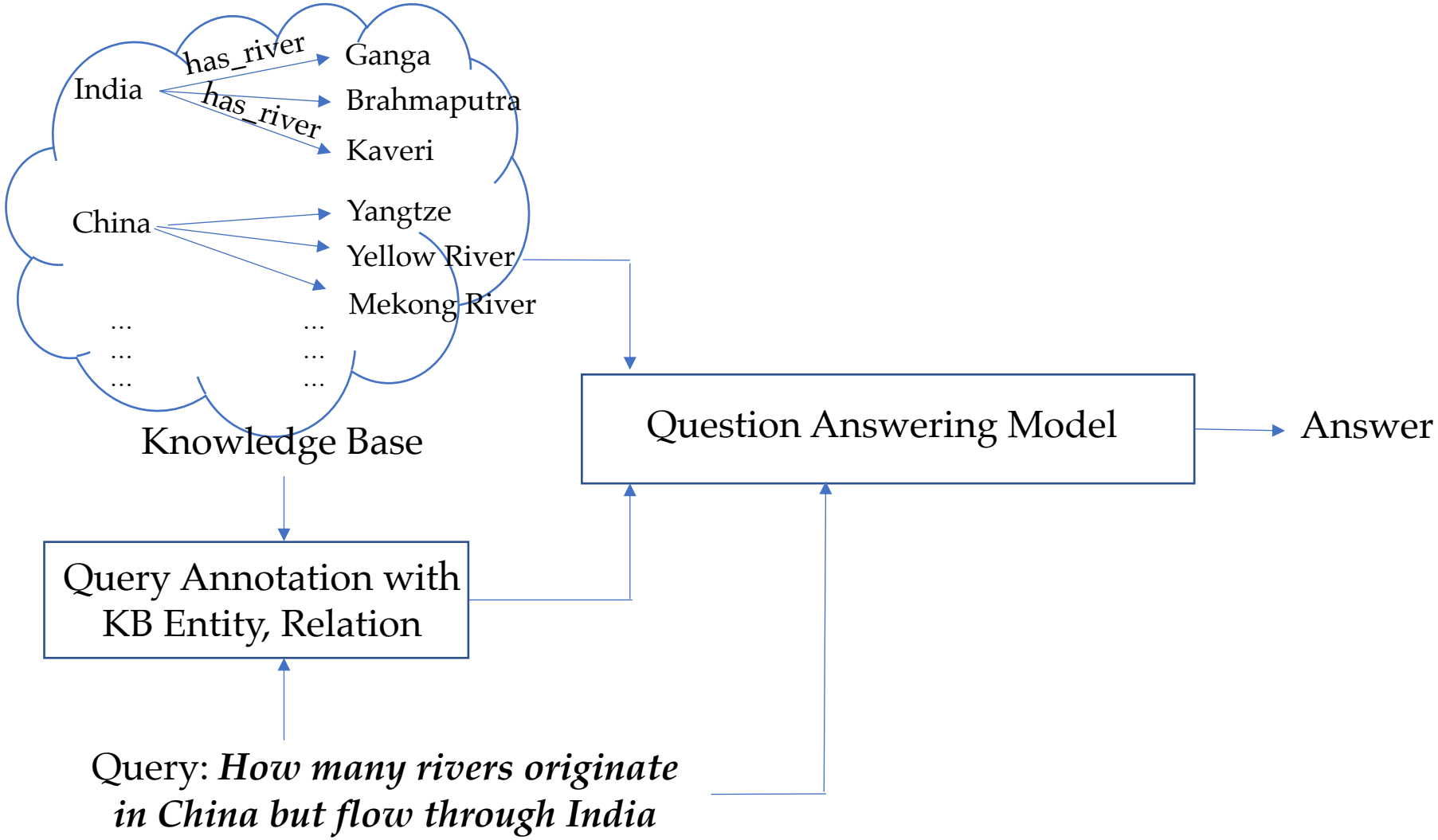
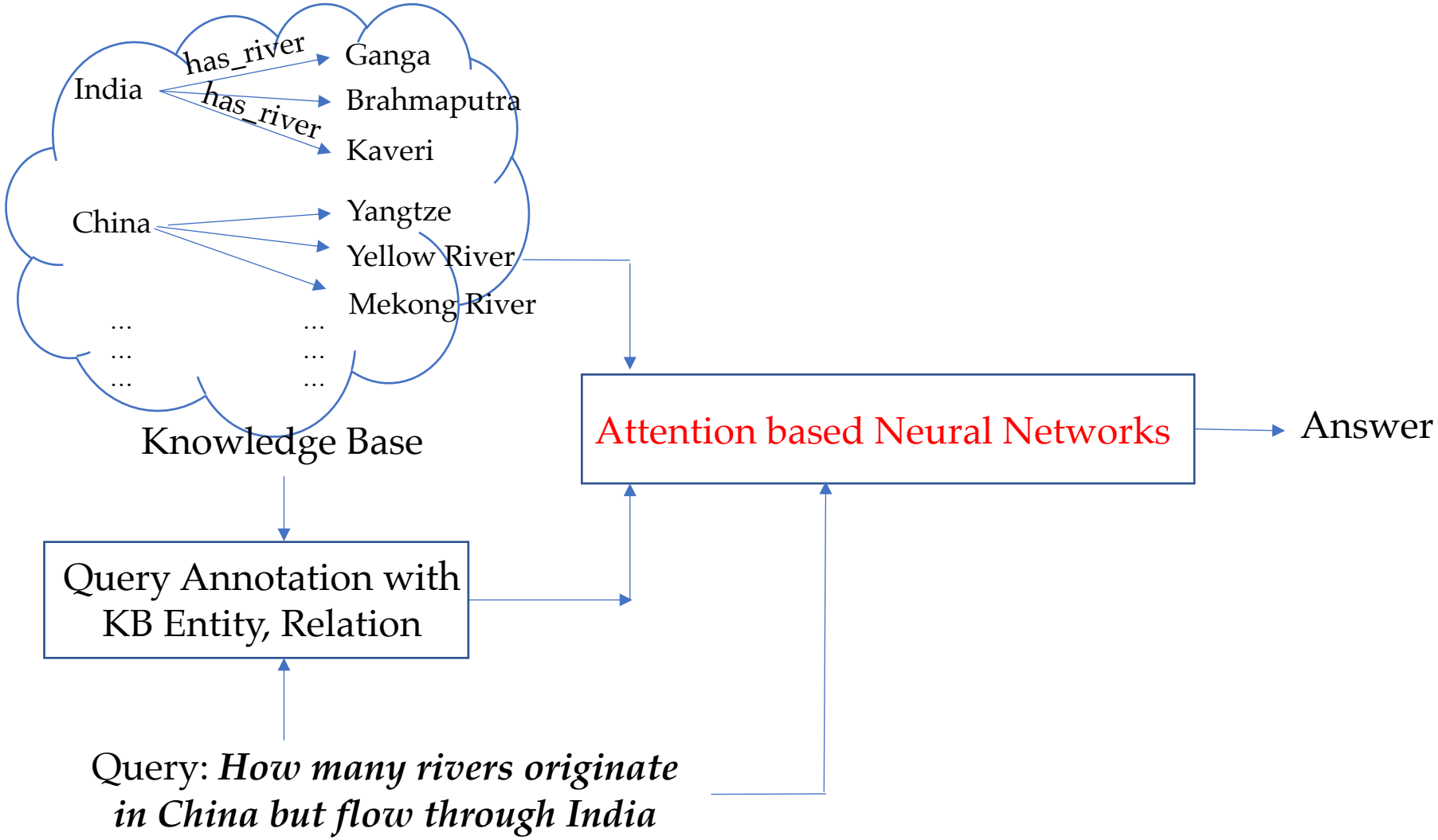
Complex Imperative Program Induction from Terminal Rewards

