KneeQApp: Supporting self-management of knee conditions with question answering

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Health problem

- Musculoskeletal disorders are the second most common cause of disability worldwide
- Knee injuries account for 40% of all musculoskeletal injuries
- 40-50% never fully recover leading to chronic conditions

Treatment

- Physiotherapists often administer multiple modalities within a single treatment session
- Information provision and exercise are used heavily in knee rehabilitation
- Most time is spent providing advice and information to patients
- A general trend of moving toward self-management of knee conditions
- Most patients will be self-managing their conditions outside of physiotherapy departments
- Information needs to be provided remotely

Taxonomy of Rehabilitation of Knee Conditions (TRAK)

- TRAK was developed as a formal ontology of rehabilitation concepts and modalities
- TRAK is based on current research evidence and expert clinical opinion
- TRAK supports clear communication among clinicians and patients
- TRAK stores knowledge about knee rehabilitation in a machine-readable form
- TRAK can support automated processing of information in this domain, e.g.

  Spasić et al. (2015) KneeTex: An ontology-driven system for information extraction from MRI reports. Journal of Biomedical Semantics, Vol. 6, 34

  Spasić et al. (2015) TRAK application suite: A web-based intervention for delivering standard care for the rehabilitation of knee conditions. JMIR Research Protocols, Vol. 4, No. 4, e122

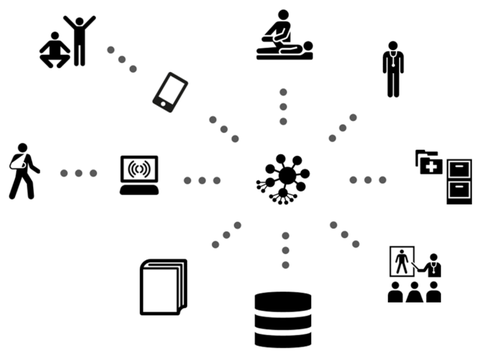

Figure 1 TRAK ontology as a knowledge source

Question answering (QA)

- Frequently asked questions (FAQs) are those commonly asked in a given context
- FAQs come together with ready-made answers
- QA aims to provide an answer to a natural language query
- QA systems can further facilitate access to information
- KneeQApp is a QA system that supports knee patient information needs

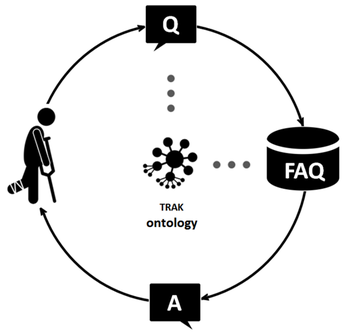

Figure 2 Question answering with use of TRAK ontology

Methods

- 342 FAQs across 12 knee conditions collected from the Web
- FAQs stored in a database
- TRAK provides a vocabulary of domain-specific terms and relationships among them, e.g.
  - ACL is a synonym of anterior cruciate ligament
  - both ACL and PCL are cruciate ligaments
- TRAK ontology supports interpretation of user questions
- Approximate string matching is used to compare user questions against FAQs
- The answer to the most similar FAQ is presented to the user
- We compared the performance of different string similarity metrics: cosine, Jaccard, Jaro-Winkler, Levenshtein, Monge-Elkan, Smith-Waterman

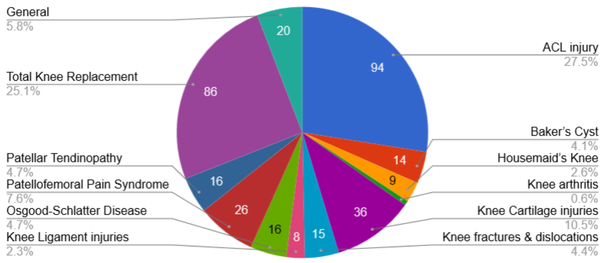

Figure 3 Collected FAQs and the topics that they cover

Results

- 48 user questions spanning twelve major knee care topics
- 36 can be answered appropriately and 12 cannot
- Recall = percentage of questions for which the system returns a correct answer where one exists
- Rejection = percentage of questions that the system correctly reports as being unanswerable
- The best recall is almost 70% using Jaccard and rejection threshold 0.0, but rejection is 0%
- The best rejection is 100% using Levenshtein and rejection threshold 0.8, but recall is around 30%
- The best combined recall and rejection is 60% and 40% respectively using Jaccard or cosine and rejection threshold 0.5
- More effective than keyword-based retrieval used in, e.g. phpMyFAQ

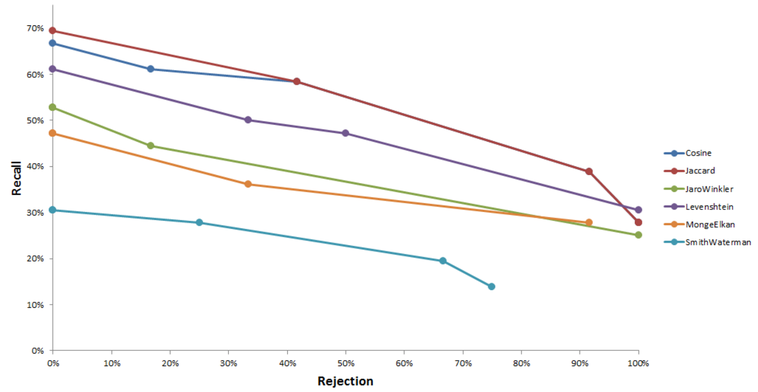

Figure 4 Recall versus rejection using different string similarity metrics

Conclusions

- KneeQApp is a QA system in the knee rehabilitation domain
- KneeQApp supports self-management of knee conditions
- KneeQApp utilises knowledge from the TRAK ontology
- KneeQApp outperforms an agnostic FAQ system
- In future work, user feedback will be used to support learning from experience

References

Button K, van Deursen R, Soldatova L, Spasić I. TRAK ontology: Defining standard care for the rehabilitation of knee conditions. Journal of Biomedical Informatics. 2013;46(4):615-625.

Athira P.M, Sreeja M, Reghuraj P.C. Architecture of an ontology-based domain-specific natural language question answering system. International journal of Web & Semantic Technology. 2013;4(4):31-39.