Course Friction Explorer

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December 15, 2021

People vector created by pch.
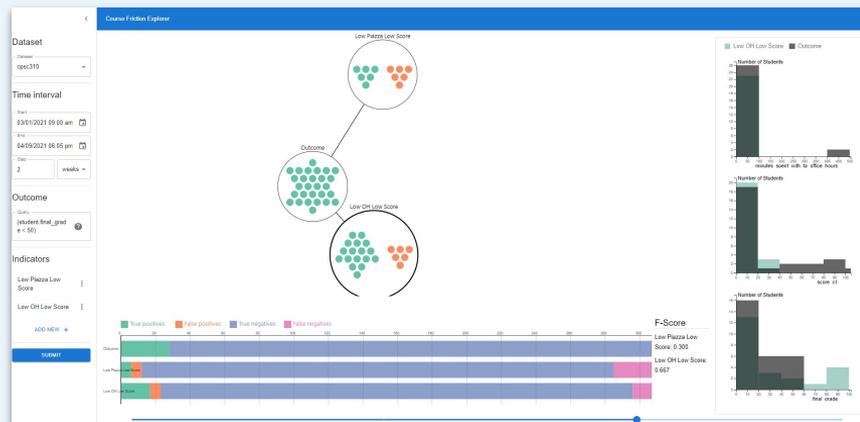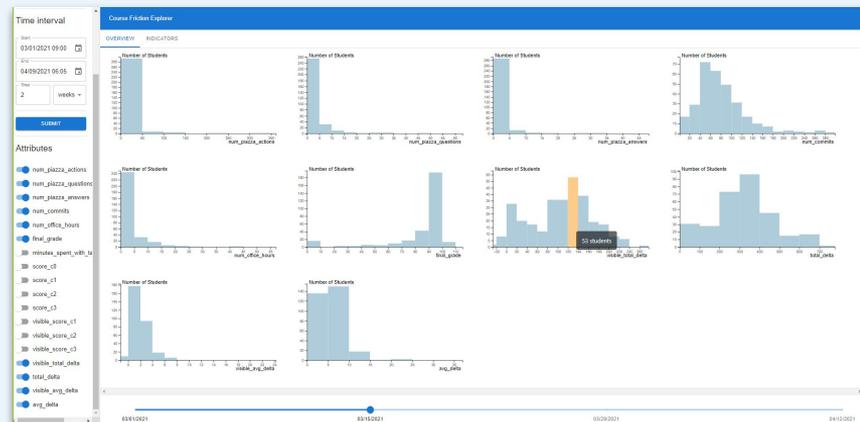
Overview

1. **Why?** Background, Motivation, Problem

2. **What?** Data, Usage Scenario

3. **How?** Idea, Implementation, Results

4. Demo

Why?

CPSC 310

- Introductory Software Engineering course

- More than 300 students registered

- Involves a term-long project

- Different resources for help available

Understanding the problems

01

No easy access to information to determine the cause of students struggling

02

Low scores on assessments as the only reliable signal so far

03

Limited possibility for interventions

Motivation

- Target User: CPSC 310 staff

- Explore students' experiences

- Identification of possible causes of struggle

- Identification of patterns of struggle or friction

- Creating intervention possibilities

What?

