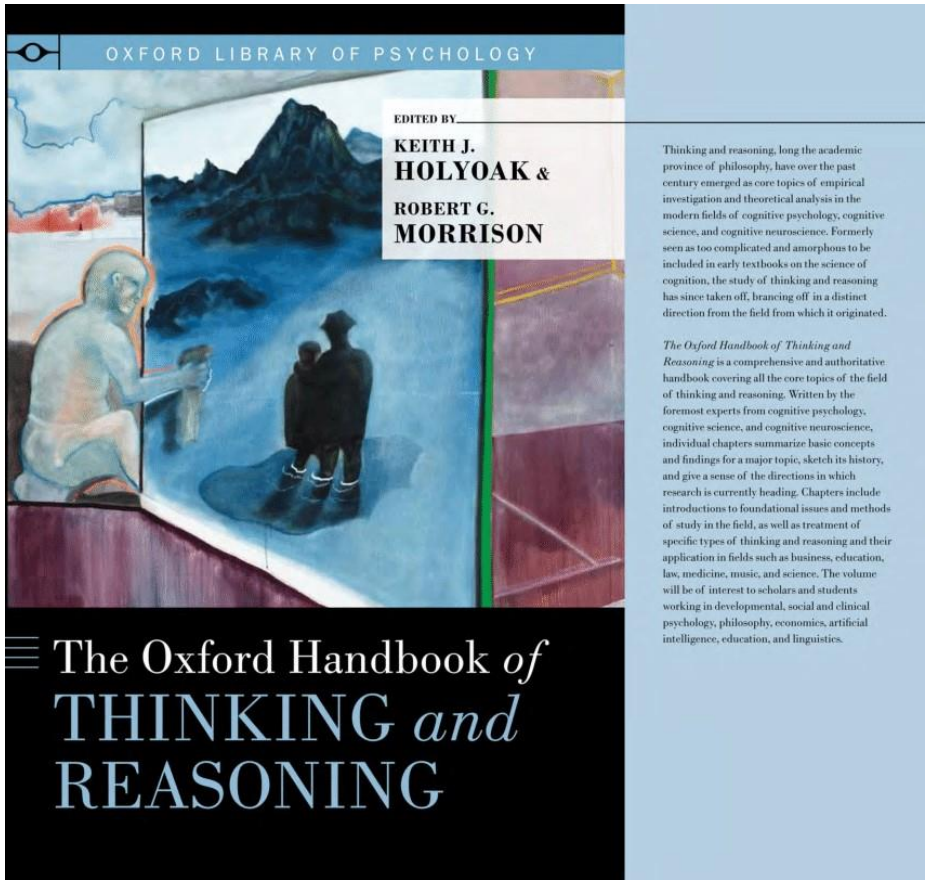


Learning | Reasoning

- Learning is to improve itself by experiencing or acquiring knowledge & skills
- Reasoning is to deduce knowledge from previously acquired knowledge in response to a query (or a cues)
- Early theories of intelligence (a) focuses solely on reasoning, (b) learning can be added separately and later! (Khardon & Roth, 1997).
- Learning precedes reasoning or the two interacting? Can reasoning be learnt? Are learning and reasoning indeed different facets of the same mental/computational process?

Many facets of reasoning

Analogical	Legal	Problem solving
Relational	Scientific	Theorem proving
Inductive	Moral	One-shot learning
Deductive	Social	Zero-shot learning
Abductive	Visual	Counterfactual
Judgemental	Lingual	
Causal	Medical	
	Musical	



Bottou's vision

- Is not necessarily achieved by making logical inferences
- Continuity between algebraically rich inference and connecting together trainable learning systems
- Central to reasoning is composition rules to guide the combinations of modules to address new tasks

“When we observe a visual scene, when we hear a complex sentence, we are able to explain in formal terms the relation of the objects in the scene, or the precise meaning of the sentence components. However, there is no evidence that such a formal analysis necessarily takes place: we see a scene, we hear a sentence, and we just know what they mean. This suggests the existence of a middle layer, already a form of reasoning, but not yet formal or logical.”

