



Explainable Graph Query Answering

Data Science Junior Research Group



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Graph Databases (GDBs)

Store information in the form of heterogeneous graphs

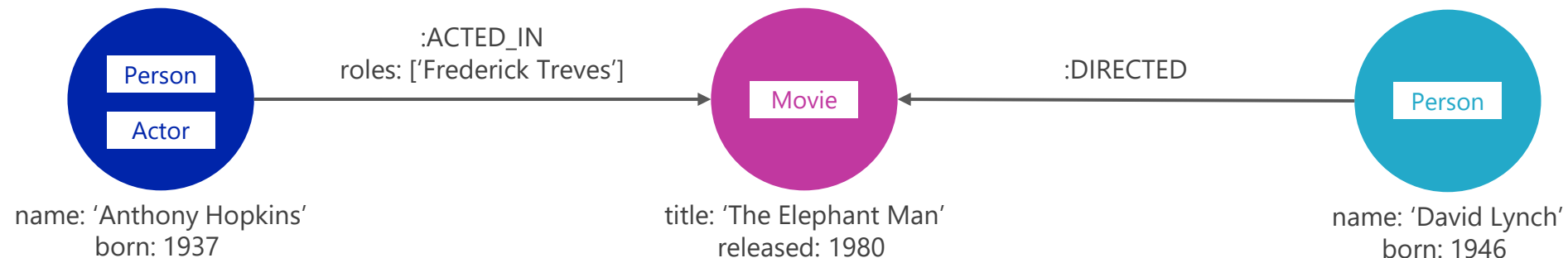
- nodes → entities
- edges → relationships between entities

Flexible data architecture

- easily adaptable to evolving data models

Powerful performance

- especially on complex, hierarchical and multi-relationship data
- enables efficient querying of multi-hop relationships





Complex Query Answering (CQA)

A *complex query* is a request for information that involves multiple conditions, relationships, and logical operations.

Biomedical

- Which drugs ($D_?$) interact with proteins (P) that are associated with both diseases t_1 and t_2 ?

E-commerce

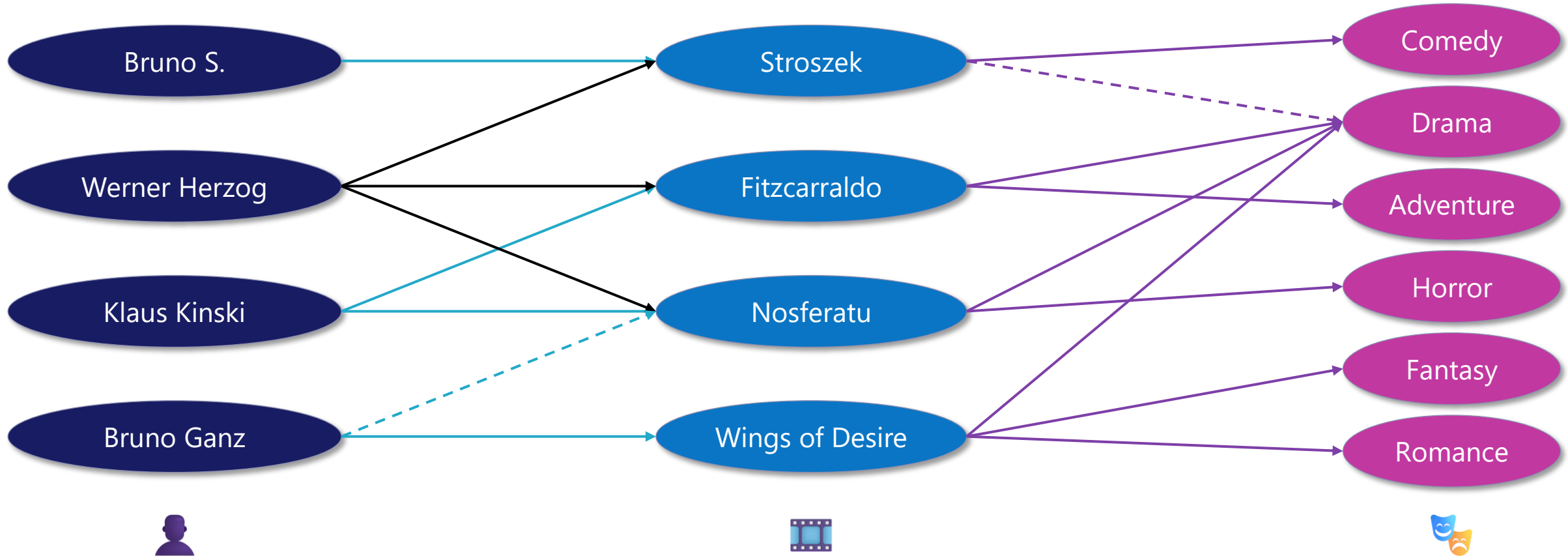
- Which products ($P_?$) in the '*clothing*' category have been purchased by users (U) who live in either *Paderborn* or *Bielefeld*?

Social Network

- Find posts ($P_?$) that user u_1 is likely to downvote but user u_2 is likely to upvote

