EDUQA : EDUCATIONAL DOMAIN QUESTION ANSWERING SYSTEM USING CONCEPTUAL NETWORK MAPPING


^SBILab, Department of ECE, IIIT-Delhi, India,
^^ Million Sparks Foundation
INTRODUCTION

- **Problem**: QA system for the K-12 Education system
- **Proposed Solution**: EDUQA: Framework to extract meaningful answers using - Concept Network - context information encoded into a network of evolving entities
Question Answering Models are of 2 types:

- **Open Domain**: Eg. DrQA*, etc
- **Closed Domain**: Eg BiDAF**, QuASE*** etc

*D. Chen, A. Fisch, J. Weston, and A. Bordes. E et al,
**M. Seo, A. Kembhavi, A. Farhadi, et al,
Drawbacks:

- **Open Domain**: variation in level of understanding, factoid based
- **Closed Domain**: factoid based, rote learning, not good enough as standalones

* T. Atapattu, K. Falkner, and N. Falkner et al,
BACKGROUND

Other drawbacks of various question answering models:

- Answer retrieval using rote learning
- Inability to capture semantic correlations within question
- Support mostly for factoid type questions
- Not resourceful for answering student queries
PROPOSED FRAMEWORK:

EDUQA: EDUCATIONAL DOMAIN QUESTION-ANSWERING SYSTEM
**Question Analysis (QuAn) Module**

1. **Input Question**
   - Define Force.
   - Relate force to pressure.

2. **Entity Extracted**
   - Force
   - Force, Pressure

3. **Number of Entities**
   - 1
   - 2

4. **Relationship Extracted**
   - N.A.
   - Related To

5. **Output Answer**
   - Force is a push or a pull....
   - Pressure is directly...
Dynamic Concept Network (DCN) Module
One of the Edges Between Entities

Entity:
- Definition
- Effects
- Types
- Examples
- Applications

Edge Identifier

Relationship
ENTITY (NODES) AND RELATION (EDGE)

**Entity: Force**

**Attributes:**
- Definition: What is Force?  
  A: A push or a pull ....
- Types: What are different types of Force?  
  A: Contact Force, .....  
- Effects: What are the effects of Force?  
  A: Change of shape, .....  
- What are the examples of Force?  
  A: Gravitational Force, .....  
- What are applications of Force?  
  A: Falling of Apple, .....  

**Entity: Pressure**

**Attributes:**
- Definition: What is Pressure?  
  A: Force per unit area ....
- Types: What are different types of Pressure?  
  A: NULL  
- Effects: What are the effects of Pressure?  
  A: Increased pressure turns liquid .....  
- What are the examples of Pressure?  
  A: Atmospheric Pressure, .....  
- What are applications of Pressure?  
  A: Drinking through Straw, .....  

**Similarity**
A: NULL

**Difference**
A: NULL

**Related To**
A: Force is directly proportional to Pressure.
ON THE FLY LEARNING

**Flowchart:**

1. **Input Question:** Define Force.
2. **Entity Extracted:** Force
3. **Number of Entities:** 1
4. **Relationship Extracted:** N.A.
5. **Output Answer:** Force is a push or a pull.

1. **Input Question:** Relate force to pressure.
2. **Entity Extracted:** Force, Pressure
3. **Number of Entities:** 2
4. **Relationship Extracted:** Related To
5. **Output Answer:** Pressure is directly...
Question Analysis (QuAn) Module

1. Input Question

Entity list
- Force
- Friction
- ...
- ...

2. Entity Extraction Module
- Tokenization
- Longest prefix sequence matching
• Entity Extraction Module - Tokenization + Longest Prefix Sequence matching (LPSM)

• Eg : Question: "What is non contact force"
  Tokenization: "What", "is", "non", "contact", "force"

  Subset of Entity list: "non contact force", "contact force", "force"

  LPSM : "non contact force"
3 Answer Retrieval (AnR) Module

Diagram:
- Number of entities found ≤ 1
  - Entity Attribute Extraction
  - [YES] Get Answer from Concept Network
  - [NO] Route to Human Expert
  - Relation found ≥ 1
    - Relationship Extraction

<table>
<thead>
<tr>
<th>Number of Entities</th>
<th>Relationship Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N.A.</td>
</tr>
</tbody>
</table>
• Attribute Recognition - similarity measure of entity attributes and input question *

\[ Sim_{overall} = (1 - \delta) Sim_{statistic} + \delta Sim_{semantic}, \]

• Relationship Extraction - more than one entity in the question
# RESULTS

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>What is Force?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>What is change in state of motion?</td>
<td>✓</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
<td>Give examples of Non-Contact Force.</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>What brings change in state of motion?</td>
<td>#</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
<td>What happens to pressure when force increases?</td>
<td>✓</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
<td>Differentiate between contact and non-contact force.</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>What happens when two forces act in the same direction?</td>
<td>#</td>
<td>✓</td>
<td>-</td>
</tr>
</tbody>
</table>

- ✓ Correct Answer
- x Wrong Answer
- - No Answer
- # Expert’s Answer
- □ Partially Correct
CONCLUSION

- Explored Question Answering - Education
- Analysis of existing frameworks and their shortcomings in educational context
- Proposed framework - based on dynamic self-evolving concept network (built specific to a topic)
FUTURE WORK

- Use better answer retrieval strategies
- Incorporating complex courses like Mathematics
- automate concept network construction
- minimize requirement of human expert at back end
- support for complex reasoning questions
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THANK YOU!