KB Based Question Answering (KBQA)



Option# 1. End-To-End Neural Models for KBQA



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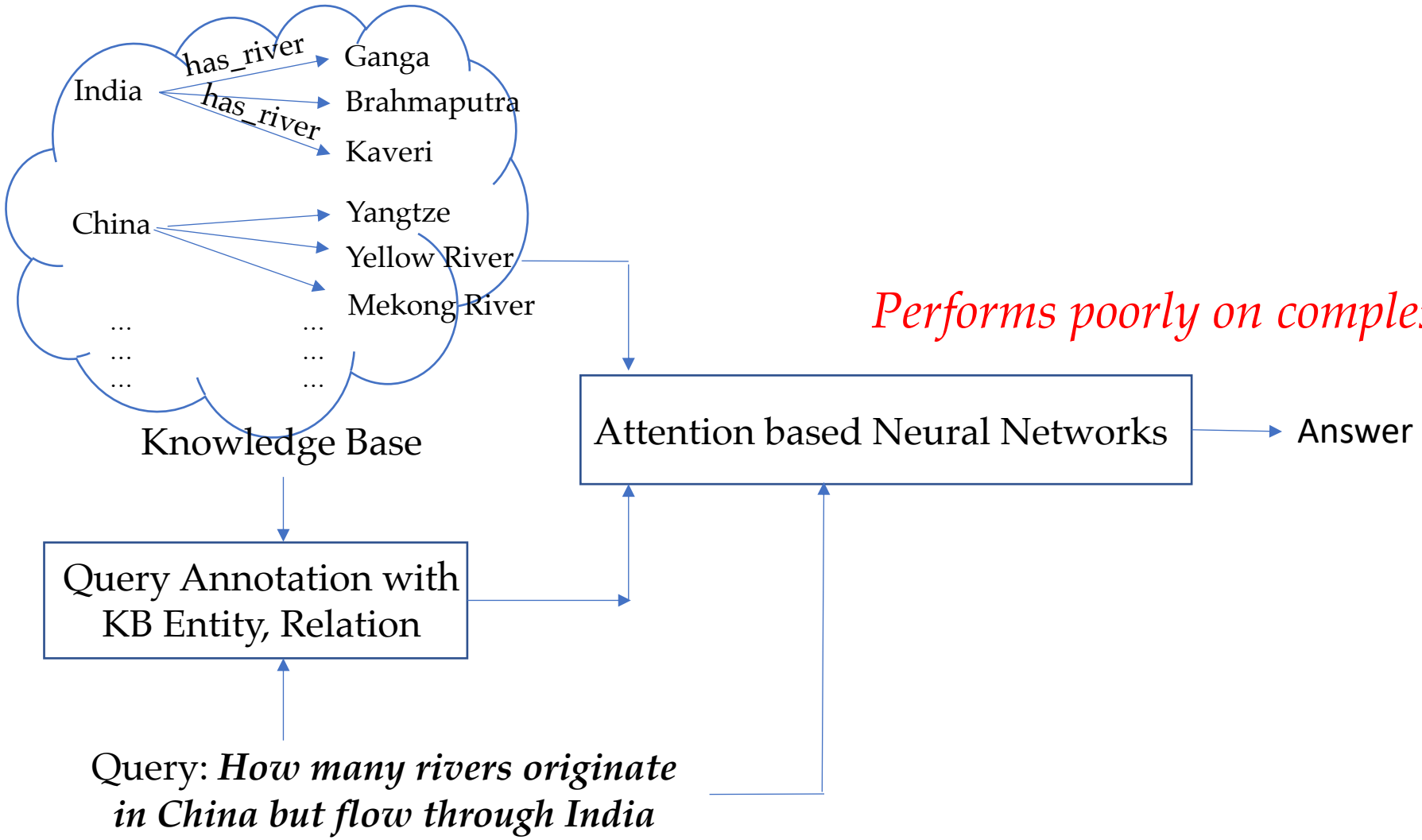
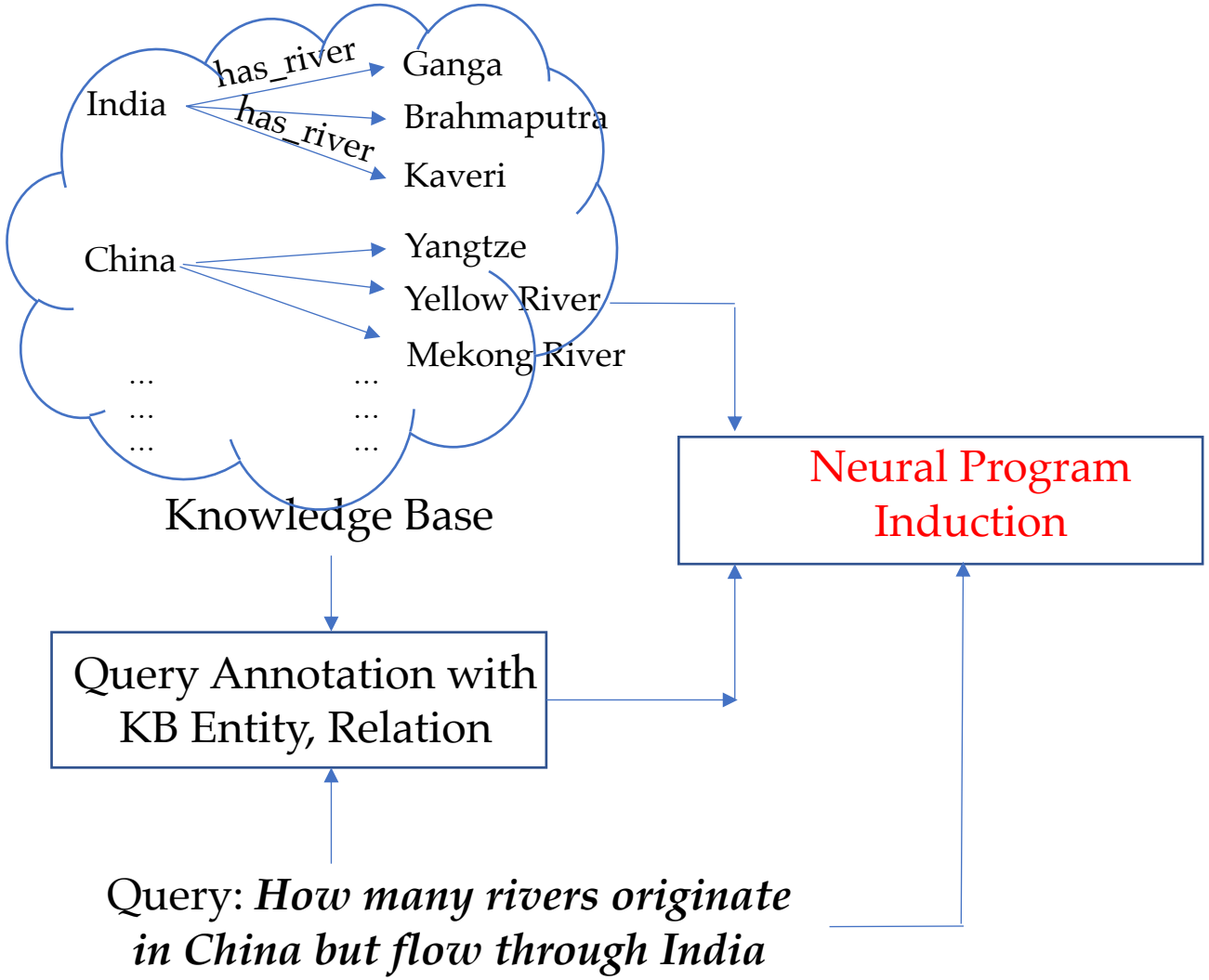
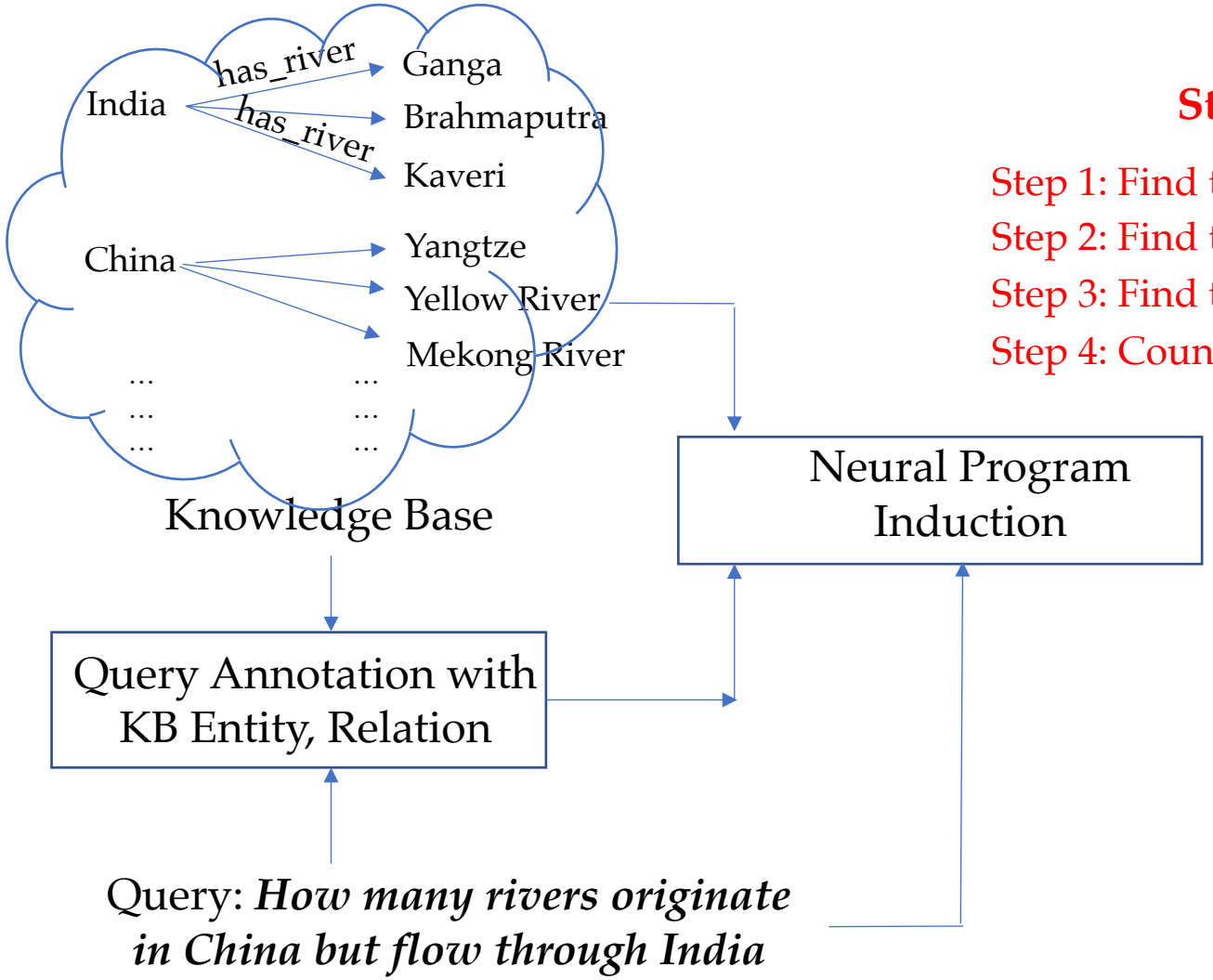


Performs poorly on complex QA!