Input Data

CPSC 310 data from 2020W2
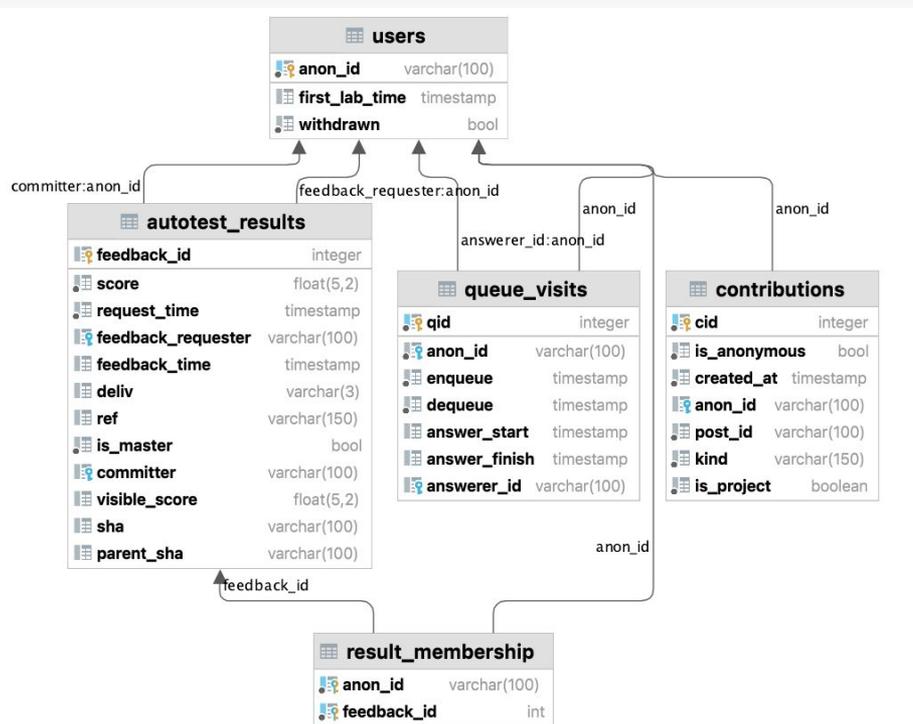
→ 409 people (students + TAs)

→ 2366 Office Hours visits

→ 5801 Piazza contributions

→ 25488 Autotest results

Categorical Attributes

Table	Description	Attribute name	Description	Example
Contributions	Piazza contributions	kind	Contribution kind	"follow-up"
		is_project	Whether the contribution was project related	
		anon_id	Identifier of user who made the contribution	
autotest_results	Automated test results	committer	Deidentified user hash of the committer	
queue_visits	TA-held office hours	anon_id	Deidentified user ID	

Ordered Attributes

Table	Description	Attribute name	Description	Range
Contributions	Piazza contributions	created_at	Timestamp of contribution	
autotest_results		score	Test score of Autotest run	0.00 to 100.00
queue_visits	TA-held office hours	answer_start	Timestamp	
		answer_finish	Timestamp	

Usage Scenario

- Identifying outliers

- Identifying causes of struggle

- Comparing causes of struggle

- Identifying struggling students

- Identifying patterns

How?

Idea - Solution

- Create a dashboard that
  - allows for groupings of students by different **indicators**
  - comparisons between these groupings and the outcome group
  - relative to time
- Reveals how well an indicator predicts some outcome

Definitions:
- Attributes: property of the students (derived)

- **Indicator:** combination of attributes
  - using operators (eg. logic, arithmetic, comparison, etc.)
  - **Outcome:** another indicator (to predict)

Attribute – Example

Attributes are derived data from the underlying dataset attributes. They abstract away time.

