

# A Knowledge Graph Enhanced Learner Model to Predict Outcomes of Questions in the Medical Field

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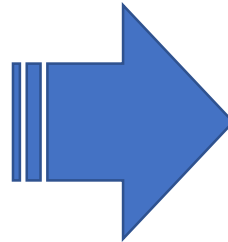
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# SIDES

Shared platform for training and testing of medical students.

- Universities can create and share new questions and tests
- Students can take official exams and train their medical knowledge



# SIDES 3.0

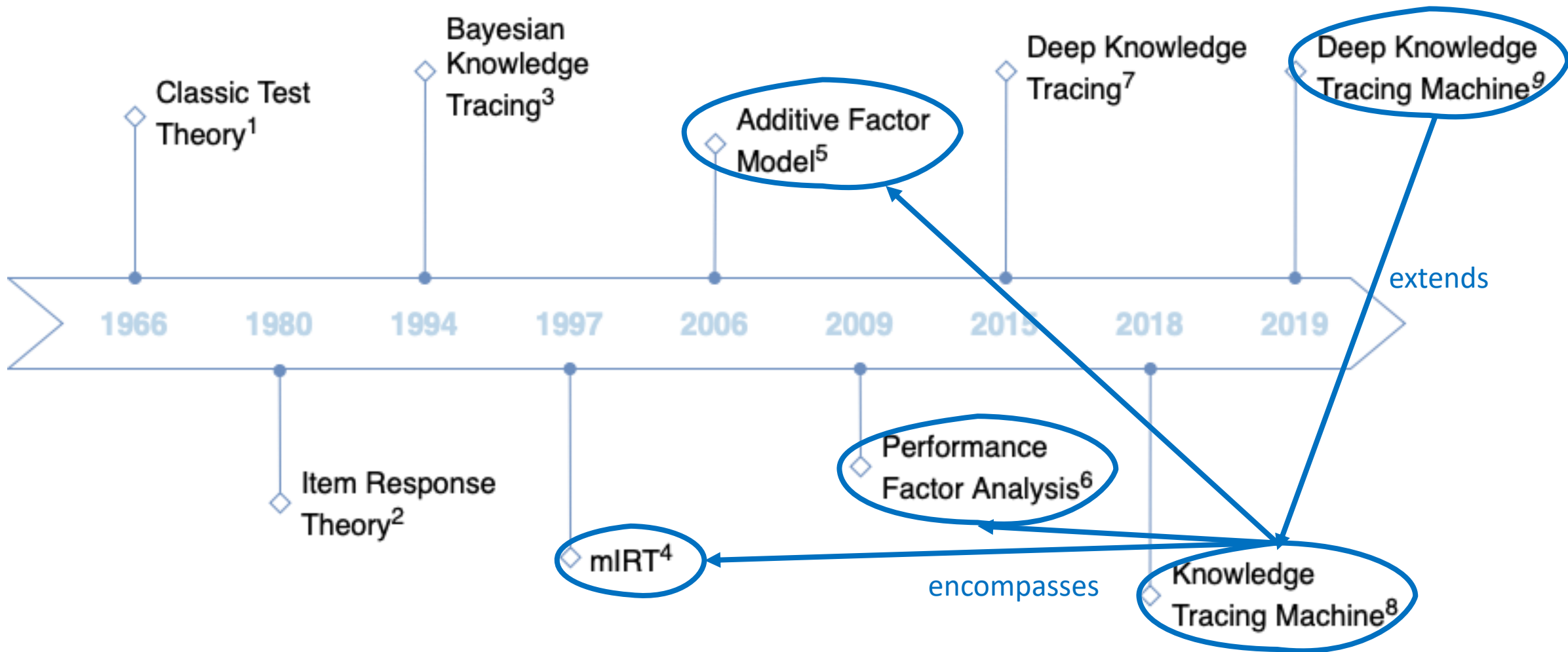
- Personalized monitoring of students using ***Semantic Web*** tools
- ***Customized services*** to the students