A simple VQA framework that works surprisingly well

CNN

Visual representation

Question
What is the brown animal sitting inside of?

Textual representation

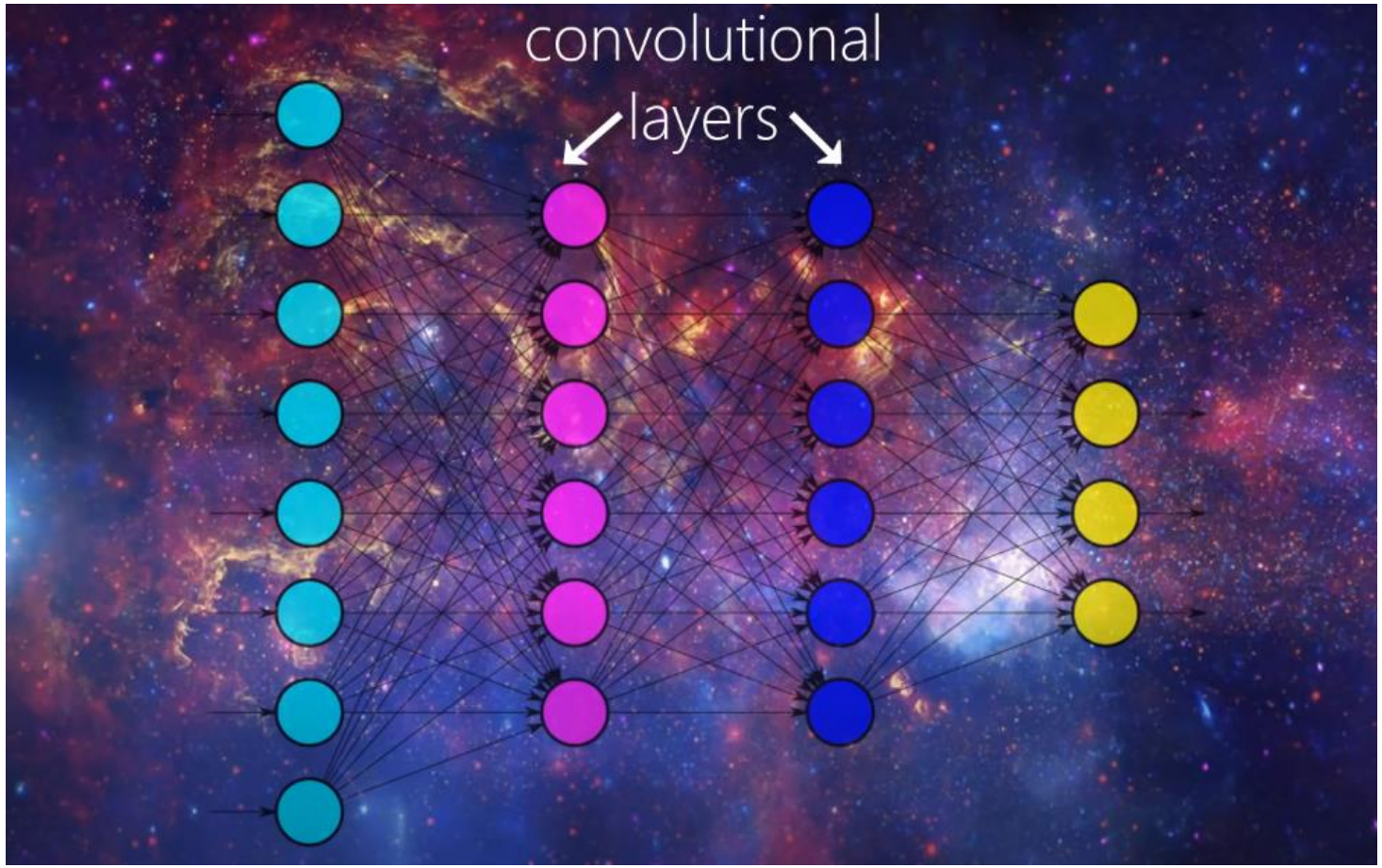
Word embedding + LSTM

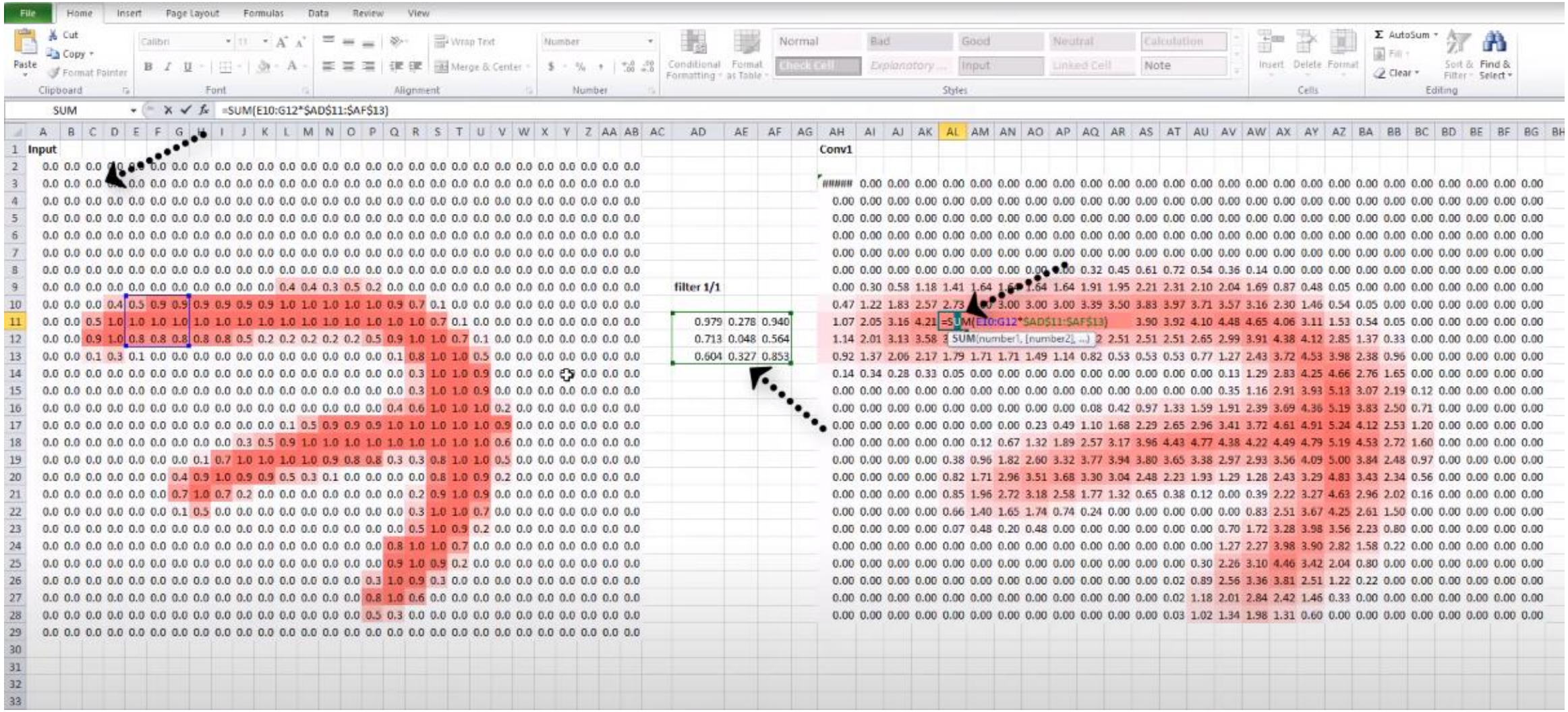