Student #1234   *student.num_commits*

- num_commits
- num_piazza_questions
- avg_delta
- ...and 15 more

time

0   1   5   7   7
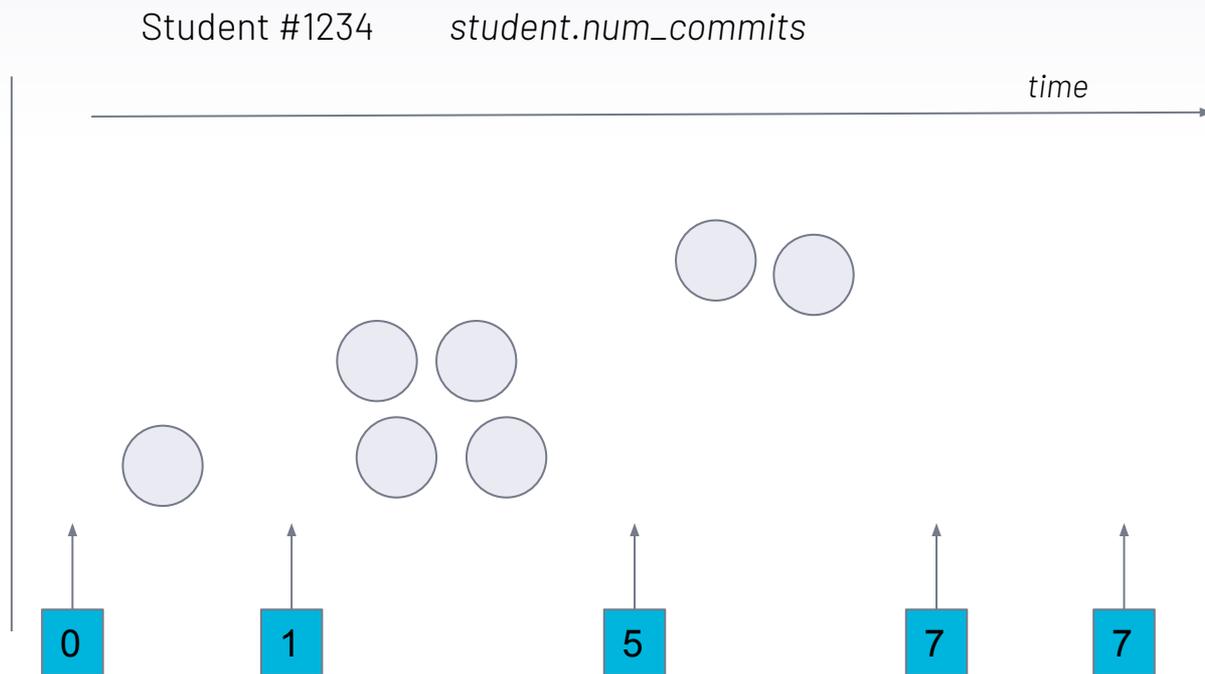
Indicator – Example

Indicator

- combination of attributes
- with operators (eg. logic, arithmetic, comparison, etc.)

Examples

(min(weekly(student.num_commits)) > 0)

- Students who makes at least 1 commit each week

((student.num_office_hours - student.num_piazza_questions) > 0)

- Students who go to more OH more often than asking Piazza questions

Indicator Circle

Students that indicator captures

Implementation

- **Frontend**: JS, TS
  - D3 data visualization
  - React: UI
  - Redux: states

- **Backend**: Python
  - DSL: Antlr
  - Server: Uvicorn, FastAPI
  - SQLite: database
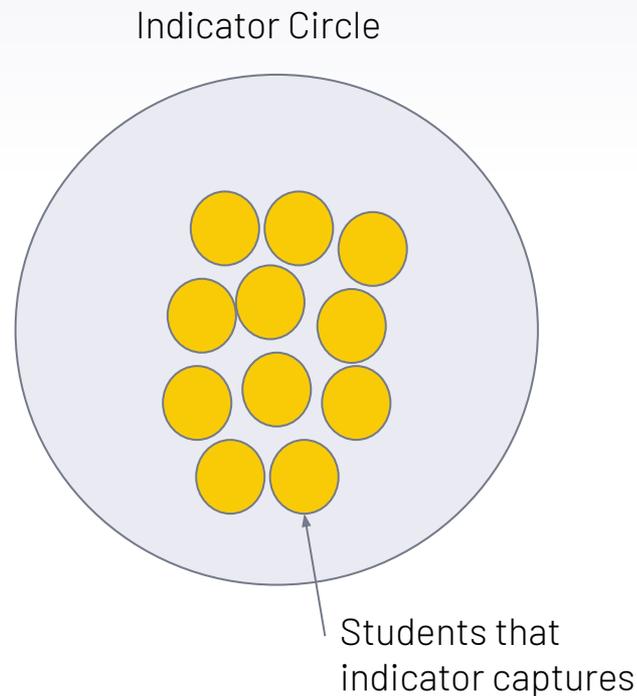
Results – Visualizations

