KBGen – Text Generation from Knowledge Bases as a New Shared Task

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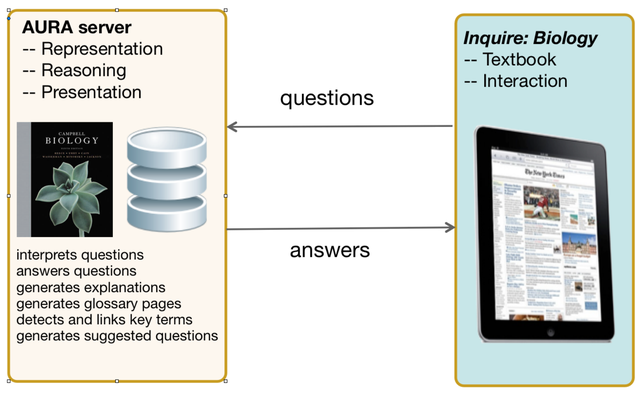
The Halo Project

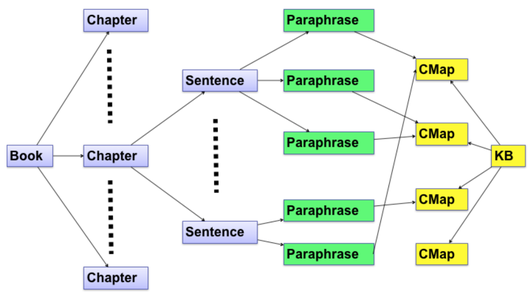
- Interactive electronic textbook on an Ipad: **Inquire**
- Answers questions about material in the textbook:
  description What is a eukaryotic cell?
  comparison What is the difference between a eukaryotic and a prokaryotic cell?
  relationship What is the relationship between genes and a cell?
  factual What are the parts of a eukaryotic cell?



The AURA knowledge base: Contents

- college-level biology textbook encoded by a team of biologists
- built on top of a library of generic concepts (CLIB)
- organized into a set of concept maps (currently over 5,000)
- each concept map corresponds to a biological entity or process
- Relations between entities and/or processes include:
  Event-to-Entity relations: links to concepts that participate in the event (e.g, agent, object, beneficiary, destination, donor, experiencer, raw-material, result)
  Event-to-Event relations: causes, enables, next-event, subevent
  Entity-to-Entity relations: has-part, possesses. Also spatial relations: is-at, is-between, is-inside, is-outside, is-along, etc.
  Property values: greater-than, size, depth, shape, color, frequency, duration, etc.

The AURA knowledge base: Encoding Process



- **An example sentence in the book:**
  In the fifth step of glycolysis, isomerase catalyzes the reversible conversion between the two isomers, but this reaction never reaches equilibrium because G3P is used as the substrate of the next reaction in step 6 as fast as it is formed.
- **Paraphrases:**
  - During Energy Investment phase of glycolysis, isomerase converts DP to G3P in an isomerization reaction
  - During Glycolysis, the G3P formed in the isomerization reaction is used in the enzymatic reaction which forms the 1, 3 bisphosphoglycerate
  - During Glycolysis, the isomerization reaction follows the decomposition reaction which utilizes the fructose-1,6-Bisphosphate
  - During Glycolysis, the enzymatic reaction forming the 1, 3 bisphosphoglycerate follows the isomerization reaction