Option# 2. Modular Neural Models for KBQA



Option# 2. Modular Style KBQA



Steps for Solving Query

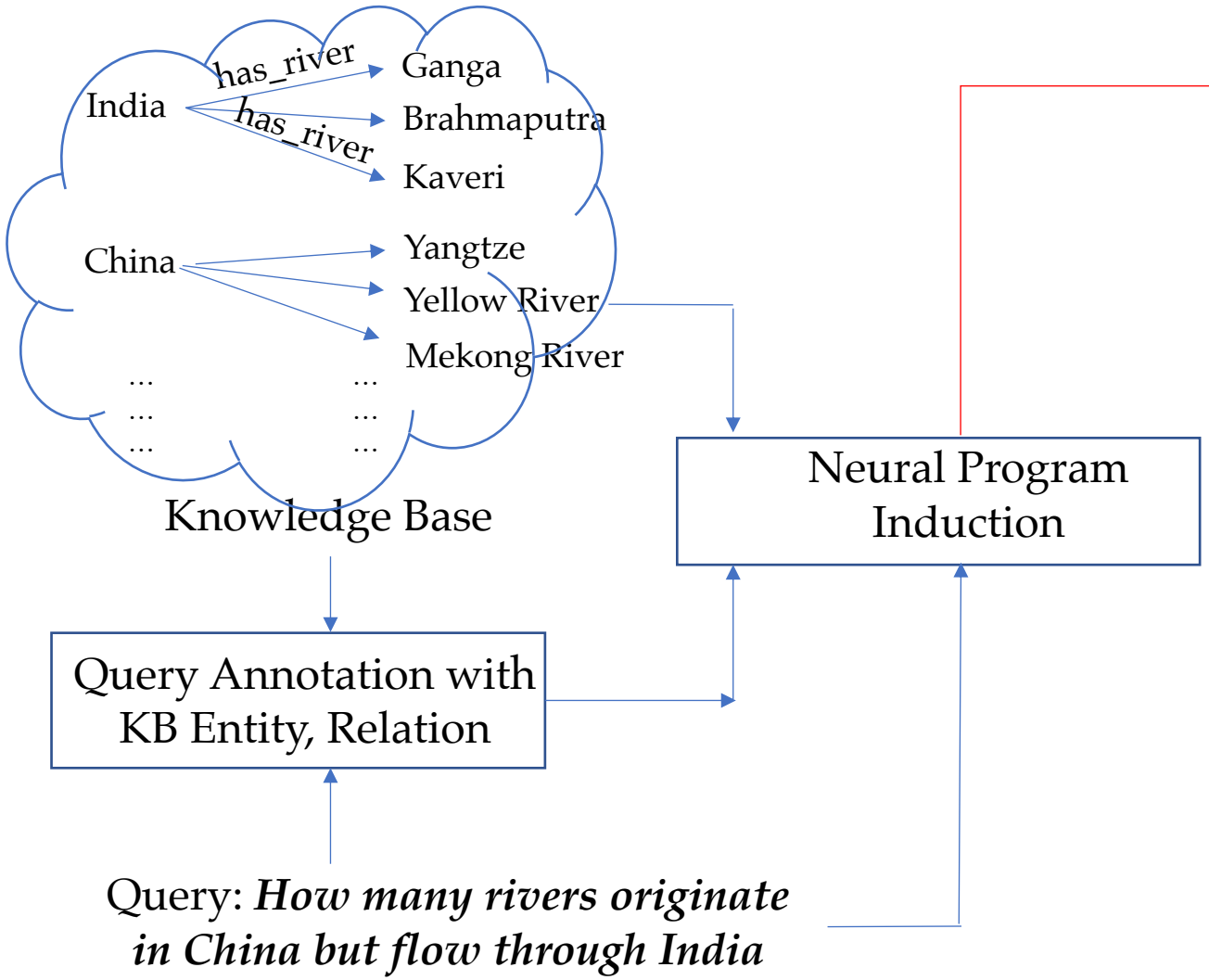
Step 1: Find the set of rivers that originate in China

Step 2: Find the set of rivers that flow through India

Step 3: Find the intersection of the two sets

Step 4: Count the number of rivers in the intersection

Program Induction Step



Generated Program

Step1: A = Generate_Set(China, has_origin, river)
Step2: B = Generate_Set(India, has, river)
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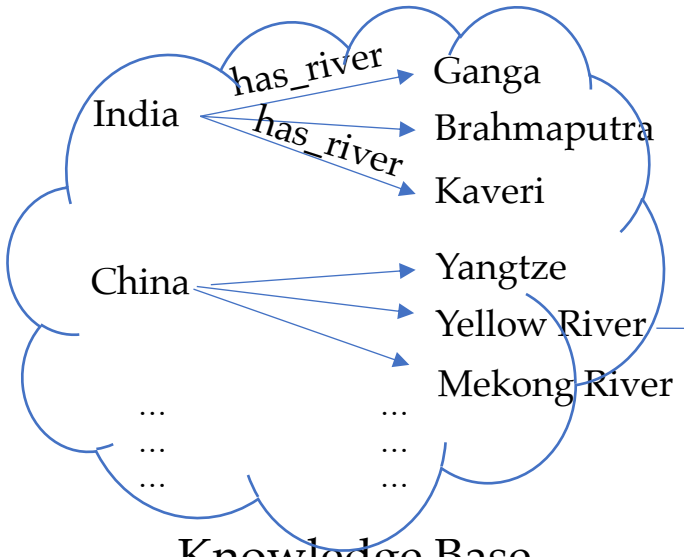
Program Execution Step



Knowledge Base

Query Annotation with KB Entity, Relation

Query: ***How many rivers originate in China but flow through India***

Neural Program Induction

Generated Program

Step1: A = Generate_Set(China, has_origin, river)
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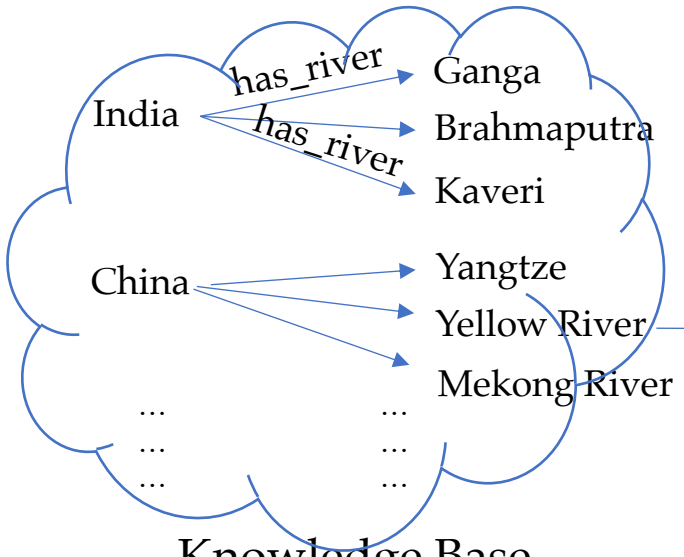
Program Executor