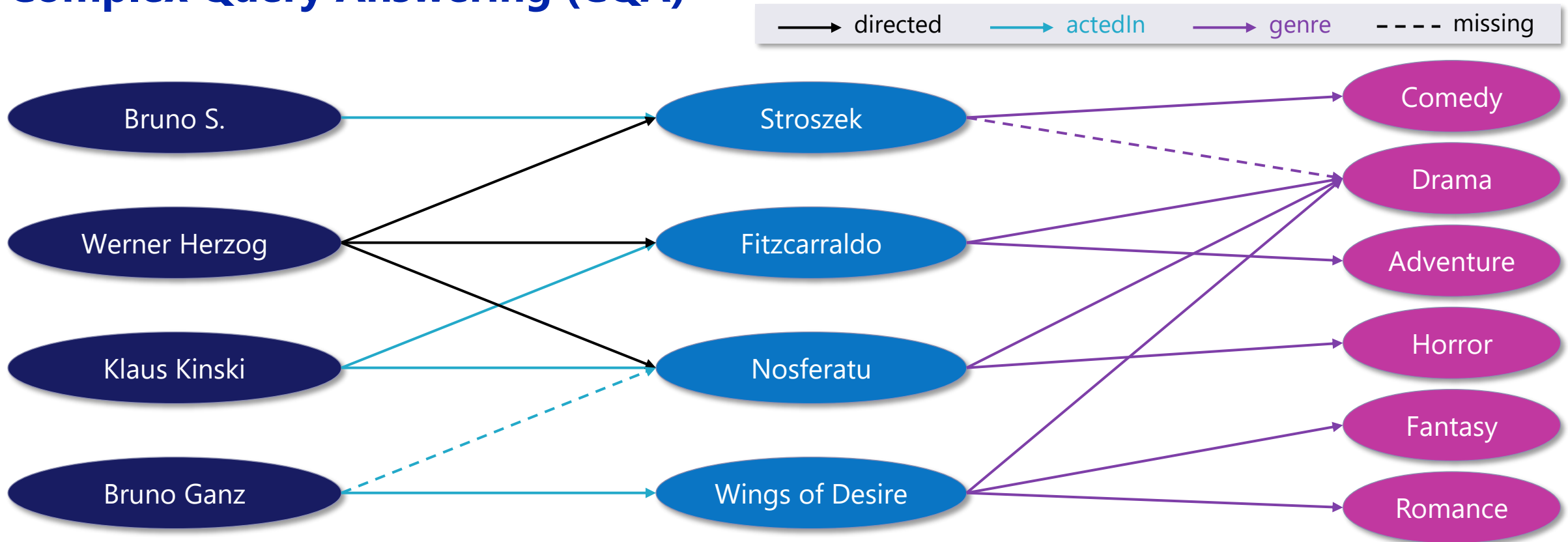


Complex Query Answering (CQA)





Complex Query Answering (CQA)

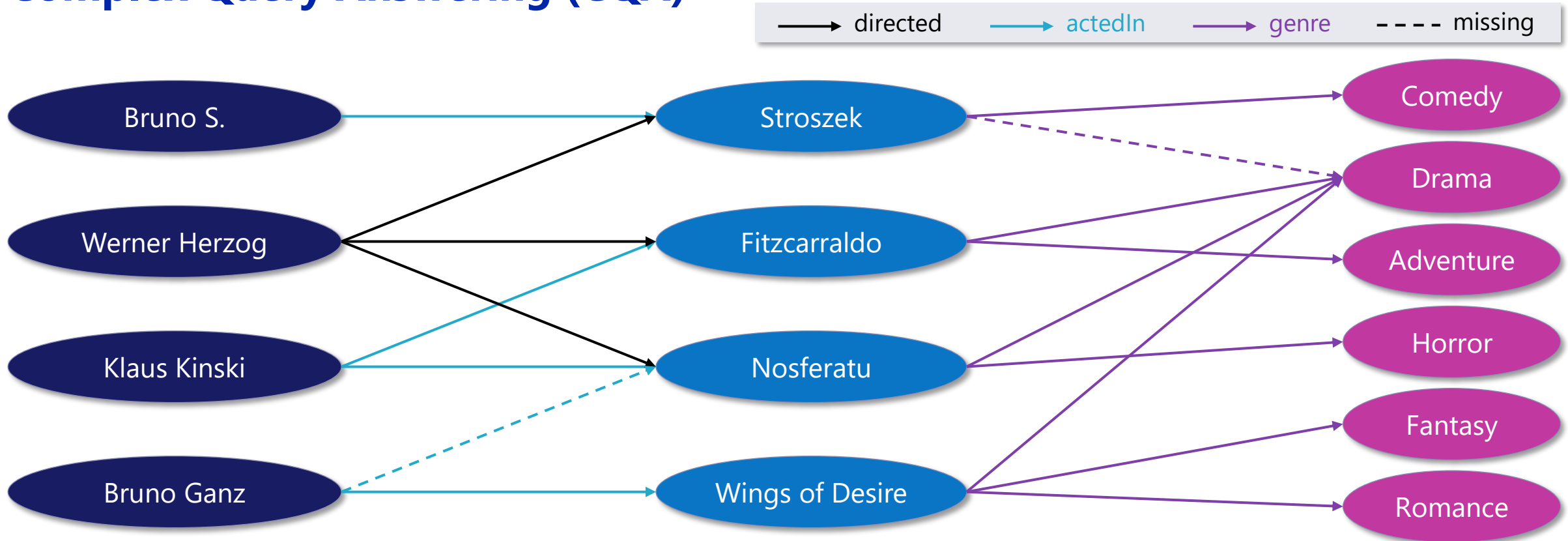


Which actors **acted in movies** directed by "Werner Herzog" that belong to the "Drama" genre?





Complex Query Answering (CQA)



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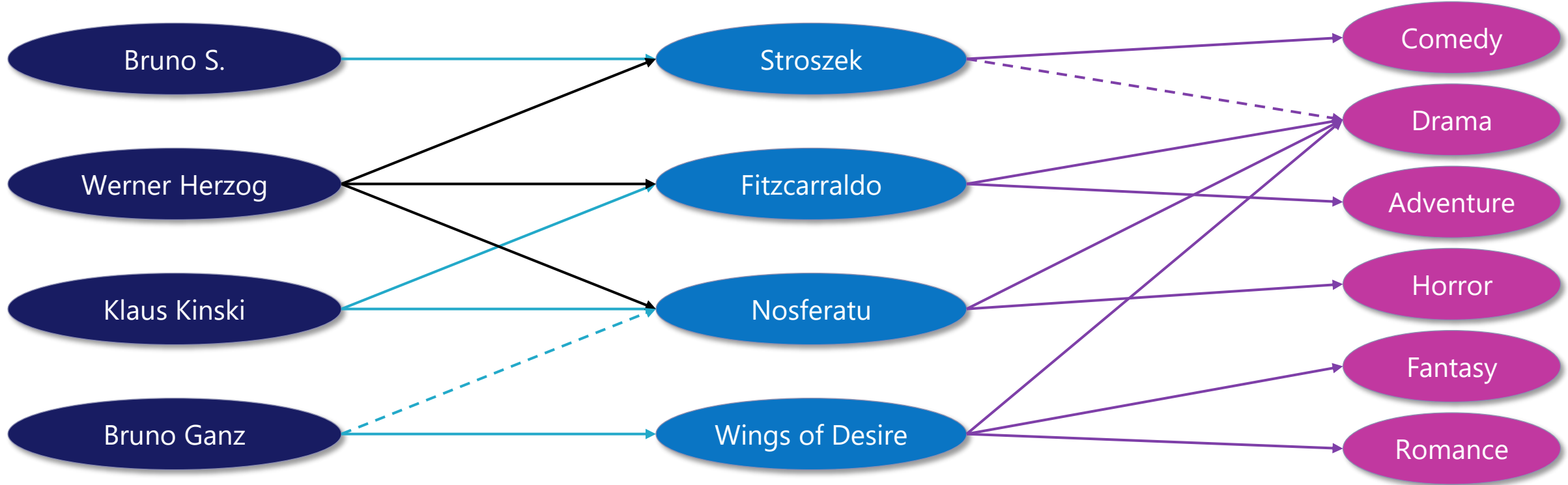
$$q = P?. \exists M: actedIn(P, M) \wedge directed("Werner Herzog", M) \wedge genre(M, "Drama")$$





