

path between node 2 and

A: The answer is yes.

A: No cycle in the graph.

Degree Computing

A: The dearee is 3.

Q: Given a graph G1.

compute the degree of

Cycle Detection

graph cycle.

A: Yes.

node 4.

Q: Given a graph G1,

deter-mine if there is a

Hamilton Path **Bipartite Matching** Q: Given a graph G2, is Q: Given a graph G2, there a path visits every whether node 1 is connective to node 4. node exactly once.

A: No.

Shortest Path

Q: Given a graph G1. find the shortest path between node 2 and 3.

A: The path is 2.0.4.3.

or structures.

Titanic and Avatar."

Knowledge Graph Generation

A: The graph is shown in the follow:

Definition: Given a graph, understand the structure and answer the question about connectivity, cycle, hamilton path, bipartite matching, shortest path and degree.

Definition: Given a passage, understand

generate a graph to satisfy the semantics

the instruction and question, and then

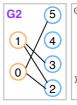
Q: Given the following passage, generate a

knowledge graph to express the semantics:

"James Cameron is a Canadian filmmaker born in

Ontario in 1954. He directed popular movies such as

Graph[name="G1"]{ node_list=[0, 1, 2, 3, 4, 5]; edge list=[(0 < -> 1) [weight=1], (0 < -> 2) [weight=3], (5)



Graph[name="G2"]{ node_list=[0, 1, 2, 3, 4, 5]; edge list=[(0 < -> 2), (0 < -> 5), $(1 \iff 2), (1 \iff 3),$

Link Prediction

Q: Given a graph G3, predict the relation between "James Cameron" and "Canada". A: place of birth.

Question Answering

Q: Given a graph G3, answer the question: what's the birthday of the film TITANIC's director? A: 1954.

Relevance Inspection

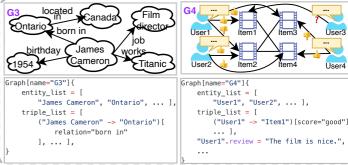
0 O a

Instruct

Graph

Q: Given a graph G3, whether the following passage is relevant to the graph. "James A: Yes. it's relevant.

Graph Language Modeling (Graph Reasoning)



Node Classification

classify the node

"Canada".

Caption Generation

Q: Given a graph G3. generate a caption to describe the graph.

A: country_name. A: James Cameron ...

"User1".review = "The film is nice.",

Collaboration Filtering

Q: Given a graph G3, Q: Given a graph G4, what's the user3's review preference towards item1? A: It's 🍁 .

Definition: Given a graph, understand the graph semantic and answer the question about caption, QA, node classification, link prediction, relevance and collaboration.

Graph Structure Modeling (Graph Reasoning)

Graph Generation Modeling

(Graph Generation)

Structure Graph Generation

Q: Given the follow description, generate a graph to release the structure. "In an undirected graph, the nodes are from 0 to 6, (i, w, j) means an edge with a weight w. All edges are: (3, 5, 5), (0, 2, 1), (0, 1, 6), (2, 3, 4), (5, 1, 6), (2, 3, 3), (1, 1, 6) and (1, 4, 6)."

A: The graph is shown in the follow:

```
Graph[name="Structure-Graph"]{
node_list = [0, 1, 2, 3, 4, 5, 6],
edge list = [
     (0 \rightarrow 1) [weight=2], (0 \rightarrow 6) [weight=1], ...],
```

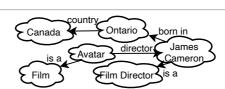
Commonsense & Factual Reasoning

Q: What's the birth country of Avatar's director? A: To answer this question, we first find the topic entity is "Avatar". Then, we construct a knowledge subgraph of the topic entity, the graph is:

Graph Thought Modeling

(Graph Reasoning and Generation)

```
Graph[name="Thought-Graph"]{
entity list = ["James Cameron", "Avatar", ... ],
triple_list = [("Avatar" -> "James Cameron")[
    relation="director"], ...],
```



Based on the graph, we can find a reasoning path that (Avatar, director, James Cameron, born in, Ontario, country, Canada), So the answer is Canada.

Definition: Given a reasoning question, think step by step: 1) find a topic entity, 2) then generate a graph that express the thinking process, 3) finally output the answer.

Arithmetical & Logical Reasoning

Q: Roger had 16 dollars. For his birthday he got 28 more dollars but spent 25 on a new game. How much money does he have now?

A: To answer this question, we first find the topic entity is "Roger". Then, we construct a graph:

```
Graph[name="Thought-Graph"]{
entity list = ["Roger", "16 dollars", ... ],
triple list = [("Rogar" -> "16 dollars")[
    relation="first has"]. ... ].
                         6 dollars
               first has
```

Based on the graph, we can find a reasoning path that (Rogar, first has, 16 dollars, add, 28 dollars, minus, 25 dollars). So the answer is 19 dollars.

-28 dollars