01

Histograms

02

Circular packing

03

Stacked bar chart

04

Histogram widgets

Overview
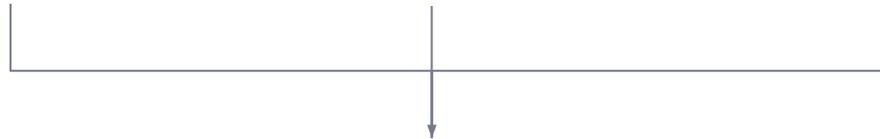
Indicators Board

Results - Histograms

01

Histograms with attributes and total amount of students

Idioms:

- small multiples
- change over time
- selection (hover)

Channels:

- length, color, vertical position
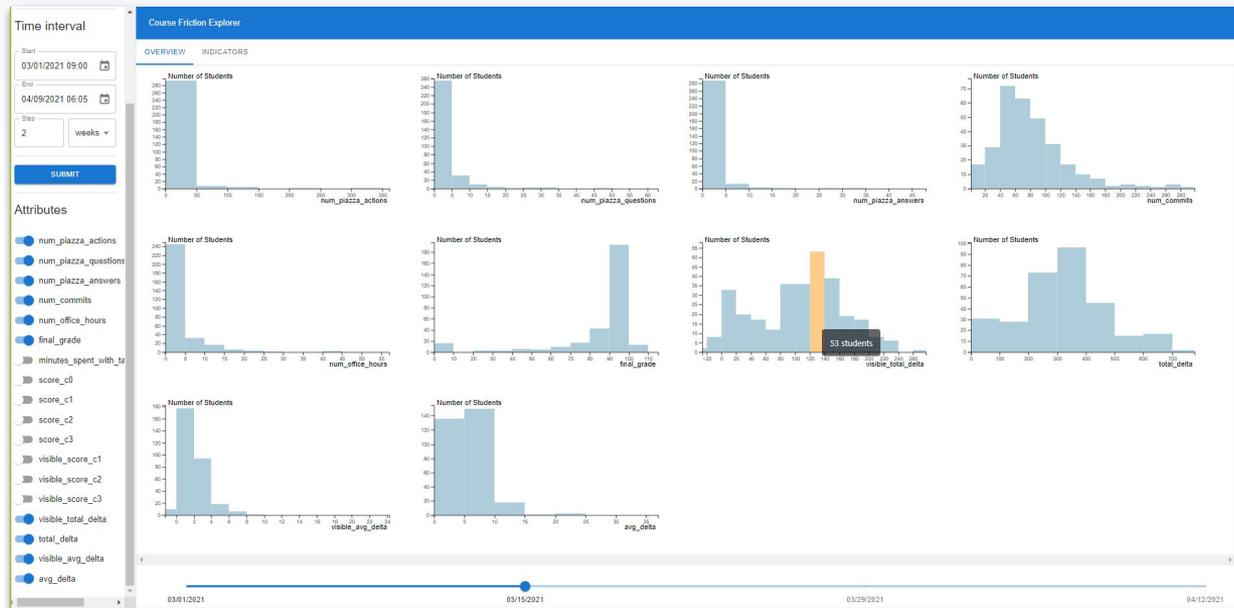
Results – Circular Packing

02

Outcome and indicator **circles** linked by **similarity** (F-Score)

Idioms:

- zooming, panning
- selection (click, hover)
- change with time

Channels:

