Natural Language Processing and Machine Learning to assist radiation oncology incident learning

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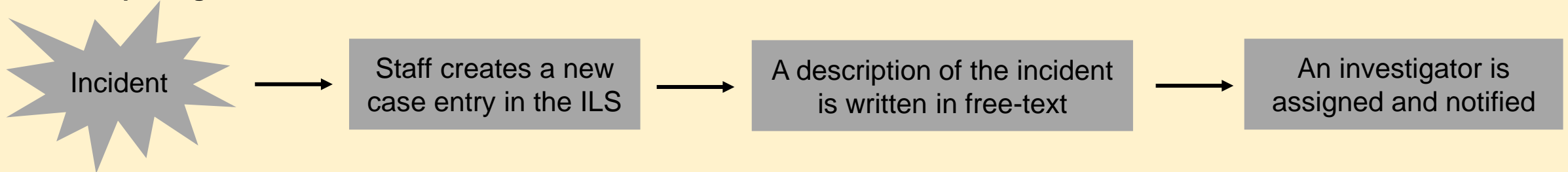
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McGill

Incident learning system (ILS)

- Software tool that enables incident learning.
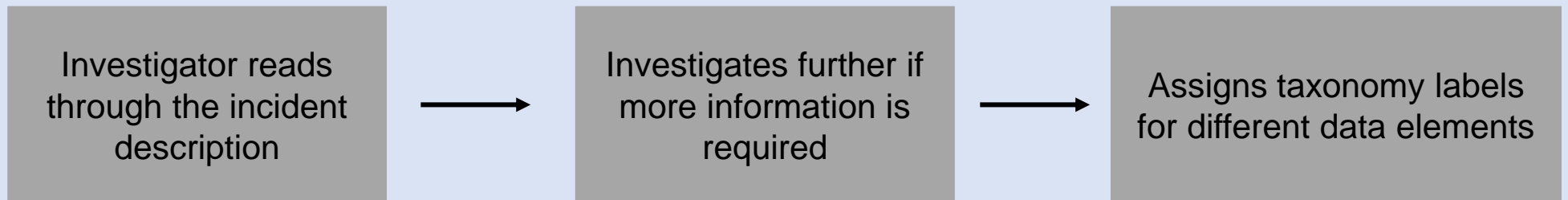- There are many international, national and local Incident learning systems.

National System for Incident Reporting – Radiation Treatment (NSIR-RT)
Safety and Incident Learning System (SaILS)

Incident reporting

Incident → Staff creates a new case entry in the ILS → A description of the incident is written in free-text → An investigator is assigned and notified

Incident investigation

Investigator reads through the incident description → Investigates further if more information is required → Assigns taxonomy labels for different data elements

Objective

To use natural language processing and machine learning tools to assist incident investigators with incident classification.

Data elements of interest:

1. Process step where incident occurred (*8 label options*)

2. Problem type of the incident (*16 label options*)

3. Contributing factors of the incident (*25 label options*)

A mock-up of the ranked drop-down list of labels for the process step data element of SaILS

Supervised learning

- We gathered more than 6500 incident reports from Canadian Institute of Health Informatics (CIHI) and SaILS databases.

- Extracted incident descriptions and labels for supervised learning.

- We decided to test all ML algorithms from Python's Scikit-learn library.

- We extended the binary classifiers to support multi-label compatibility using two techniques: MultiOutputRegressor and RegressorChain.

<u>Incident descriptions</u>

Example:

Plan not ready. Pt was scheduld for 8:45 for plan 2, plan was not ready . Pt was called at 8:00 to come for 11:00. Plan ready @ 12:15.

