



## **Automating Gap Analysis of Learning Outcomes**

Vijay Mago, Department of Computer Science, Lakehead University, Thunder Bay April 16, 2018



## Automating Gap Analysis of Learning Outcomes through Natural Language Processing 2017-17-ONCAT









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Automating Gap Analysis of Learning Outcomes



## Text Extraction

Natural Language Processing Visualization of results

Automating Gap Analysis of Learning Outcomes



#### **Extracting Learning Outcomes**

#### Introduction to Databases

Syllabus

#### Web Page

http://www.cs.northwestern.edu/~pdinda/db

#### Instructor

Peter A. Dinda 1890 Maple Avenue, Room 338 847-467-7859 <u>pdinda@cs.northwestern.edu</u> Office hours: Thursdays, 2-4pm or by appointment

#### **Teaching assistants**

Ananth Sundararaj 1890 Maple Avenue, Room 332 847-491-7150 ais@cs.northwestern.edu

Office hours: Mondays, 10:15am-12:15pm, Wednesdays 11:15am-12:15pm or by appointment

Bin Lin 1890 Maple Avenue, Room 224 847-491-7159

binlin@cs.northwestern.edu Office hours: Tuesdays, 10-12am, Wednesdays 3:30-4:30pm or by appointment

#### Location and Time

1890 Maple Avenue, CS Department classroom, MWF 9-9:50am

#### Prerequisites

Required Highly recommended Highly recommended

Highly recommended

CS 311 or equivalent data structures course CS 213 or equivalent computer systems course Familiarity with concepts from discrete math such as set theory Some familiarity with Perl or other scripting language

CO	<u>C</u>	OURSE OUTLINE					
LLEO	SCHOOL:	School of Engineering Technology and Applied Science					
ц Ш Ш	DEPARTMENT:	Information and Communication Engineering Technology (ICET)					
	PROGRAM: Software Engineering Technician/Technologist (3109, 311 3408, 3409, 3419, 3508, and 3508)						
	COURSE TITLE:	Introduction to Databases					
	COURSE CODE:	COMP122					
	TOTAL COURSE	HOURS: 60 Hours					
	PRE-REQUISITES	CO-REQUISITES: COMP100					
	COURSE ELIGIBILITY FOR PRIOR LEARNING ASSESSMENT AND RECOGNITION (PLAR): Yes						
	ORIGINATED BY:	Bhim Harlal					
	REVISED BY:	Bhim Harlal					
	DATE:	August 2009					
	APPROVED BY:						
		Chairperson/Dean					

#### Automating Gap Analysis of Learning Outcomes



#### Natural Language Processing

- Dependency parsing to establish syntactical relationship between words
- Example 1: Prepare financial statements and related disclosures



Fig 1. Dependency parsing



#### Natural Language Processing

- Dependency parsing to establish syntactical relationship between words
- Example 2: Analyze and account for complex business transactions



Fig 2. Dependency parsing

Both the learning objectives are parsed separately and the parsing information is compared.

**Automating Gap Analysis of Learning Outcomes** 



#### **Data Extraction - Challenges**

Course outlines do not have a defined format

Assessing the relevance of the text in the document

Documents may have header/footer text

Text might be divided into text columns, which makes it important to analyze the layout of the document before proceeding with text extraction.



#### Natural Language Processing

1. Similarity between peculiar words in a domain e.g. in computer science, we have different programming languages: Java, Python, C, C++. Using a general purpose corpus (vocabulary) would not yield precise similarities between such terms.

2. Size of the corpus pertaining to a specific domain We decided to use Wikipedia as corpus since it covers all the domains and is constantly updated with the new terms and content.