Fusion

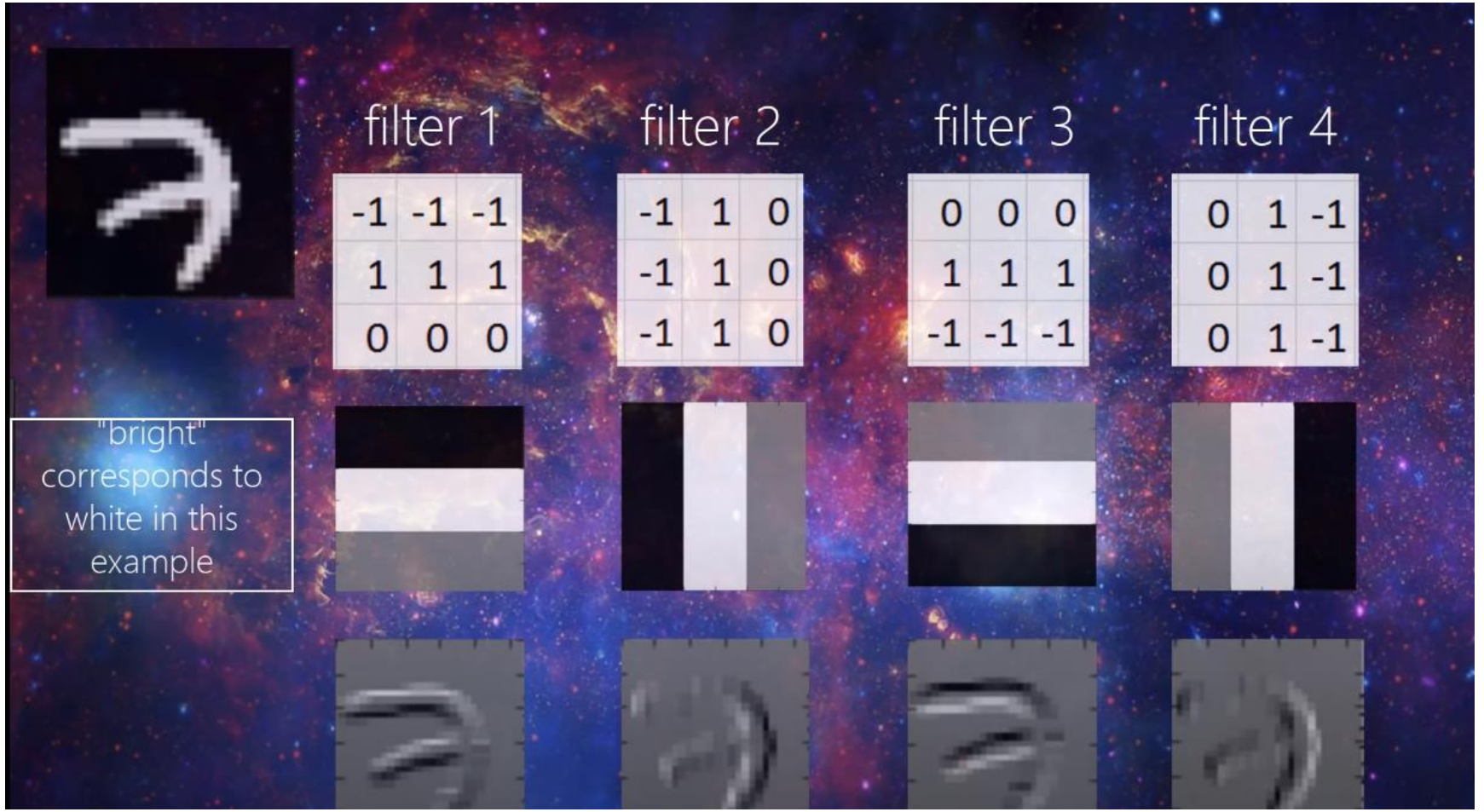
Predict answer

Answer box

CNN(Convolutional Neural Network)