- circle size, color, link length, 2D position
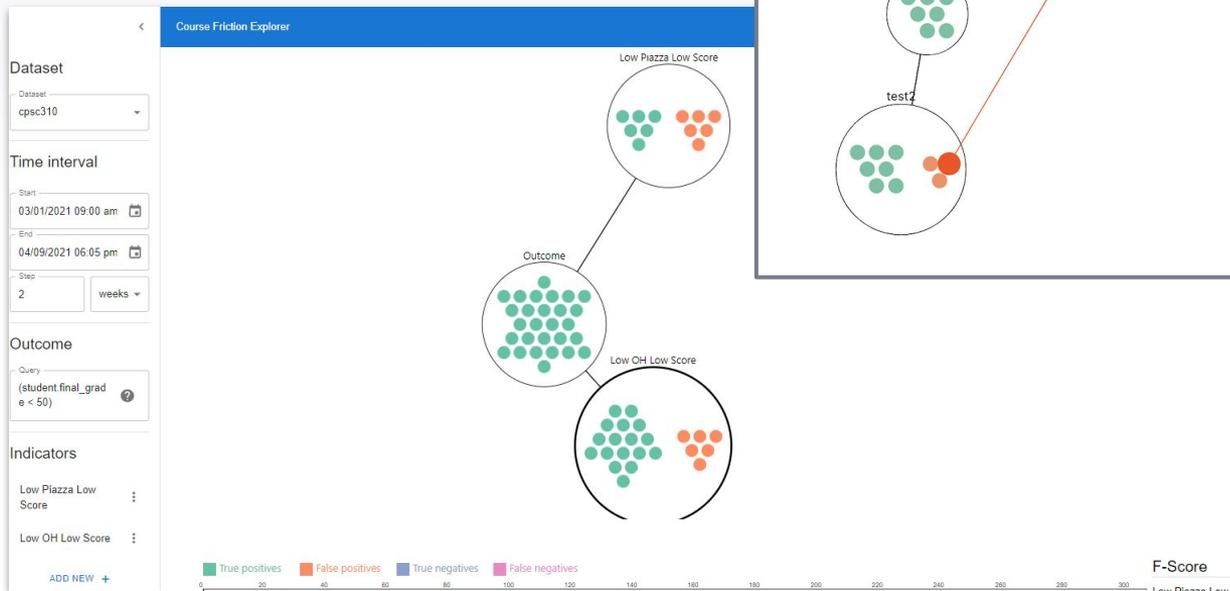
Results – Stacked Bar Charts

03

Bar chart showing the **ratio** of true/false positives and negatives overall

- linked views
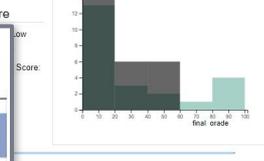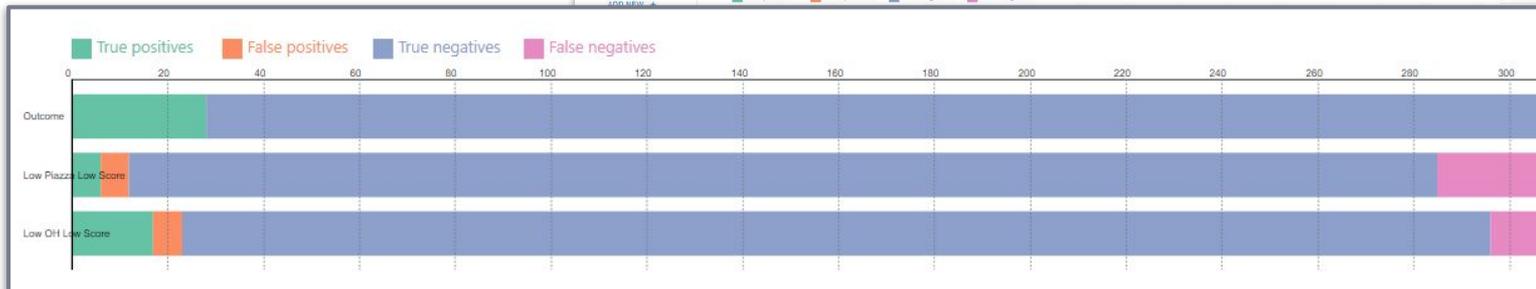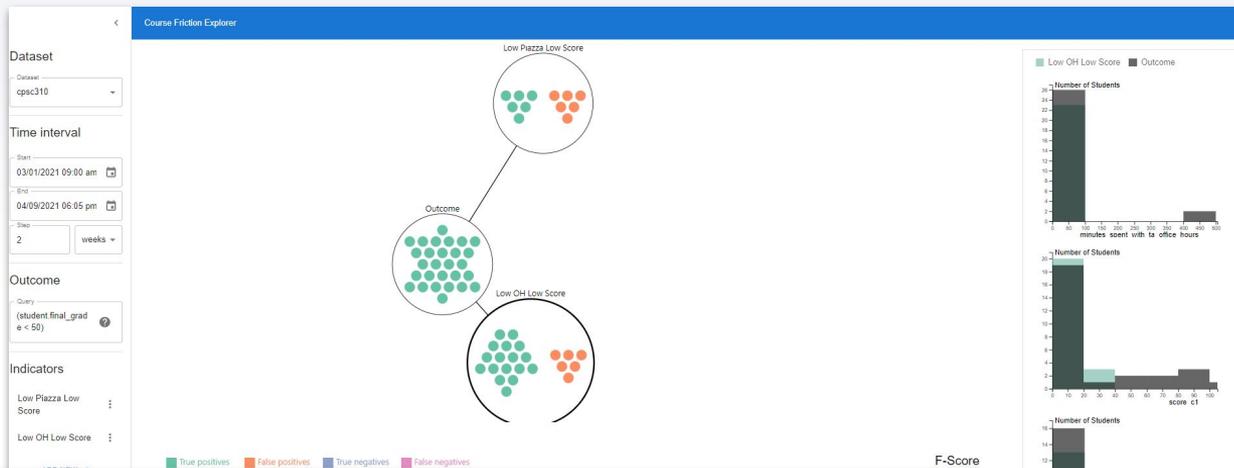
Results – Histogram Widgets