# Predicting students' outcome

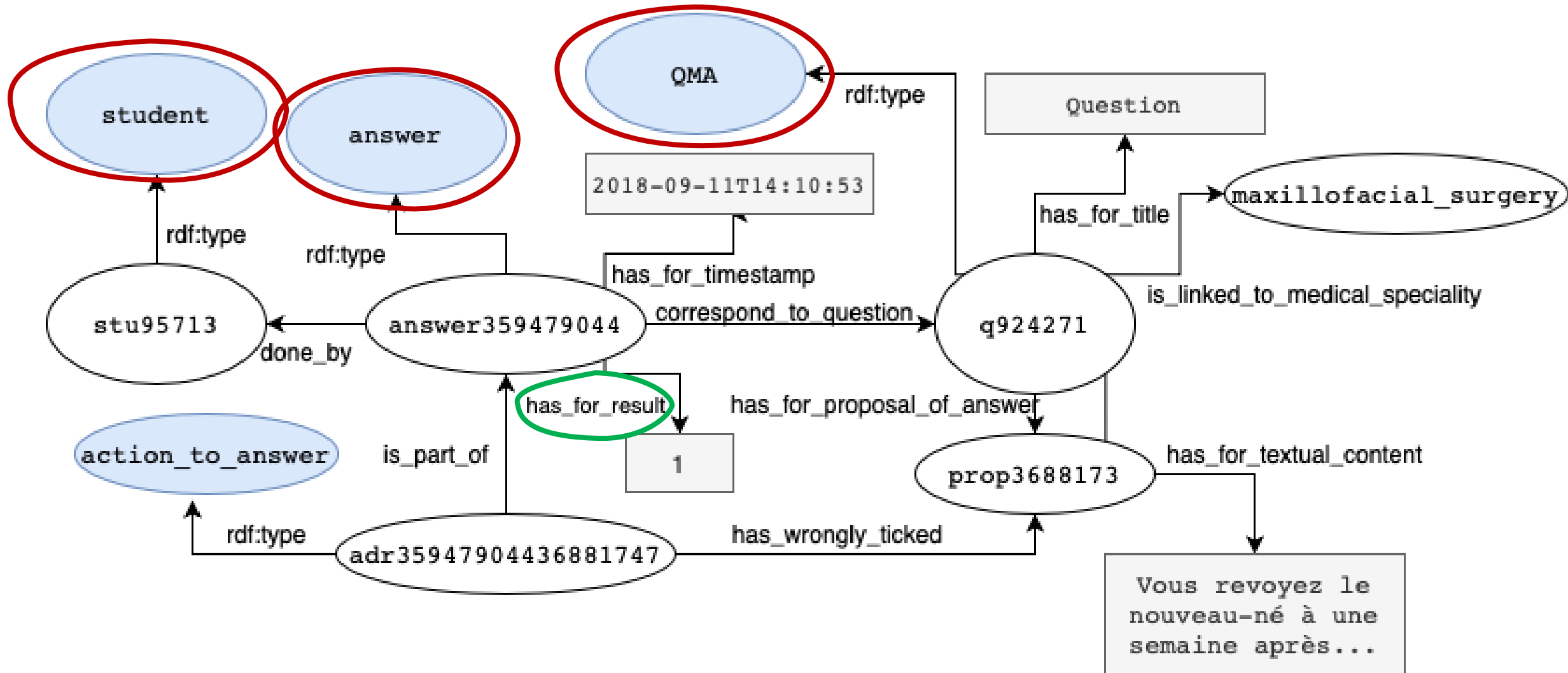
3 research questions:

- How to model students' learning on the SIDES platform?
- Which set of features should be extracted from the OntoSIDES knowledge graph?
- Can considering the knowledge graph structure improve prediction results?