Input
Conv1
filter 1/1
0.979 0.278 0.940
0.713 0.048 0.564
0.604 0.327 0.853
=SUM(E10:G12*$AD$11:$AF$13)
SUM(number1, [number2], ...)


filter 1
-1 -1 -1
1 1 1
0 0 0
filter 2
-1 1 0
-1 1 0
-1 1 0
filter 3
0 0 0
1 1 1
-1 -1 -1
filter 4
0 1 -1
0 1 -1
0 1 -1
"bright" corresponds to white in this example

Diagrammatic Reasoning(DR) Problems

Visual IQ questions that are based on RPM vary in nature and diverse in complexities. Answers of RPM-based reasoning requires common sense, idea about the shapes, and knowledge of mathematics. There exist different types of DR problems. For examples, a typical 2 × 2 DR problem, 4 × 1 problems ,etc DR problems of the order 3 × 3 are considered as formal RPMs

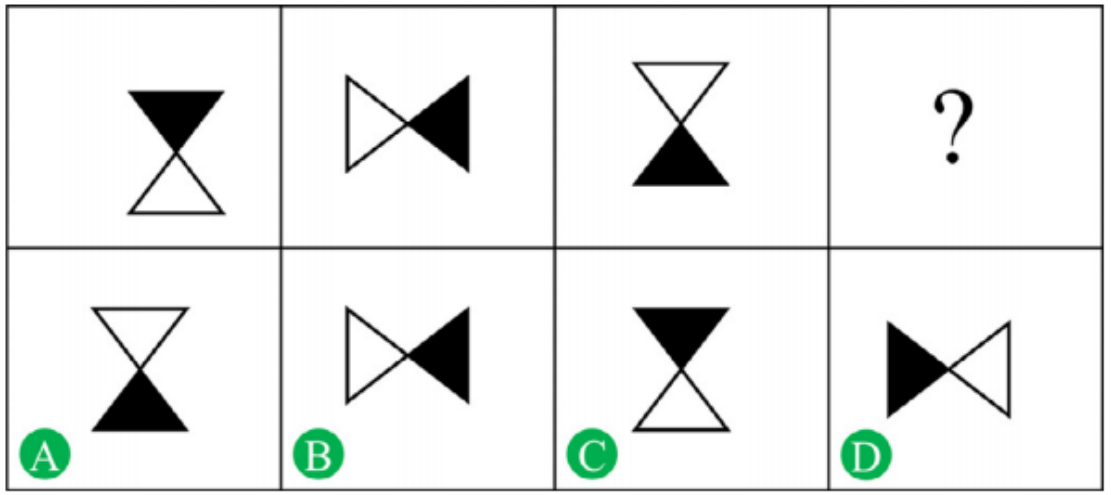
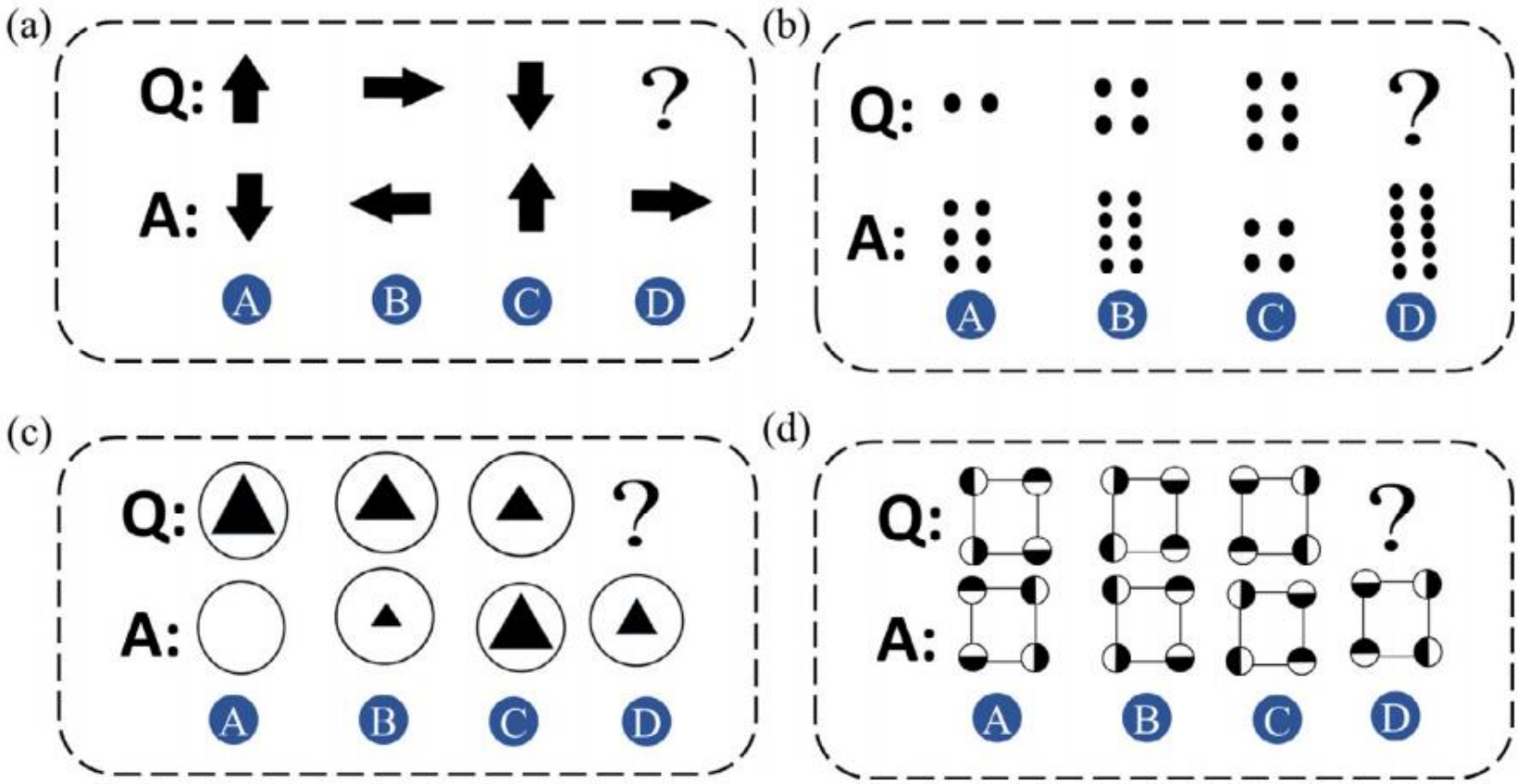