Complex Query Answering (CQA)

Edge Traversal (SPARQL)



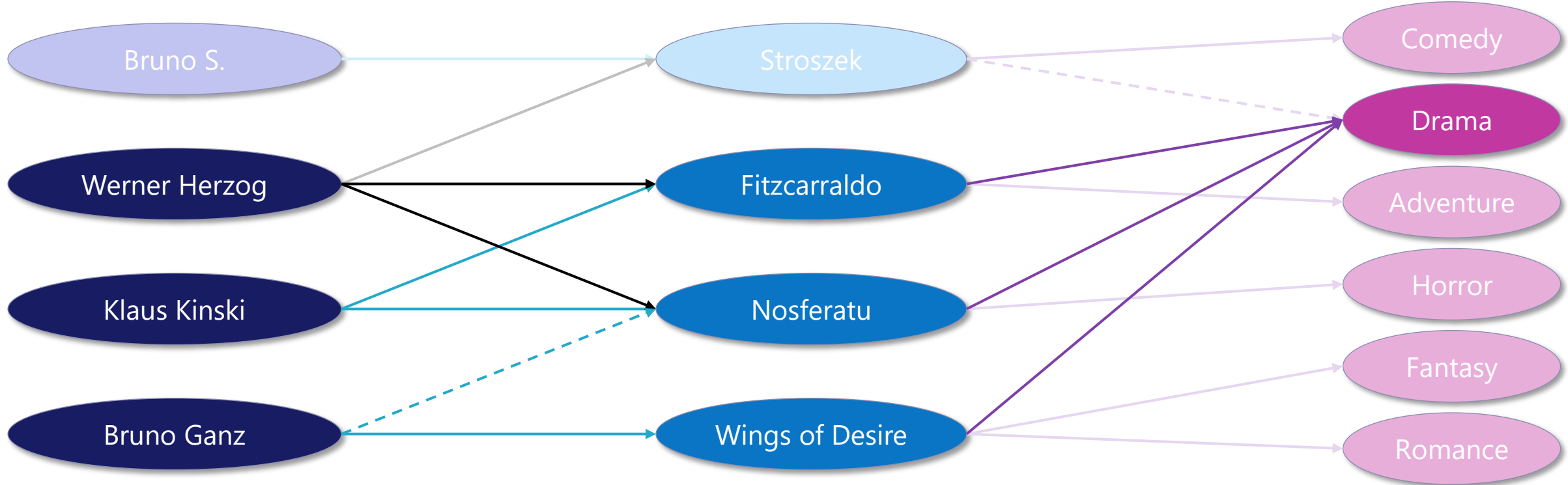
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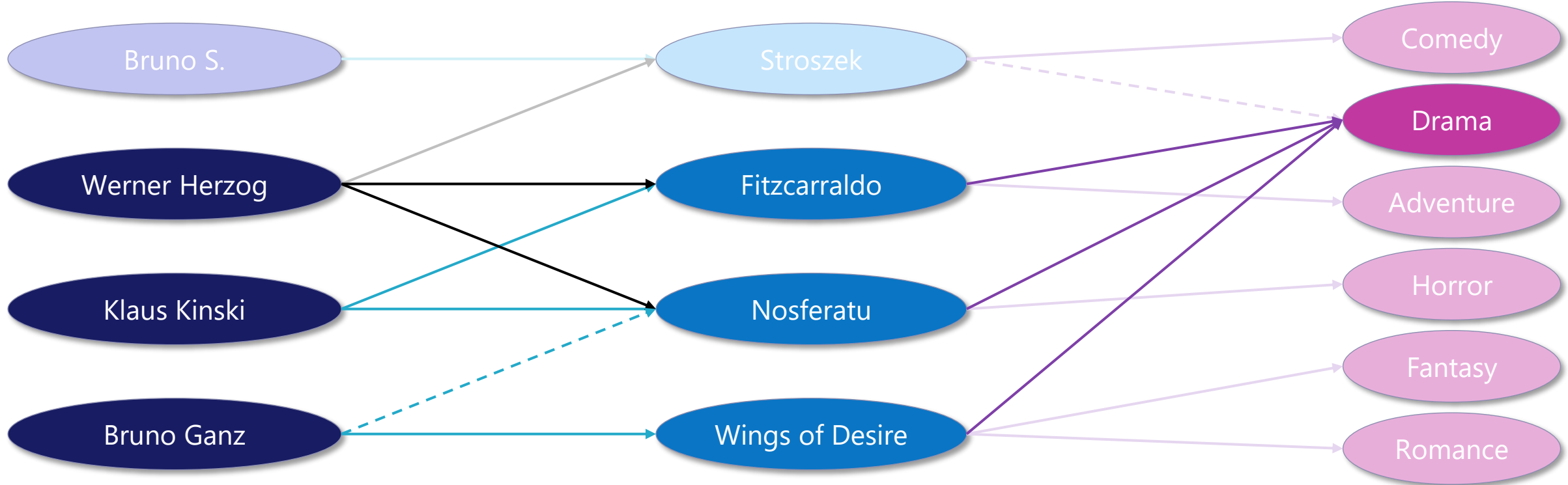
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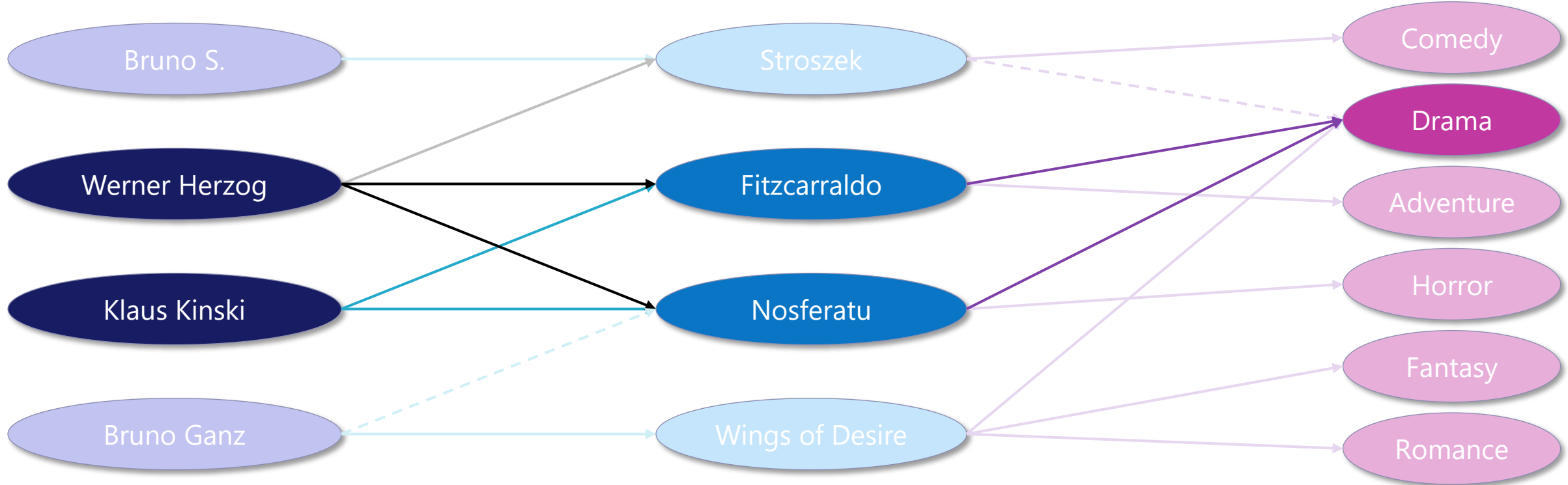