# Knowledge Tracing

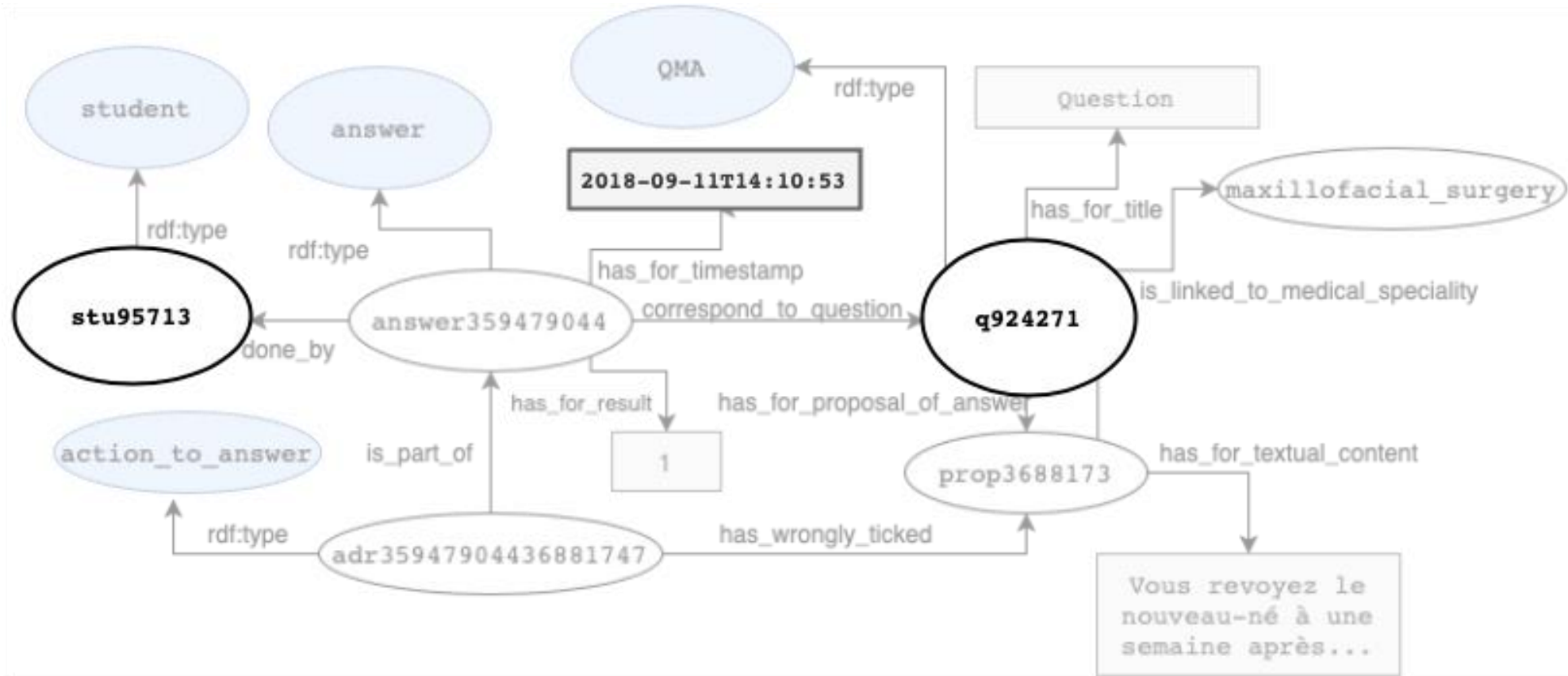


# OntoSIDES



# Features (1)

- Basic features: directly extracted from the knowledge graph

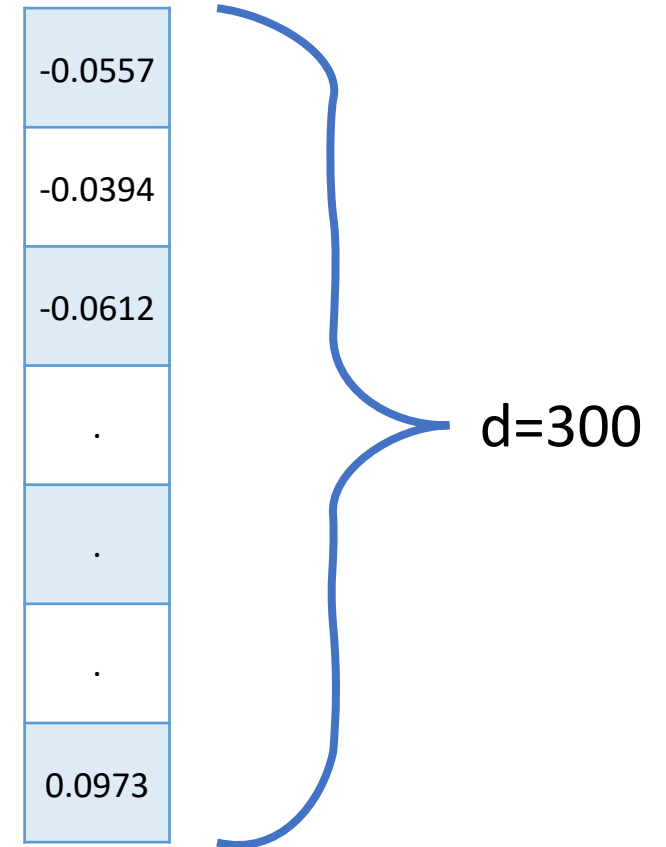
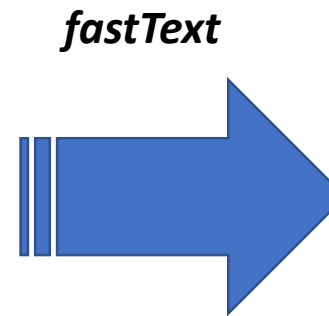