Program Execution Step



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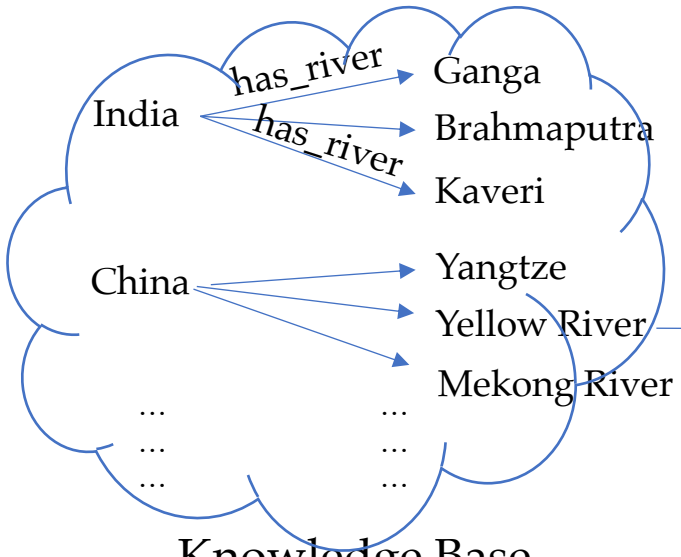

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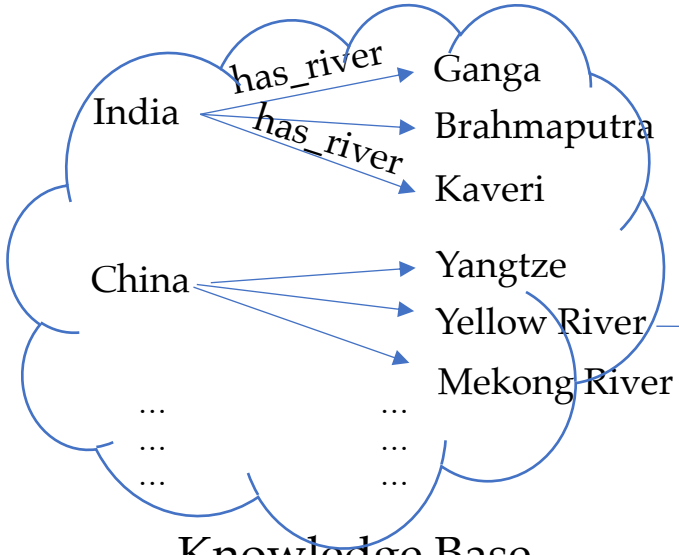
Weak Supervised Program Induction for KBQA



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Neural Program Induction

Getting Gold Program as supervision is hard!

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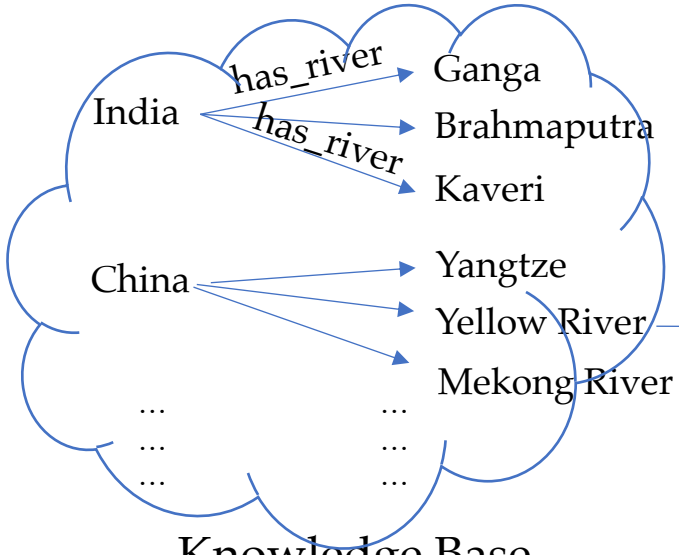

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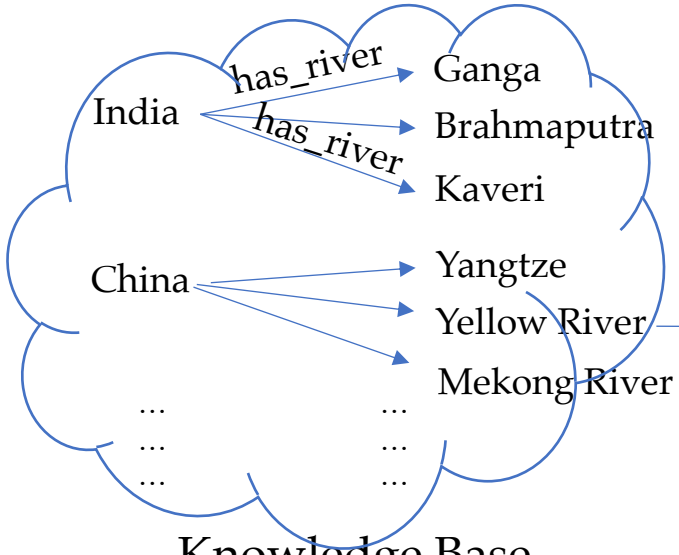
But QA pairs are easily available

Weak Supervised Program Induction for KBQA



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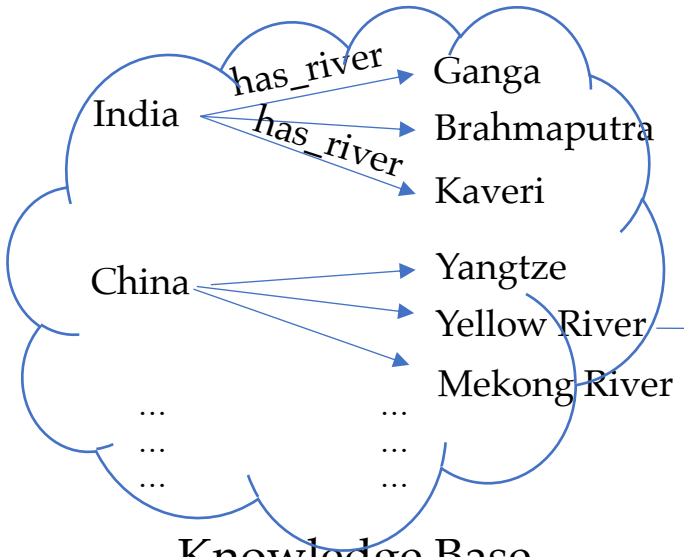
Update Model based on Reward

CIPITR for KBQA

Complex Imperative Program Induction from Terminal Rewards (CIPITR)