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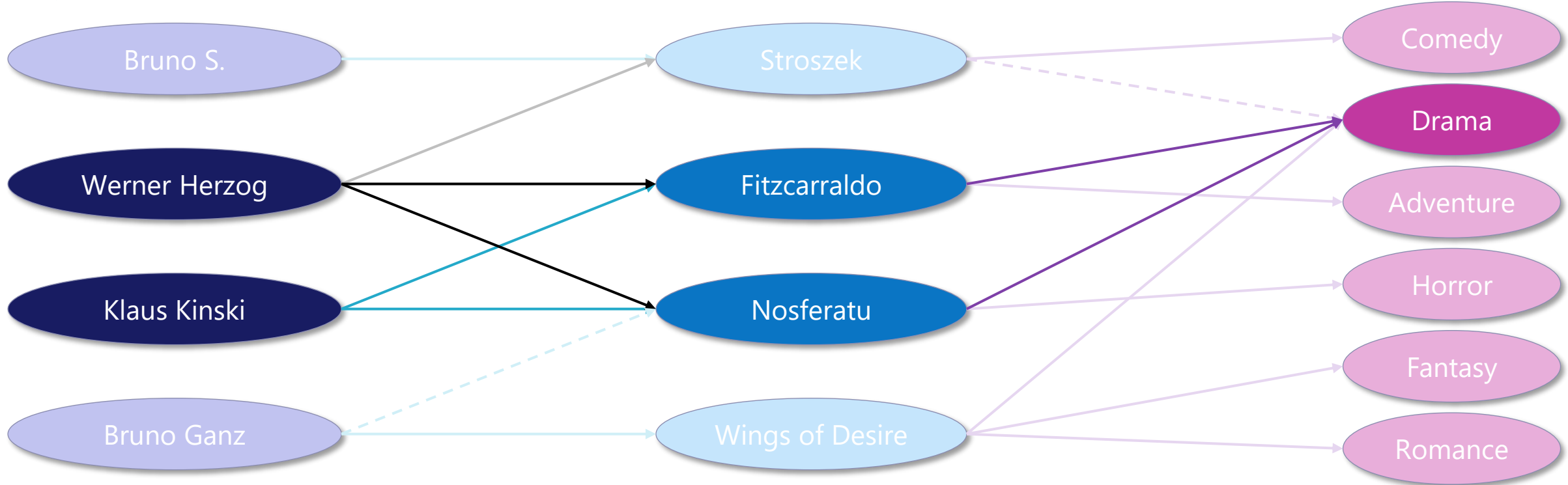
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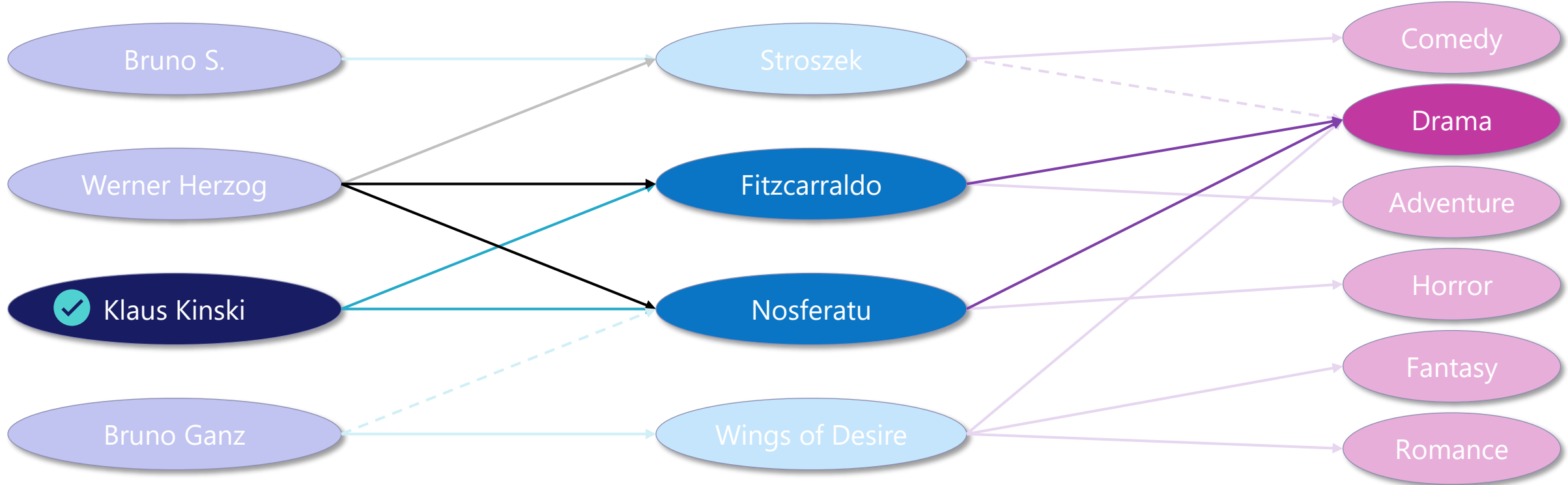
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Complex Query Answering (CQA)