04

Juxtapose selected indicator students to the outcome

Idioms:

- superimposed views

Channels:

- color, length, vertical position
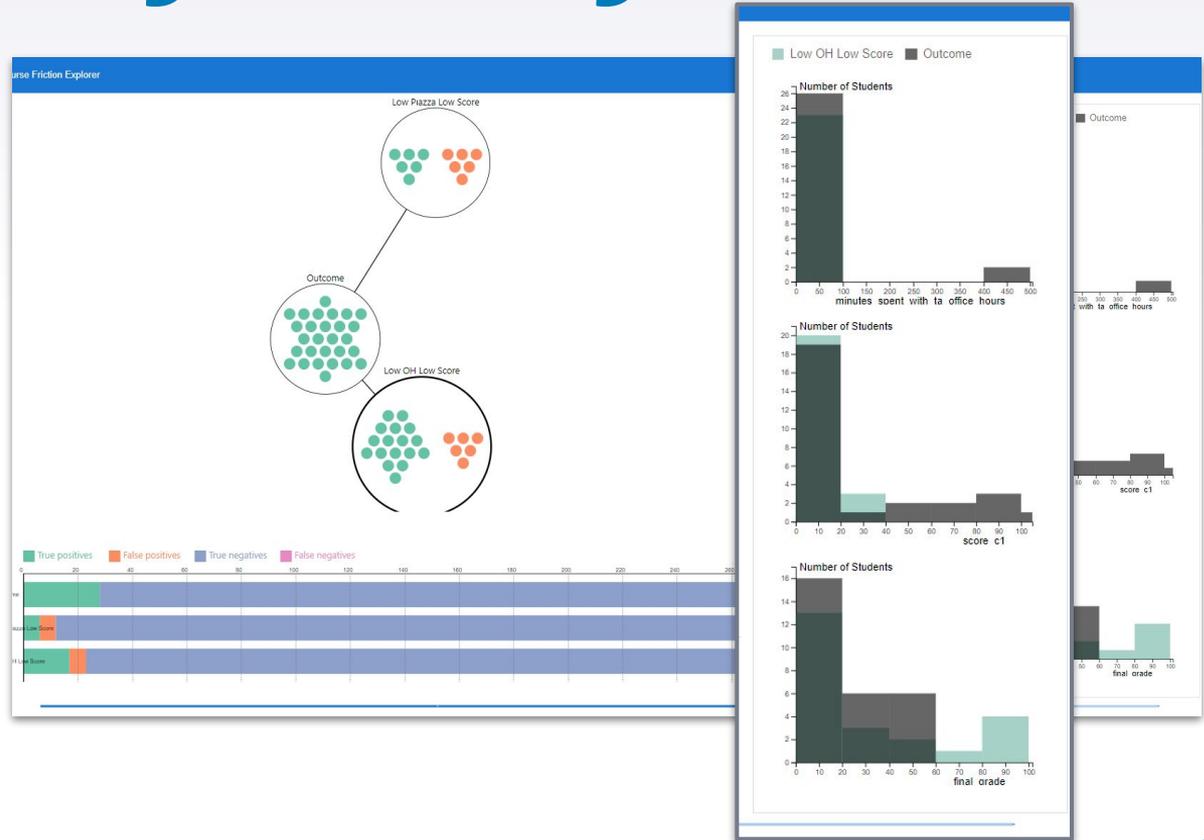
Demo

Demo link

Short demo version (2:30 min):
https://www.youtube.com/watch?v=-yWqeSw0s-k

More detailed version (4:30 min):
https://www.youtube.com/watch?v=ly-if4Qrb2k

Course Friction Explorer: A tool for CPSC 310

Allows staff to…..

- identify causes for struggle

- identify patterns

- identify struggling students

- create interventions

THANKS!

Any questions?
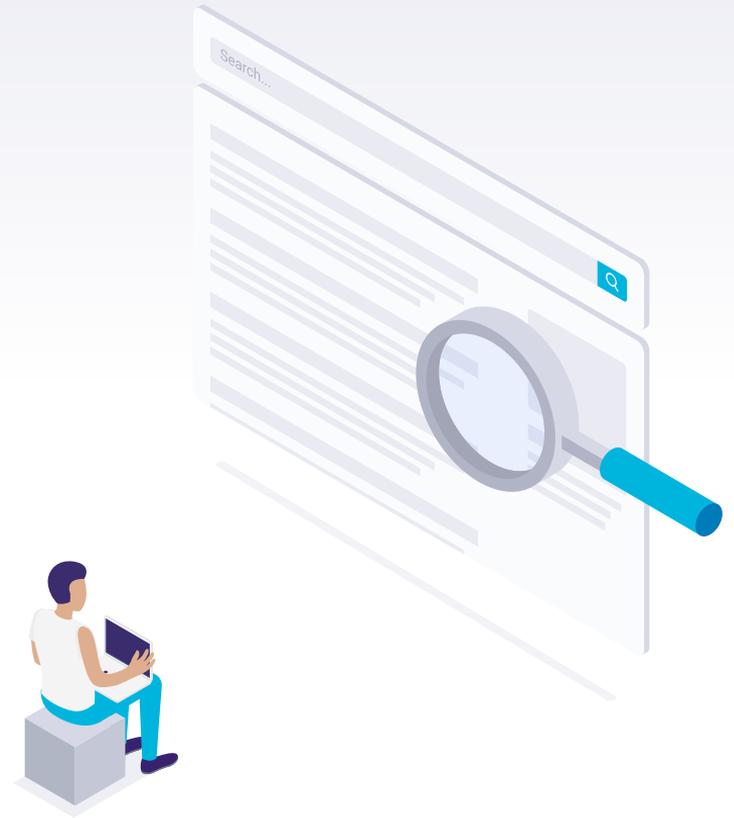
Future Work

- Scalability of circular packing for larger indicators

  - Introduce additional hierarchy level, group the students

- Sparsity of viz, uses distance between circles to encode similarity

  - Explore other channels, like link width for encoding similarity (F-Score)

- Difficult to identify recurring students in different indicators

  - Visualize overlap between indicators when an indicator is selected

- No UI for defining indicators (rely on DSL)

  - Buttons, selections, sliders to express query without needing the DSL explicitly