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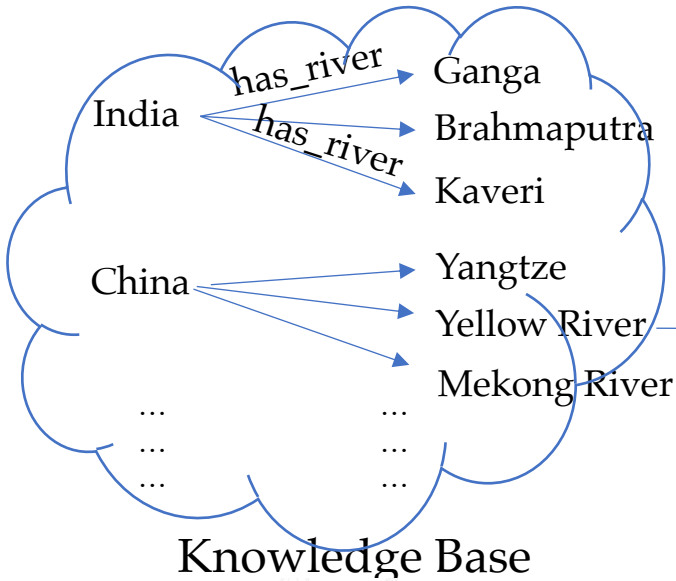

Knowledge Base

Query A ... on with KB E... ation

Use Oracle Query Annotation

Neural Program Induction

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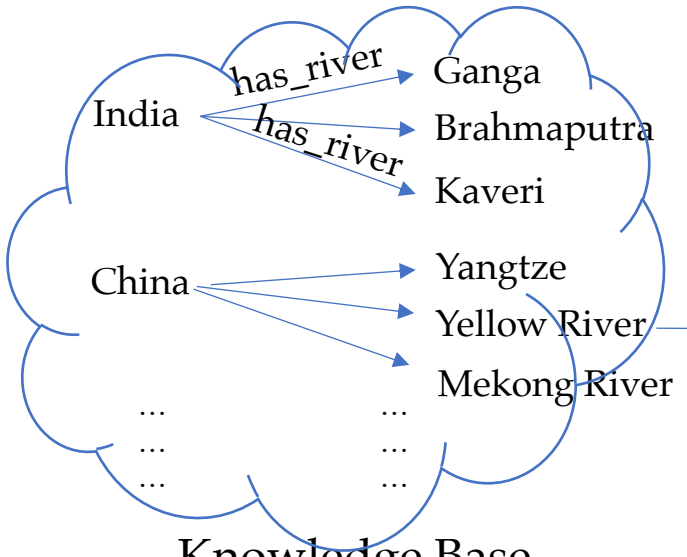
CIPITR for KBQA: Challenges



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Query Annotation with KB Entity, Relation

Query: ***How many rivers originate in China but flow through India***

Neural Program Induction

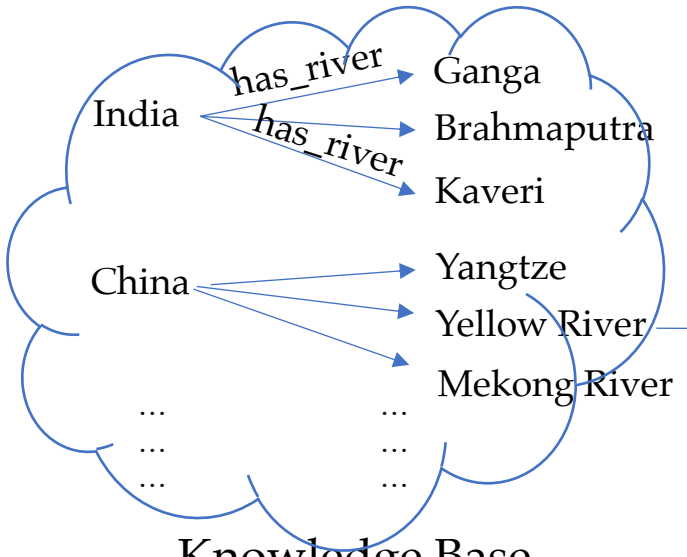
Update Model based on Reward

Challenge# 1: Long Programs owing to complex questions

Challenge# 2: Exponential Search Space of Programs

Challenge# 3: Extreme Reward Sparsity

CIPITR for KBQA: Challenges



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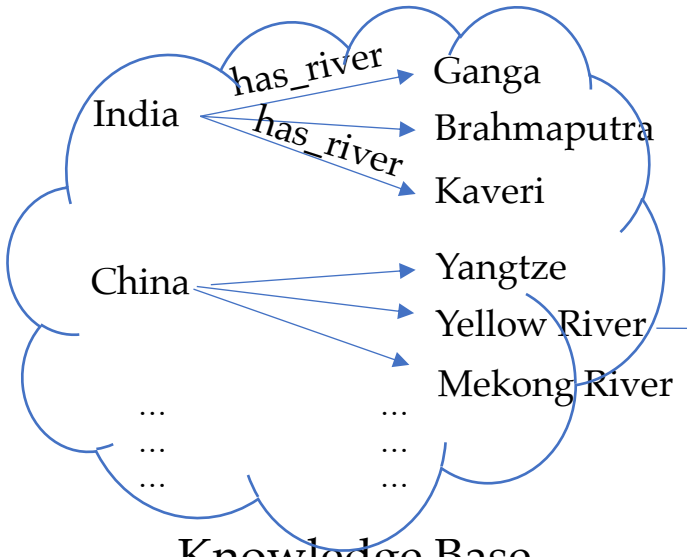