3. Cleaning the textual content from Wikipedia pages to get rid of ASCII characters, URLs and unnecessary tags.

4. Forming collocations in the entire corpus and then training the model e.g. replacing "computer science" with "computer\_science" and "programming languages" with "programming\_languages"

5. An algorithm to establish similarity between two learning objectives and extending it to cover broader scope such as course comparison and program comparison





Website: http://www.loaga.science

Test User Credientials: Username: testuser1@loaga.science Password: password

### Contact: Vijay Mago: vmago@lakeheadu.ca

Automating Gap Analysis of Learning Outcomes



#### **Bloom's Taxonomy**

Though Bloom's taxonomy is the suggested standard for designing the course outline, we have found that a considerable number of course drafts differ significantly from the norm. To use the Bloom's taxonomy, we establish the 'Bloom Index'. The Bloom Index represents the gap between two learning outcomes according to the verbs in LOs.



#### **Finding Learning Outcome**



## Visualizing the Mapping of Outcomes, Content, and Curriculum between programs to support transfer

Nerissa Mulligan, Brian Frank, Roderick Turner, Mary Pierce, Jake Kaupp, Vijay Mago

## 2015 ONCAT Project : Framework



## **2016 ONCAT Project : Comparisons**



## Content vs. complexity

## First year calculus content

Functions, limits, derivatives; optimization, rate problems, exponentials, logarithms, inverse trigonometric functions; exponential growth as an example of a differential equation. Fundamental Theorem of Calculus, Riemann integral; applications to problems involving areas, volumes, mass, charge, work, etc. Some integration techniques.

Cognitive complexity? Novelty of problems? How scaffolded?

## **Learning Outcomes**

analyze, interpret, and produce electrical and electronics *drawings*, *technical reports* including other related documents and graphics.

*Concept*: engineering drawing

Bloom's cognitive level: analyze interpret produce

## Anderson and Krathwohl, 2001: Cognitive Process

# SOLO Taxonomy: Structural complexity

# Categorizing Instructor's Scaffolding

Prescribed	The activity instructs the student to follow a prescribed sequence of calculations or an explicitly stated approach.
Constrained	The activity description does not specify the solution; the general approach is implied through question sequencing, headings, etc.
Scaffolded	The activity requires the student to choose from a range of approaches.
Adopted	The activity requires the student to synthesize different methods and formulate novel methods or apply existing ones to novel applications.



Learning outcomes assessments for two core courses in Electrical/Electronic engineering in (a) technology and (b) engineering exam questions as scored by content specialists using a three-part framework.

# Goal: Automate some analysis and visualization



# **Focus Groups**

- Two focus groups
- 19 Institutions

## 31 Participants from 6 different programs

Academic Quality Lead Academic Manager (Nursing Program) Admission Assistant **Assistant Professor** Assistant Registrar Associate Dean Associate Professor **Business Program Contact** Chair (Admissions Committee) Credit Transfer Officer Curriculum Consultant Dean

Director (School of Kinesiology) **Director** (Centre for Academic Excellence) **Enrolment Services and** Strategic Partnerships International Recruitment Officer **Registrar's Office** Manager Transfer Credit Advisor Pathways and Credit Transfer Coordinator

Program Coordinator (Bachelor of Applied Health Information Science) Program Head Program Manager Student Advisor Undergraduate Academic Advisor

# **Survey Questions**

- 1. What information do you typically have when assessing student transfers coming into (or going out of) your program?
- 2. What information would you ideally *like to have* (but do not) when assessing student transfers coming into (or going out of) your program?

ranscripts	PLO	course assessment tools
course syllabi	institutional information	course textbook lists
CLO	course success	other

- 3. What do you think are the most common barriers to transfers in your program?
- 4. Please tell us a bit about any tools, assessments or methodologies that you have found successful when dealing with transfers that you can share with us.