Edge Traversal (SPARQL)



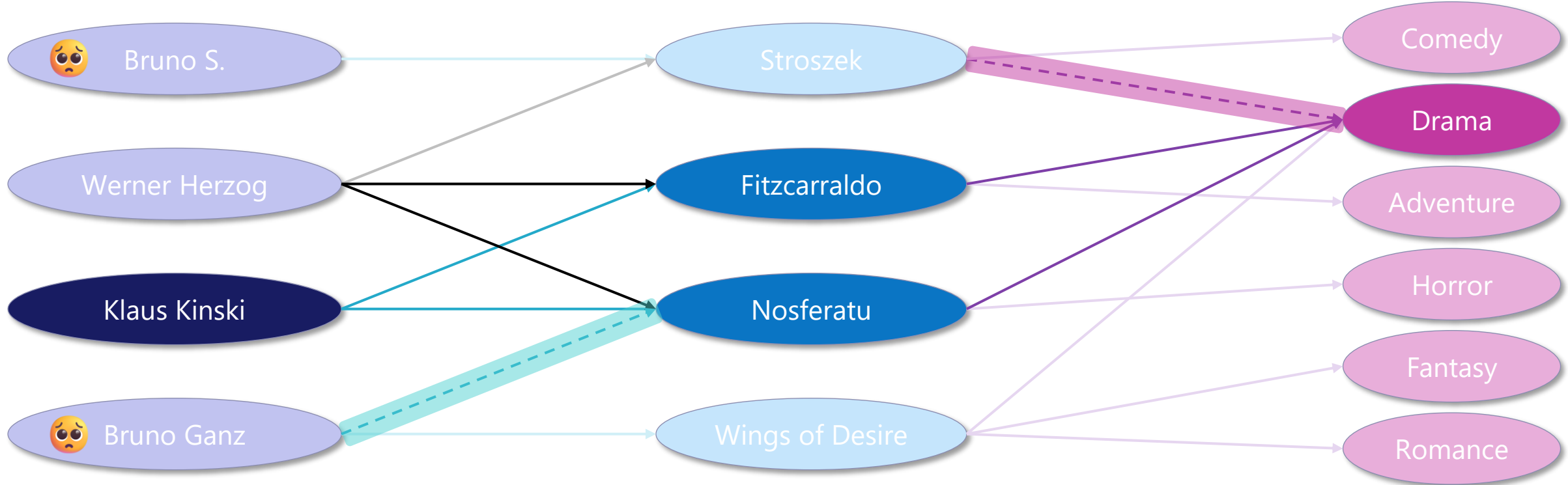
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Complex Query Answering (CQA)

Neural Query Execution



→ directed
 → actedIn
 → genre
 - - - missing

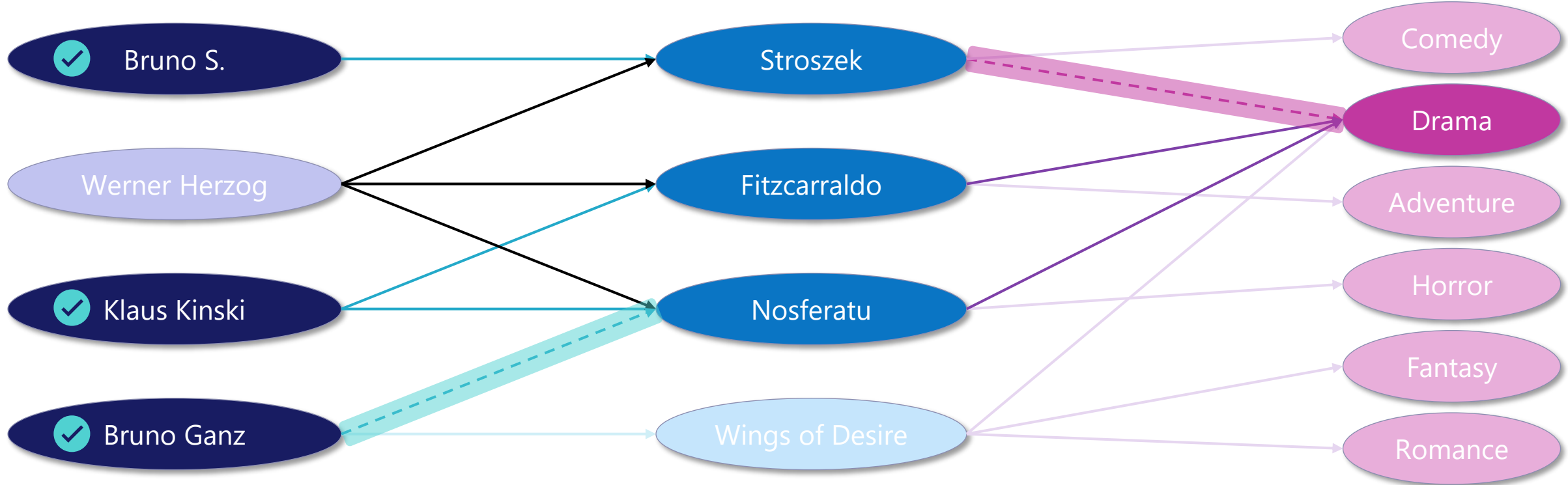
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Complex Query Answering (CQA)