Fig. 1. A typical example of a diagrammatic reasoning problem. The first row presents the first three objects of a sequence of four objects in a particular order. The second row presents the multiple choices typically shown to an examinee. Option D is the right answer for the above problem.

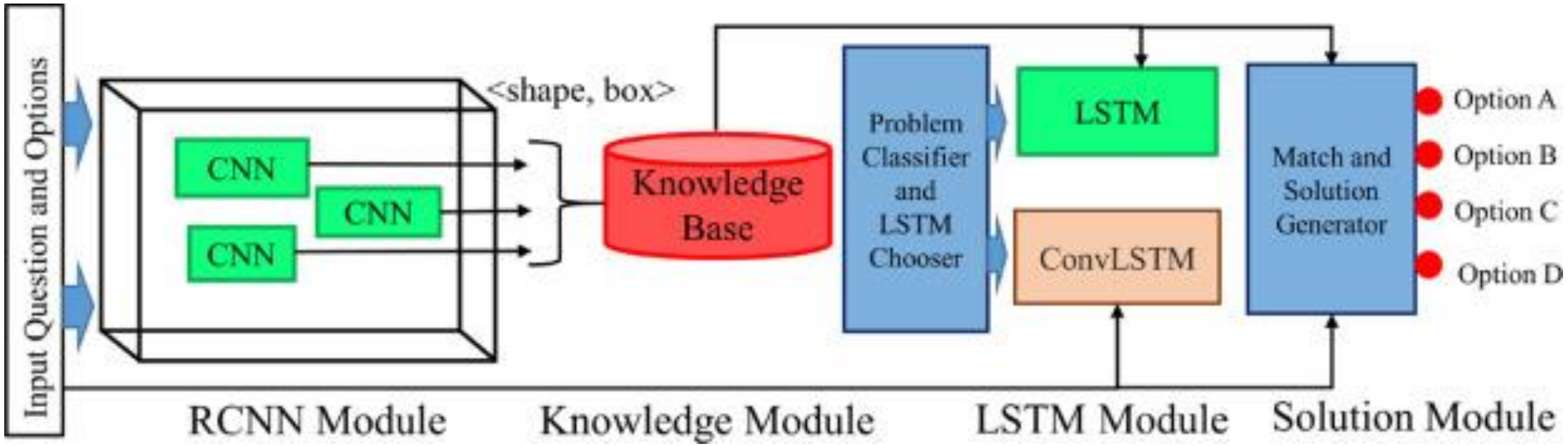
Types of DR problems



Raven's Progressive Matrices (RPM) Solving Methods

Ref	Problem Type	Feature	Method
Kunda et al. [3]	2×2	High-level(Symbol)	Model-based
Lovett et al. [4]	3×3	High-level (Object)	Model-based
Ragini et al. [5]	3×3	High-level (Structure)	Model-based
Mcgreggor et al.[6]	3×3	High-level (Object)	Model-based
Lovett et al.[7]	3×3	High-level (Structure)	Model-based
Santoro et al.[1]	3×3	Low-level (Raw Image)	Learning-based
Hill et al. [2]	3×3	Low-level (Raw Image)	Learning-based
Zhang et al. [8]	3×3	Low-level (Raw Image)	Learning-based
Sekh, Arif Ahmed, et al [9]	4×1	High-level (Relation) + Low-level (Raw Image)	Learning-based

"Can We Automate Diagrammatic Reasoning?." *Pattern Recognition* (2020)



Paper links

1. A. Santoro , F. Hill , D. Barrett , A. Morcos , T. Lillicrap , Measuring abstract rea- soning in neural networks, in: International Conference on Machine Learning, 2018, pp. 4 477–4 486 .
2. F. Hill , A. Santoro , D. Barrett , A. Morcos , T. Lillicrap , Learning to make analo- gies by contrasting abstract relational structure, in: International Conference on Learning Representations, 2019, pp. 1–14 .
3. M. Kunda , K. McGreggor , A. Goel , Addressing the ravens progressive matrices test of ægeneral g intelligence, in: AAAI Fall Symposium Series, 2009, pp. 22–27 .
4. A. Lovett , K. Forbus , J. Usher , A structure-mapping model of raven's progres- sive matrices, in: Proceedings of the Annual Meeting of the Cognitive Science Society, 32, 2010, pp. 2761–2766 .
5. M. Ragni , S. Neubert , Solving raven's iq-tests: an ai and cognitive modeling approach, in: Proceedings of the 20th European Conference on Artificial Intel- ligence, IOS Press, 2012, pp. 666–671 .
6. K. McGreggor , A. Goel , Confident reasoning on raven's progressive matrices tests, in: 28th AAAI Conference on Artificial Intelligence, 2014, pp. 380–386 .
7. A. Lovett , K. Forbus , Modeling visual problem solving as analogical reasoning., Psychol Rev. 124 (1) (2017) 60 .
8. C. Zhang , F. Gao , B. Jia , Y. Zhu , S.-C. Zhu , Raven: A dataset for relational and analogical visual reasoning, in: Proceedings of the IEEE Conference on Com- puter Vision and Pattern Recognition, 2019, pp. 5317–5327 .
9. Sekh, Arif Ahmed, et al. "Can We Automate Diagrammatic Reasoning?." *Pattern Recognition* (2020): 107412.