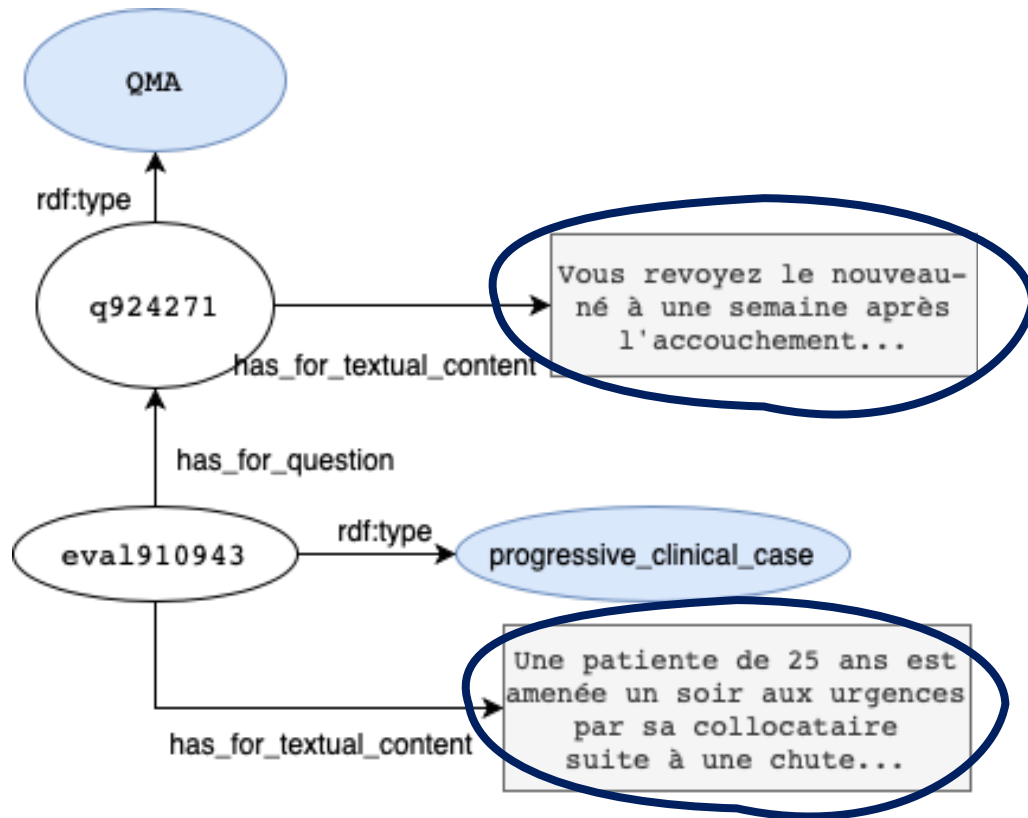


# Features (2)

- Features computed based on the extracted ones:
  - Wins
  - Fails
  - Attempts

# Features (3)

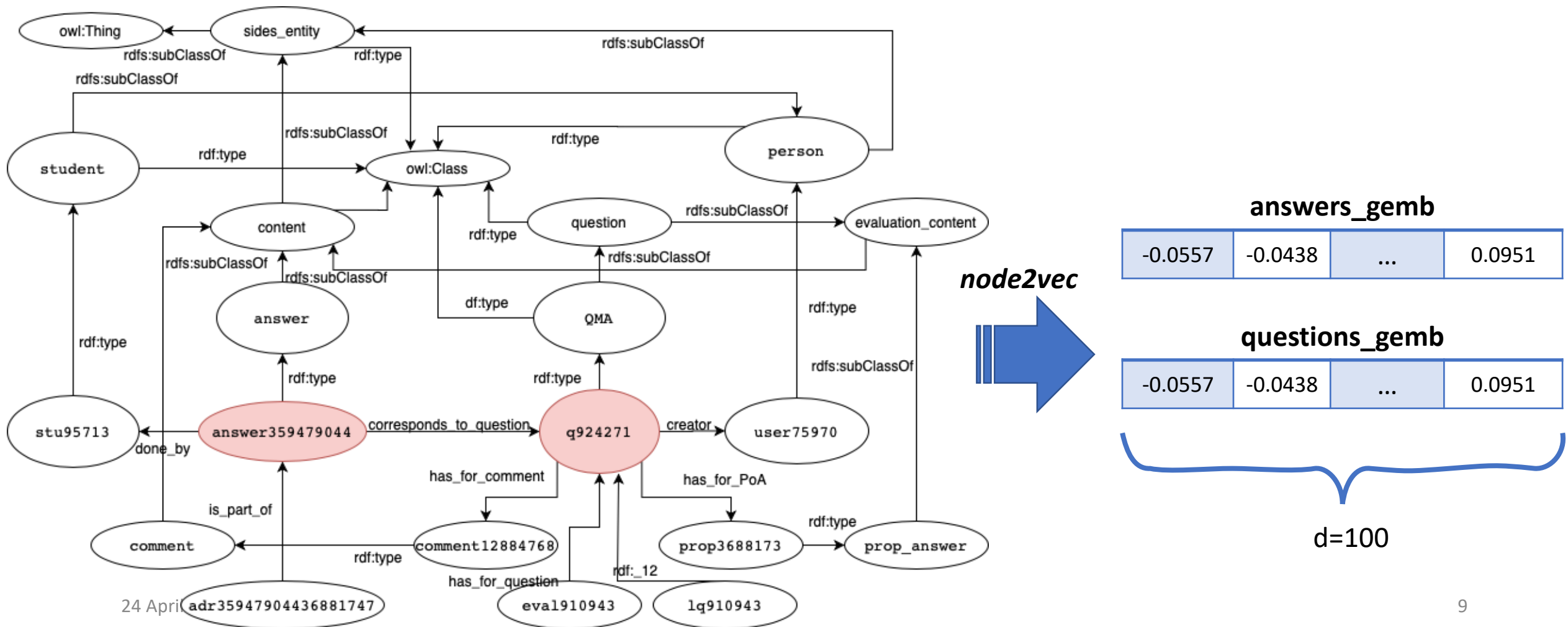
- Text embeddings of questions' textual content