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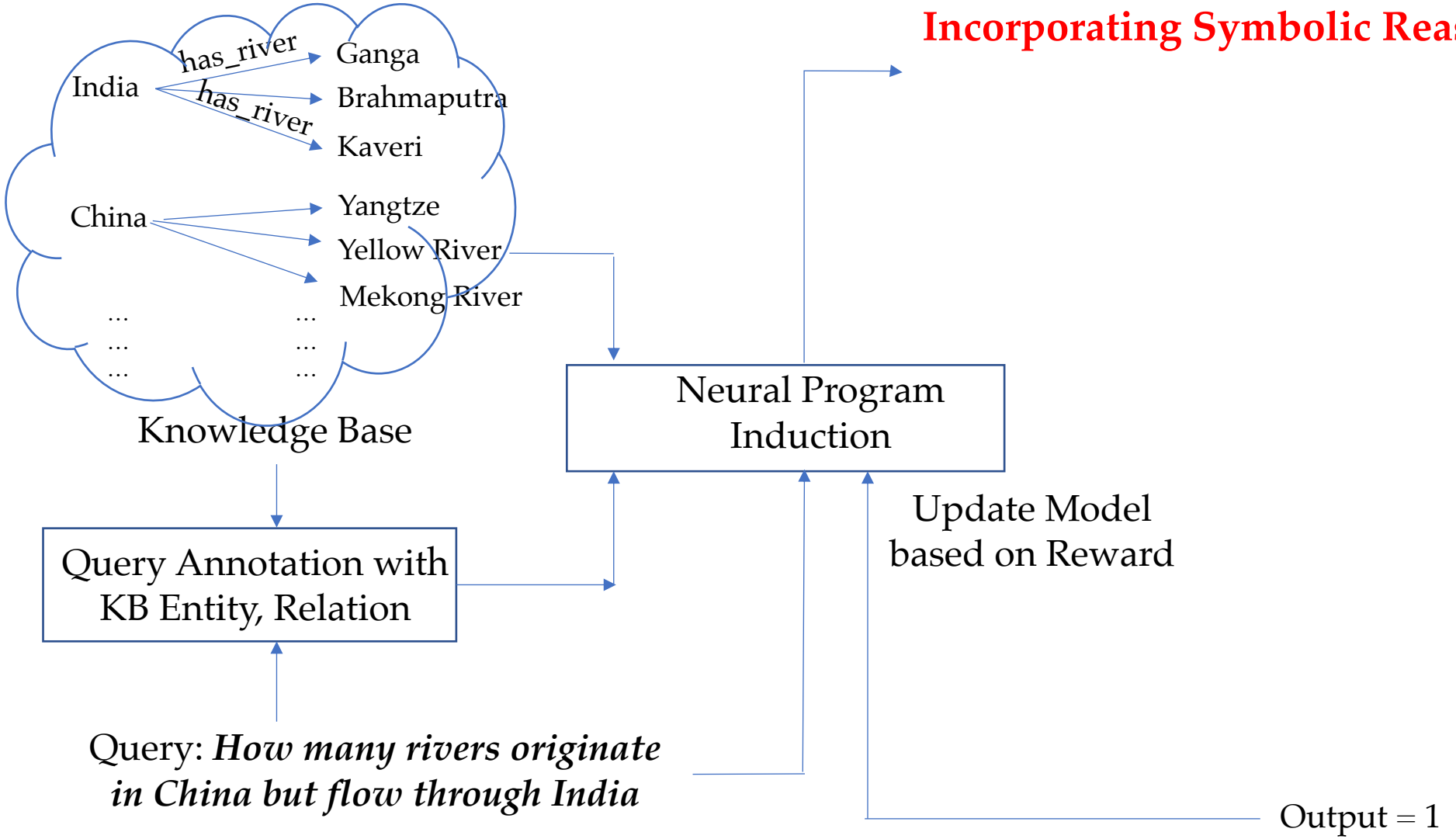
Addressing the challenges by …

Incorporating Symbolic Reasoning in NPI



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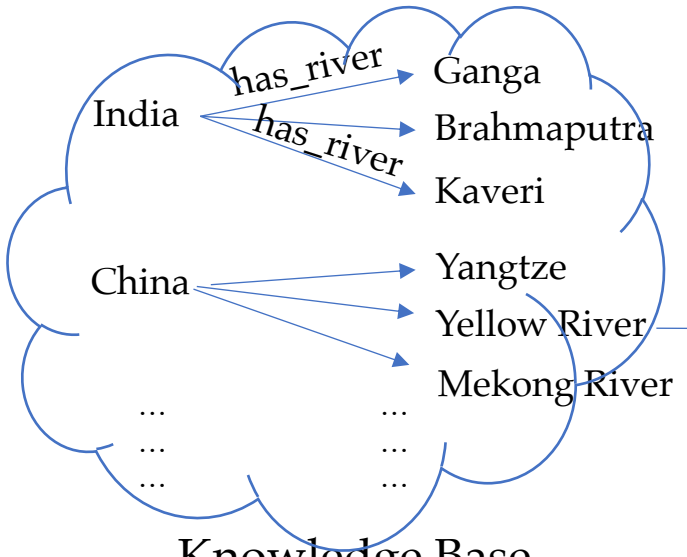

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Neural Program Induction

Update Model based on Reward

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Incorporating Symbolic Reasoning in NPI

- Generic Programmatic Styles
  - No repetition of lines of program
  - Decomposition of program generation into phases

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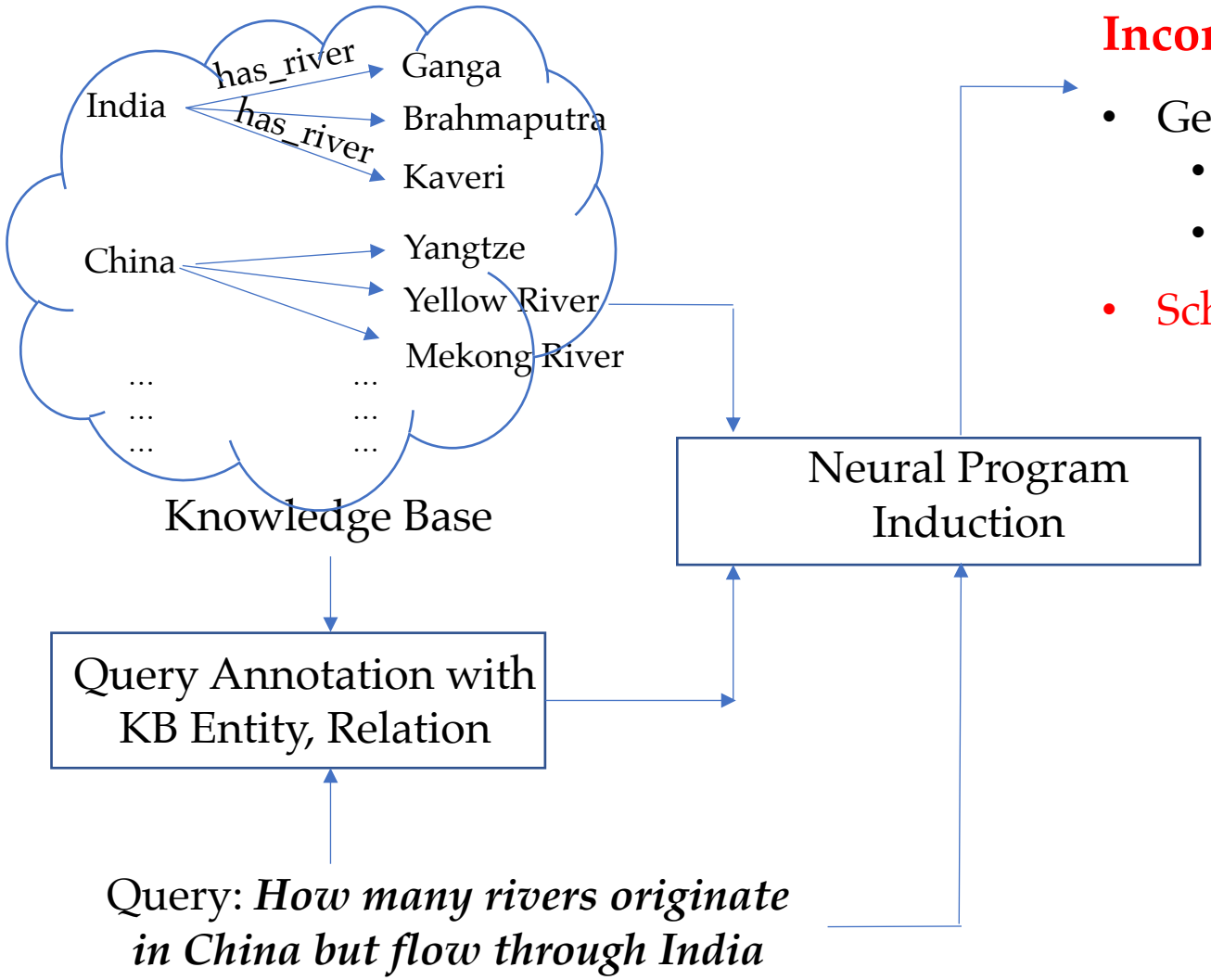