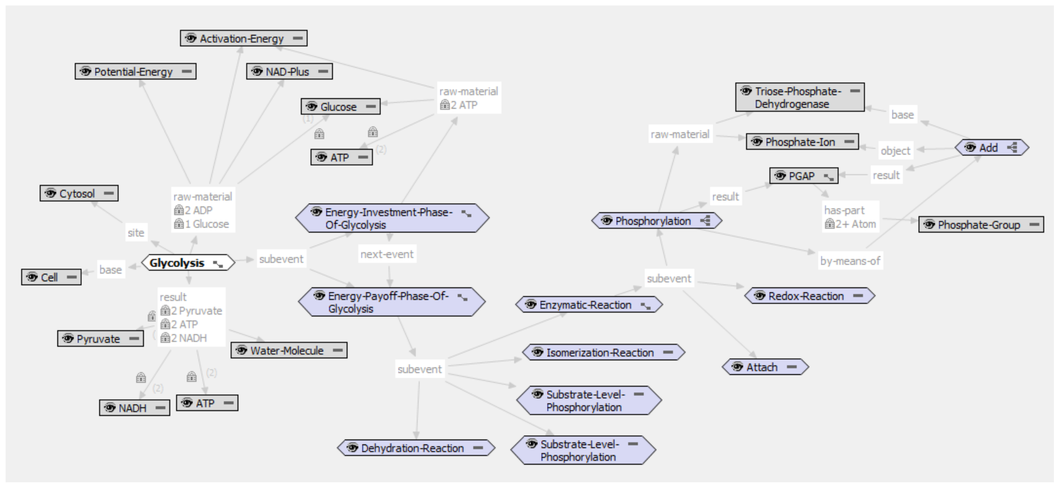
Lexicons Available for The Shared Task

- A list of synonyms for each concept
- A mapping from argument slots in event frames to prepositions
- A morphological lexicon

Reference data and human resources for evaluation

- Paraphrases for sentences of the underlying biology textbook
- Model output texts could be produced by biologists involved in AURA project
- Biologists, biology teachers and students recruited by SRI for the evaluation of the KB and the electronic textbook application (roughly 400 people)

Generating from KB Relations: Complex Surface Realisation Track



(Glycolysis13791 subevent Energy-Payoff-Phase13785)
(Energy-Payoff-Phase13785 subevent Enzymatic-Reaction10598)
(Enzymatic-Reaction10598 subevent Phosphorylation10577)
(Phosphorylation10577 result PGAP10580))

PGAP is the result of phosphorylation which happens in the enzymatic reaction during the energy payoff phase of glycolysis.

Input	A few frames from a concept map
Output	A sentence describing an entity, an event or a relation between two concepts
Subtasks	Aggregation, Intrasentential Pronouns Surface Realisation
Evaluation	BLEU or Levenstein distance Manual Evaluation (400 biologists, biology teachers and students recruited by SRI)

Generating from KB Relations: Discourse Generation Track

```
(Glycolysis13791           subevent    Energy-Payoff-Phase13785)
(Energy-Payoff-Phase13785 subevent    Enzymatic-Reaction10598)
(Enzymatic-Reaction10598  subevent    Phosphorylation10577)
(Phosphorylation10577     result      PGAP10580))
(Phosphorylation10577     by-means-of Add10586)
(Add10586                 base        TPD10588)
(Add10586                 object      Phosphate-Ion10587)
(Add10586                 result      PGAP10580)
(Glycolysis13791          instance-of Glycolysis)
(Energy-Payoff-Phase13785 instance-of Energy-Payoff-Phase)
(Enzymatic-Reaction10598  instance-of Enzymatic-Reaction)
(Phosphorylation10577     instance-of Phosphorylation)
(PGAP10580                instance-of PGAP)
(Add10586                 instance-of Add)
(TPD10588                 instance-of TPD)
(Phosphate-Ion10587       instance-of Phosphate-Ion)
```

Glycolysis has two phases: an energy investment phase and an energy payoff phase. One of the steps of the energy payoff phase is an enzymatic reaction. In this enzymatic reaction, TPD is phosphorylated to produce PGAP.

Input	Most frames from a concept map
Output	A text (2-3 paragraphs) describing the sub-events, the results, etc. of a biological process
Subtasks	Text Structuring, Discourse Pronouns, Aggregation Surface Realisation
Evaluation	User Based Evaluation

Possible Extensions

The KBGen SR task naturally extends to

- more complex generation tasks (content selection, discourse planning)
- KB applications e.g., verbalising KB queries; verbalising KB content

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