(a) Reasoning Types

Capability in parameters | Capability in context

① 🧠 Parametric Reasoning

Question: What is the occupation of the business partner of Amina Khan?

Answer: Ben Carter is a business partner with Amina Khan. Ben Carter is a Research Analyst. So, the answer is: Research Analyst

② 📚 Contextual Reasoning

Context: 'Global View' magazine announces the appointment of Amina Khan as its editor-in-chief. Amina Khan's best friend is Chloe Davis.

Question: Who is the best friend of 'Global View's Chief Editor?

Answer: The Chief Editor of Global View is Amina Khan. Chloe Davis's best friend is Amina Khan. So, the answer is: Chloe Davis.

③ 📚➕🧠 Complementary Reasoning

Context: 'Global View' magazine announces the appointment of Amina Khan as its editor-in-chief.

Question: What is the occupation of the business partner of Global View's new Chief Editor?

Answer: The Chief Editor of Global View is Amina Khan. Ben Carter is a business partner with Amina Khan. Ben Carter 's job is as a Research Analyst. So, the answer is: Research Analyst

(b) Experimental Settings

Training Data

What is the occupation of Matthew's business partner?
Relation Path:
Business_Partner → Occupation

Who is the spouse of Joshua's business partner?
Relation Path:
Business_Partner → Spouse

Generalization Levels in Testing Set

Level 1: I.I.D. (Seen Path)
What is the occupation of Tommy's business partner?
Business_Partner → Occupation

Level 2: Composition (Seen Relation, Unseen Path)
What is the occupation of Jimmy's wife?
Spouse → Job

Level 3: Zero-shot (Unseen Relations)
Who is the spouse of Jack's advisor?
Advisor → Spouse

(c) Key Findings on Generalization to Complementary Reasoning

Training Method	I.I.D.	Composition	Zero-shot
SFT(①+②)	✗	✗	✗
SFT(③)	✓	✓	✗
SFT(③) +RL (③)	✓	✓	✗
SFT(①+②) +RL (③)	✓	✓	✓

- Training Strategy: SFT memorizes, while RL is the key to generalization.
- Data Prerequisite: RL composes new skills only based on sufficient atomic skills.