Incorporating Symbolic Reasoning in NPI

- Generic Programmatic Styles
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- Schema and Task(KB) Specific constraints

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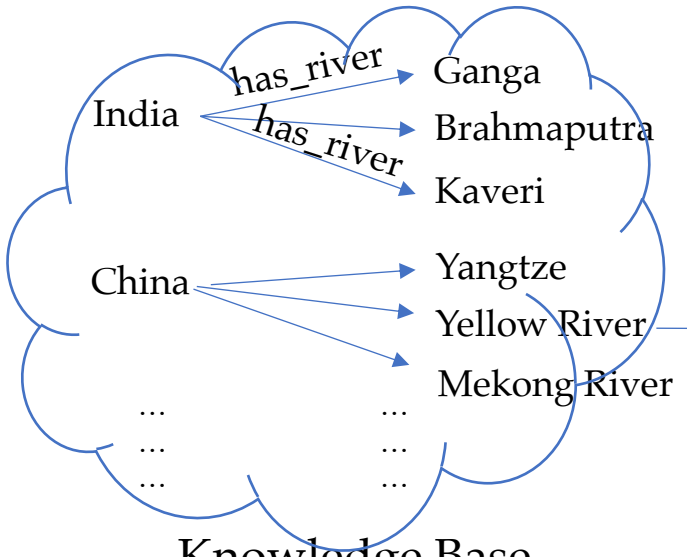

Neural Program Induction

Query Annotation with KB Entity, Relation

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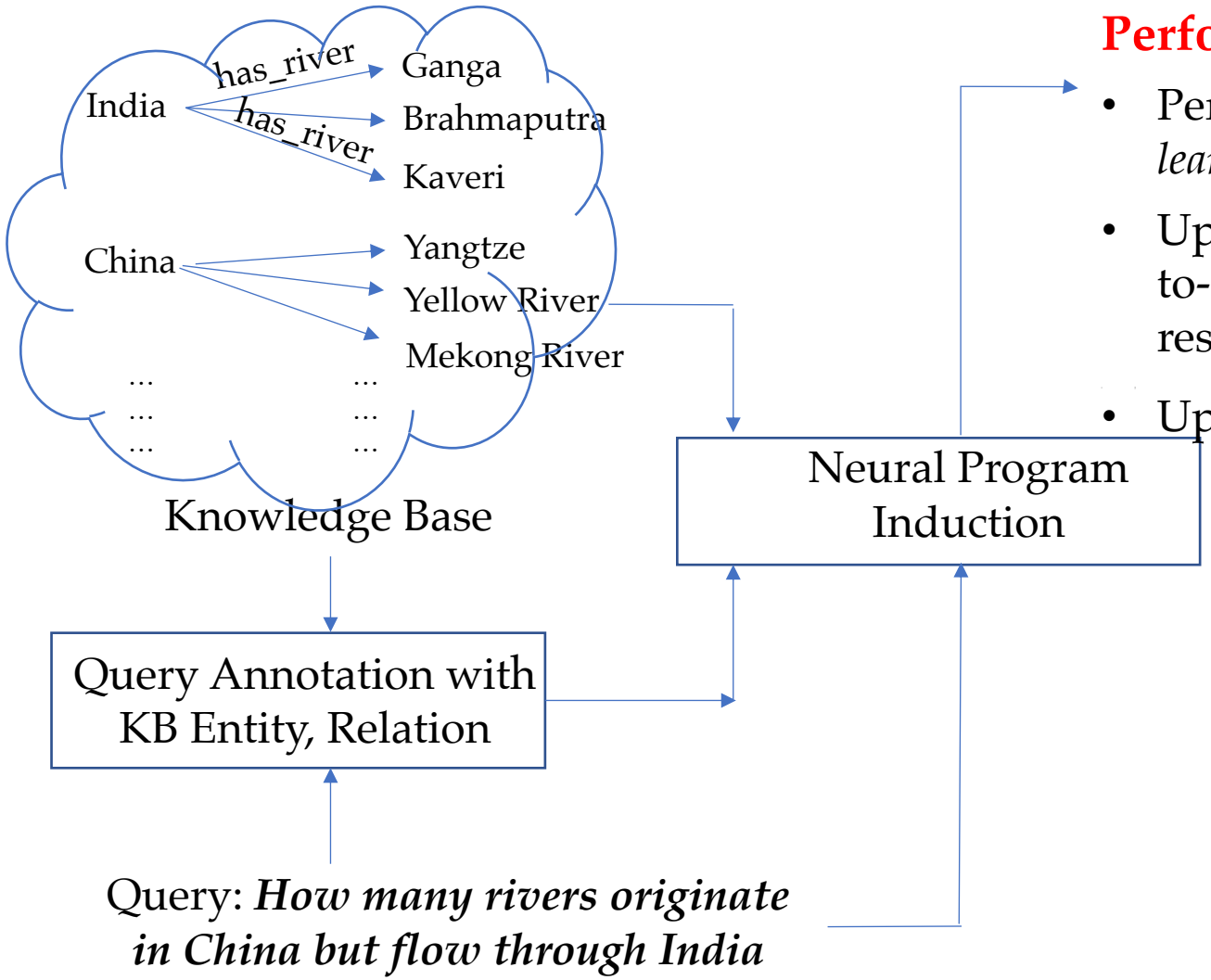
Incorporating Symbolic Reasoning in NPI

- Generic Programmatic Styles
  - No repetition of lines of program
  - Decomposition of program generation into phases
- Schema and Task(KB) Specific constraints
- Semantically Correct Programs
  - Biasing towards answer of meaningful type
  - Curriculum Learning of Answer Type first, value later

Performance Comparison …



Performance comparison with existing models

- Performs slightly better than RuleBased model despite *learning* rules
- Upto *20*× & *89*× improvement over existing NPI and End-to-End Neural models for 2-5 step & 5-10 step programs resp.
- Upto *5*× better generalizability over 7 different query types