Neural Query Execution



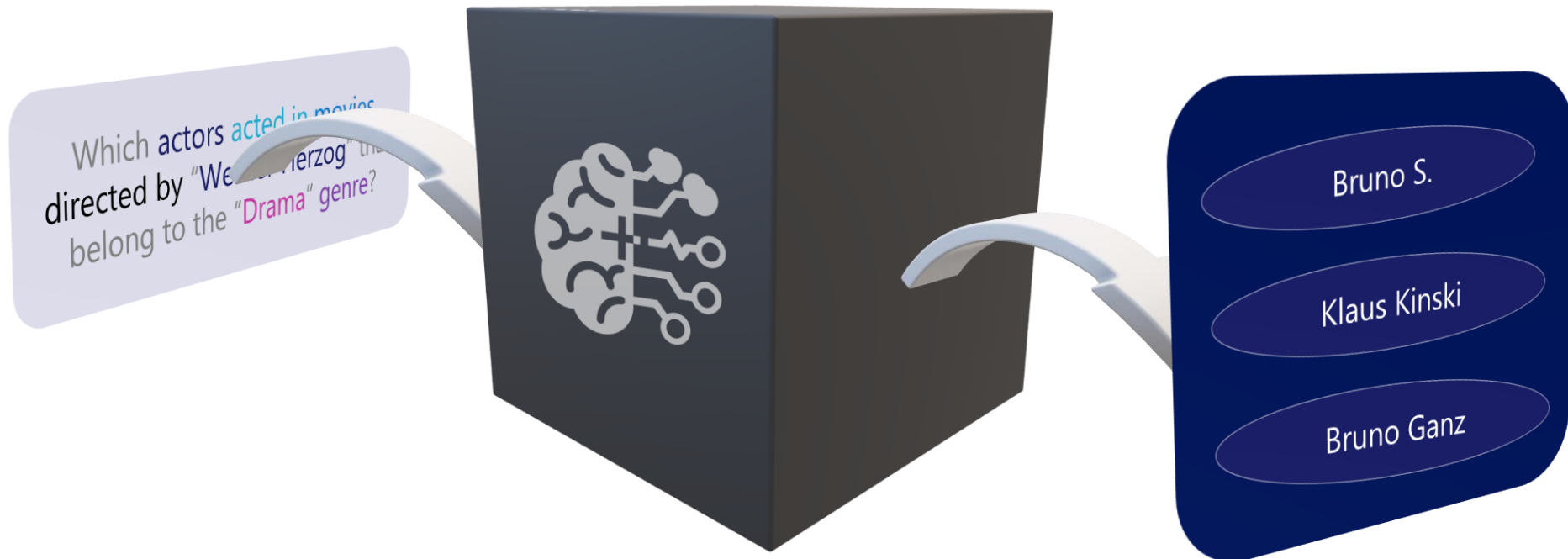
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Explainability

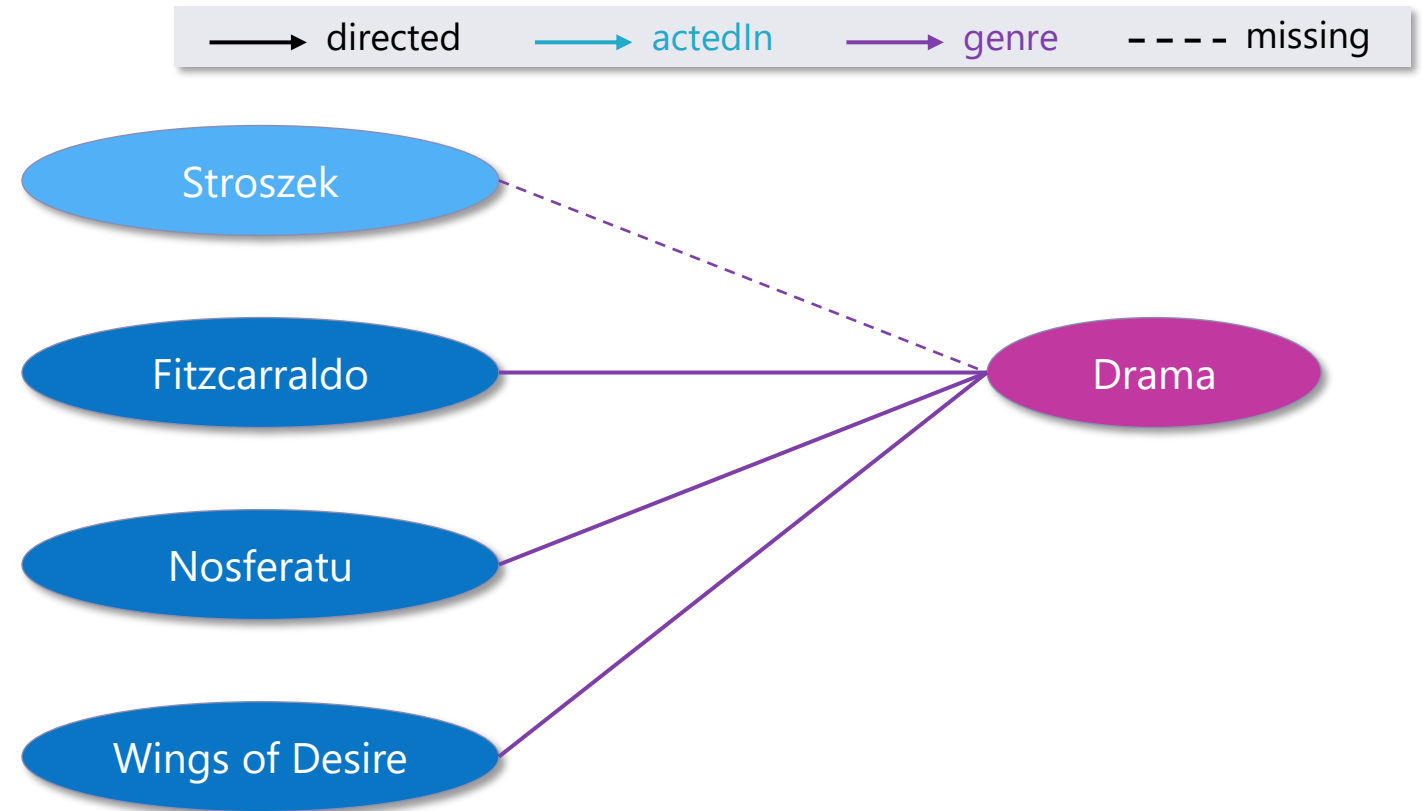
Most GQA models function as black boxes, providing only the final output without offering insight into the reasoning process