## **Transfer Information**

Program	Transcripts	Course svllabi	CLOs	PLOs	Institutional information	Course	other
		Synabi				rates	
1	$\checkmark$	$\checkmark$			$\checkmark$		
2	$\checkmark$	$\checkmark$	$\checkmark$				
3	$\checkmark$						
4	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	⇔
5	$\checkmark$	$\checkmark$	$\checkmark$				
6	$\checkmark$	$\checkmark$	$\checkmark$				
7	$\checkmark$				$\checkmark$		
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9	$\checkmark$	$\checkmark$			$\checkmark$		
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21	$\checkmark$	$\checkmark$			✓		

## **Transfer Information Wish List**

Program	Transcripts	Course svllabi	CLOs	PLOs	Institutional information	Course success	other
		ey name				rates	
1					$\checkmark$		
2							
3		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	
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7		$\checkmark$	$\checkmark$	$\checkmark$			
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# **Primary Barriers to Transfer**

Time

Cost

Equivalency

Changes to Courses

Availability of Information

**Course Alignment** 

Accreditation

Age of Credits

# **Primary Barriers to Transfer**

## Time

Cost

Equivalency

Changes to Courses

**Availability of Information** 

**Course Alignment** 

Accreditation

Age of Credits

# **Tips for assessing transfer**

- Course syllabi online
- Pathways
- Bridging Programs
- Students
- Learning Outcomes
- Percentage overlap
- Database
- Shared folders

- Official transfer credits
- Backwards design & course-tocourse
- Credit Transfer Evaluation
  Guide
- Transfer agreements for business

# **Focus Group Questions**

1. What information do you use to evaluate transfer now?

- Title
- Description
- Learning Outcomes
- Assessment Criteria
- Textbook list
- Degree of difficulty

- Work samples
- Program calendar
- Credit hours
- Program accreditation map

# **Focus Group Questions**

 If you were to setup a multi-institutional transfer agreement between diploma programs and degrees in your discipline, what information would you use?

- Past performance of students
- Well-written learning outcomes
- Context of learning outcomes
- Conversations between instructors
- Accreditation
- Professional registration status of instructor

# **Focus Group Questions**

3. What analysis, comparison, and/or visualization would you find useful to accomplish Q2?

- Course-to-course
- Program-to-program
- Gap Analysis
- Heat map
- Beyond Bloom's

- Institutional matches
- Record of past equivalencies
- Ability to "drill down"

## **TRAIL: TRAnsfer Improvement Link**

create visualizations to help support student transfer and the creation of pathways in Ontario.

# **Web Application Requirements**

- Easy upload of course materials
- Automated categorization of **outcome verb**, curriculum structure, prerequisites.
- Simple user interface
- Output visualizations
- Draw on existing tools when possible.
- Ability to save imported programs
- Code publically available.

# **Original Functional Requirements**

Input:

- Pull information in real-time
- Access PLOs, CLOs, WLOs
- Textbook lists
- Transcripts
- Adaptable

Output:

- Course-level overlap analysis
- Gap analysis
- Information about existing pathways
- Customizable
- Flexible

# **Web Application Elements**

## **Information Elements**

- Landing page (login)
- FAQ
- How to Use
- Background
- Contact Us

## **Tool Elements**









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Learning Outcomes	

## Engineering

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## **Engineering technology**

plan develop design establish use **Design and drafting Design and drafting Design and drafting Design and drafting** Design and drafting monitor analyze prepare apply Design and drafting Design and drafting Design and drafting **Design and drafting** 





# Learning Objective Automated Gap Analysis

Vijay Mago

# Progress

Task	Status
Application Design	Completed
Solo/bloom tree map	Completed
Solo/Bloom heatmap	Completed
Pie chart(Additional)	Completed
Export visuals as pdf/png format	Completed
Add new course to existing program	Completed
Add more than one program in one session	Completed
Store user's sessions and comparisons	In progress
Show details of courses user uploads	In progress
Share by email	In progress
Design of Other pages	In progress
Extraction of learning outcomes and course name from pdf	In progress

# Activity: Small groups

Review the visualizations

- 1. Do you think these current visualizations provide useful information? How could they be used?
- 2. How could the visualizations be adapted, or new analysis added, to support building transfer pathways?

## PollEv.com/brianfrank116

# Where this is going

Develop proposal for province-wide pathway between engineering technology and engineering

Continue developing the app to support pathway development

Identify other groups who would like to adapt and expand the tool

## Visualizing the Mapping of Outcomes, Content, and Curriculum between programs to support transfer

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