# Features (4)

- Graph embeddings of answers and questions



# Candidate models

- Several combinations of features to analyze the impact of each feature
- From the simplest ***sq***: student\_id (s), question\_id (q)
- To most complete ***sqawfTAQ***:
  - student\_id (s),
  - question\_id (q),
  - attempts (a),
  - wins (w),
  - fails (f),
  - T (questions text embeddings),
  - A (answers graph embedding),
  - Q (questions graph embeddings)

# Datasets

- Students' training for ECNp 2019
  - Test 1: ***pediatrics***
    - 100.000 answers to
    - 22.551 questions, given by
    - 8.535 students
  - Test 2: ***cardiovascular***
    - 100.000 answers, to
    - 22.505 questions, given by
    - 8.655 students

# Results: pediatrics

| Model           | ACC          | AUC          | F1-score (neg.) | F1-score (pos) |
|-----------------|--------------|--------------|-----------------|----------------|
| sq              | 0.621        | 0.611        | 0.676           | 0.541          |
| sqa             | 0.602        | 0.601        | 0.617           | 0.568          |
| sqawf           | 0.626        | 0.616        | 0.680           | 0.548          |
| sqawfT          | 0.609        | 0.611        | 0.620           | 0.597          |
| sqawfA          | 0.702        | 0.701        | 0.721           | 0.680          |
| sqawfQ          | 0.607        | 0.606        | 0.625           | 0.585          |
| sqawfAQ         | 0.722        | 0.721        | 0.737           | 0.704          |
| <b>sqawfTAQ</b> | <b>0.738</b> | <b>0.738</b> | <b>0.753</b>    | <b>0.722</b>   |

+11%

+12%

+7%

+18%

# Results: cardiovascular

| Model           | ACC          | AUC          | F1-score (neg.) | F1-score (pos) |
|-----------------|--------------|--------------|-----------------|----------------|
| sq              | 0.623        | 0.615        | 0.675           | 0.549          |
| sqa             | 0.622        | 0.620        | 0.643           | 0.578          |
| sqawf           | 0.622        | 0.613        | 0.682           | 0.531          |
| sqawfT          | 0.590        | 0.591        | 0.595           | 0.584          |
| sqawfA          | 0.707        | 0.706        | 0.724           | 0.687          |
| sqawfQ          | 0.601        | 0.605        | 0.592           | 0.609          |
| sqawfAQ         | 0.729        | 0.729        | 0.742           | 0.715          |
| <b>sqawfTAQ</b> | <b>0.743</b> | <b>0.744</b> | <b>0.751</b>    | <b>0.735</b>   |

+12%

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+7%

+20%

# Conclusions

- Empirical determination of a ***model to predict outcome*** of SIDES students to the specialties ***pediatrics*** and ***cardiovascular***
- Extension of ***topological information*** from the OntoSIDES ***knowledge graph***

# Perspectives

- Experiments on the other 29 medical specialties
- Improvement of the vector representation
  - Accounting for skills information
  - Considering semantics contained in the knowledge graph
  - Integrating Bloom taxonomy information
- Collaboration on the creation of the SIDES recommender system
- Evaluation of the automatic classification of questions according to the Bloom taxonomy and refinement of the algorithm

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