Explainability

Intermediate Results



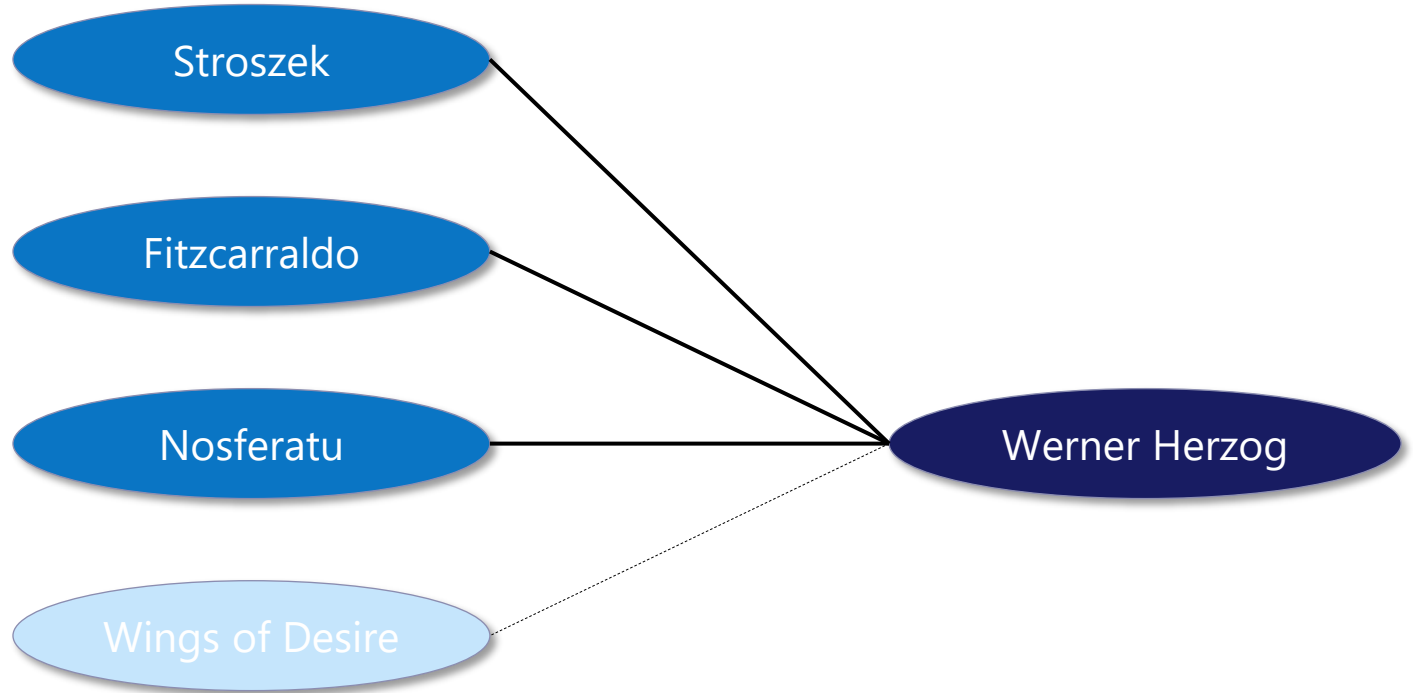
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Explainability

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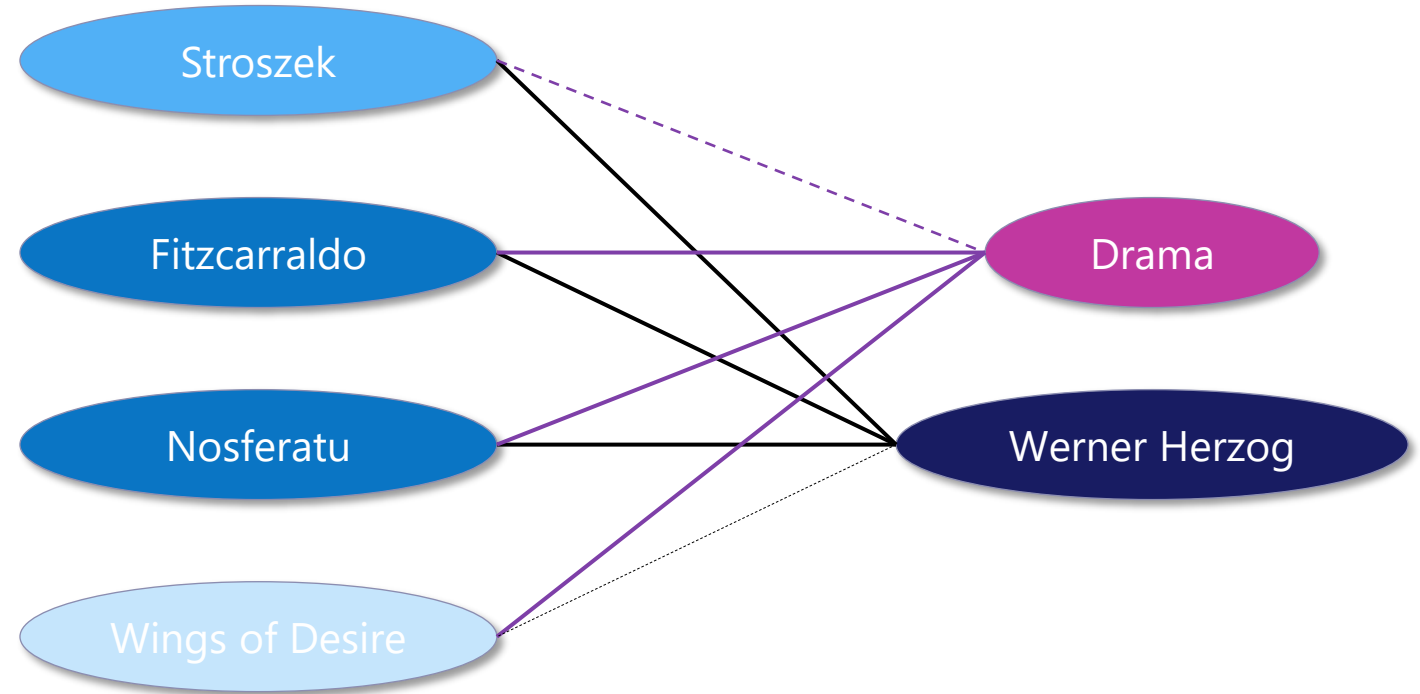
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Explainability

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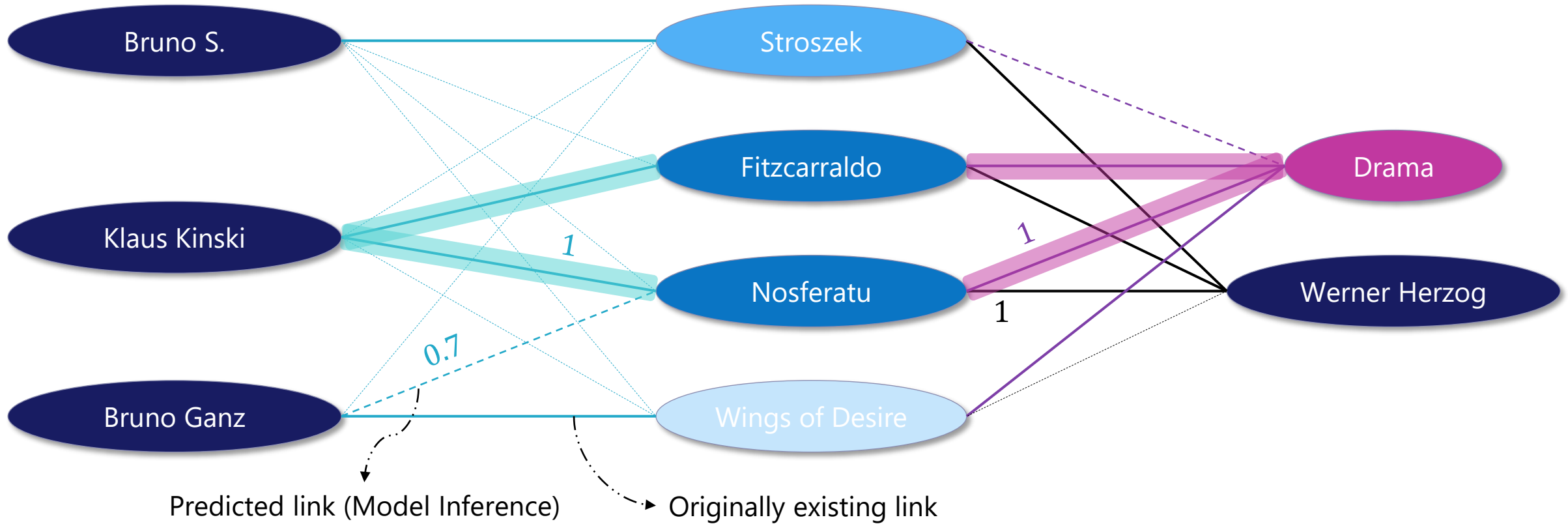


$$q = P_?. \exists M: actedIn(P, M) \wedge \overset{3}{directed("Werner Herzog", M)} \wedge genre(M, "Drama")$$



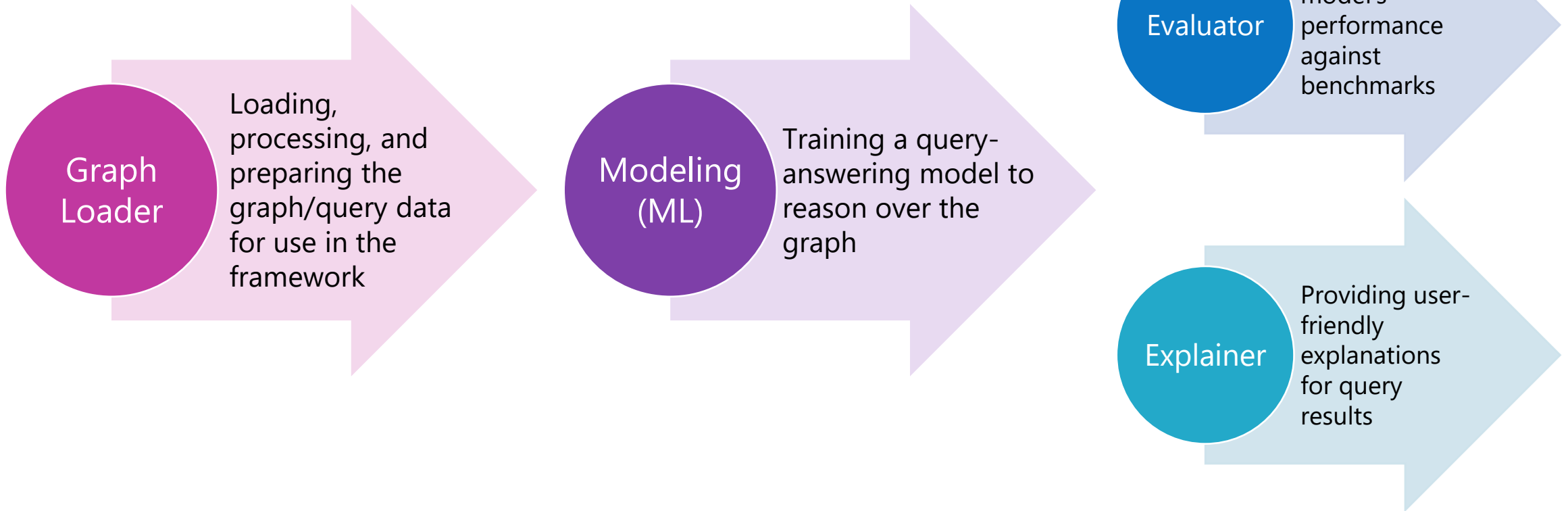


Explainability Reasoning Graph





Components





Project Benefits

Team Collaboration

- develop teamwork and communication skills through collaborative project development

Real-World Impact

- contribute to developing a system with potential applications in various domains

Hands-on Experience

- gain practical experience in cutting-edge research areas like graph databases, CQA, and xAI

Academic Writing

- opportunity to publish impactful research





Thank you!

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