Training on the data is difficult because:
- Abbreviations
- Shorthand
- Spelling mistakes
- Grammatical errors
- Improper sentence structure

TrueLabelIndex score

Multi-label models generate a ranked list of possible labels

Model prediction: [Label 5, Label 3, Label 1, Label 4, Label 2]

If True label (expert labelled value) = Label 3,

Then, TrueLabelIndex score = 2

Process step where incident occurred	
Treatment delivery	0.85
Treatment planning	0.10
Post-treatment completion	0.03
Imaging for radiotherapy planning	0.02

Model performance on test set

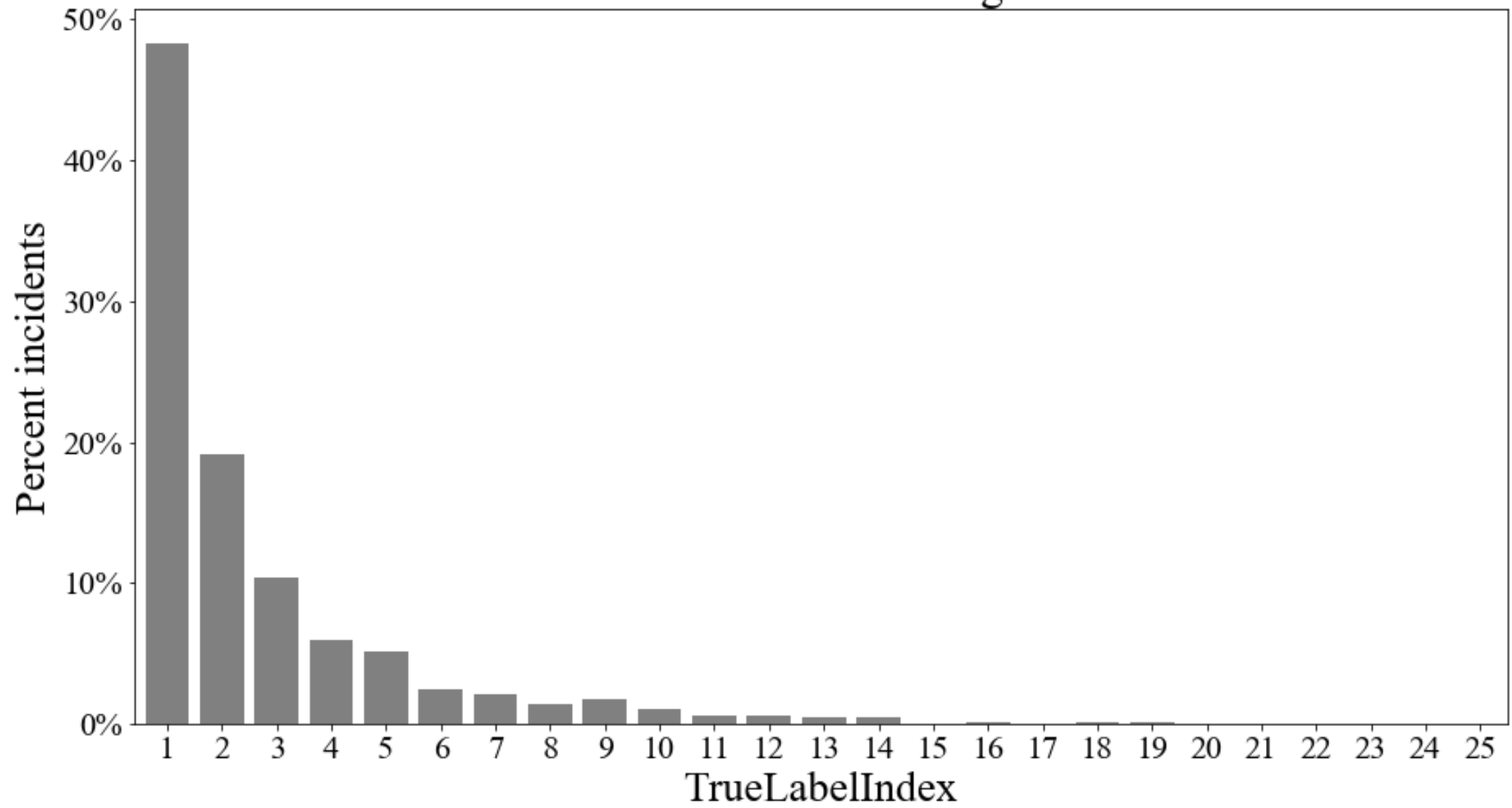| Data element	Best performed model	Final test - TrueLabelIndex score (Best score =1)
Process step	MultiOutputRegressor + Linear SVR	1.47
Problem type	MultiOutputRegressor + Linear SVR	1.72
Contributing factors	MultiOutputRegressor + Linear SVR	2.65

Data element: Process step
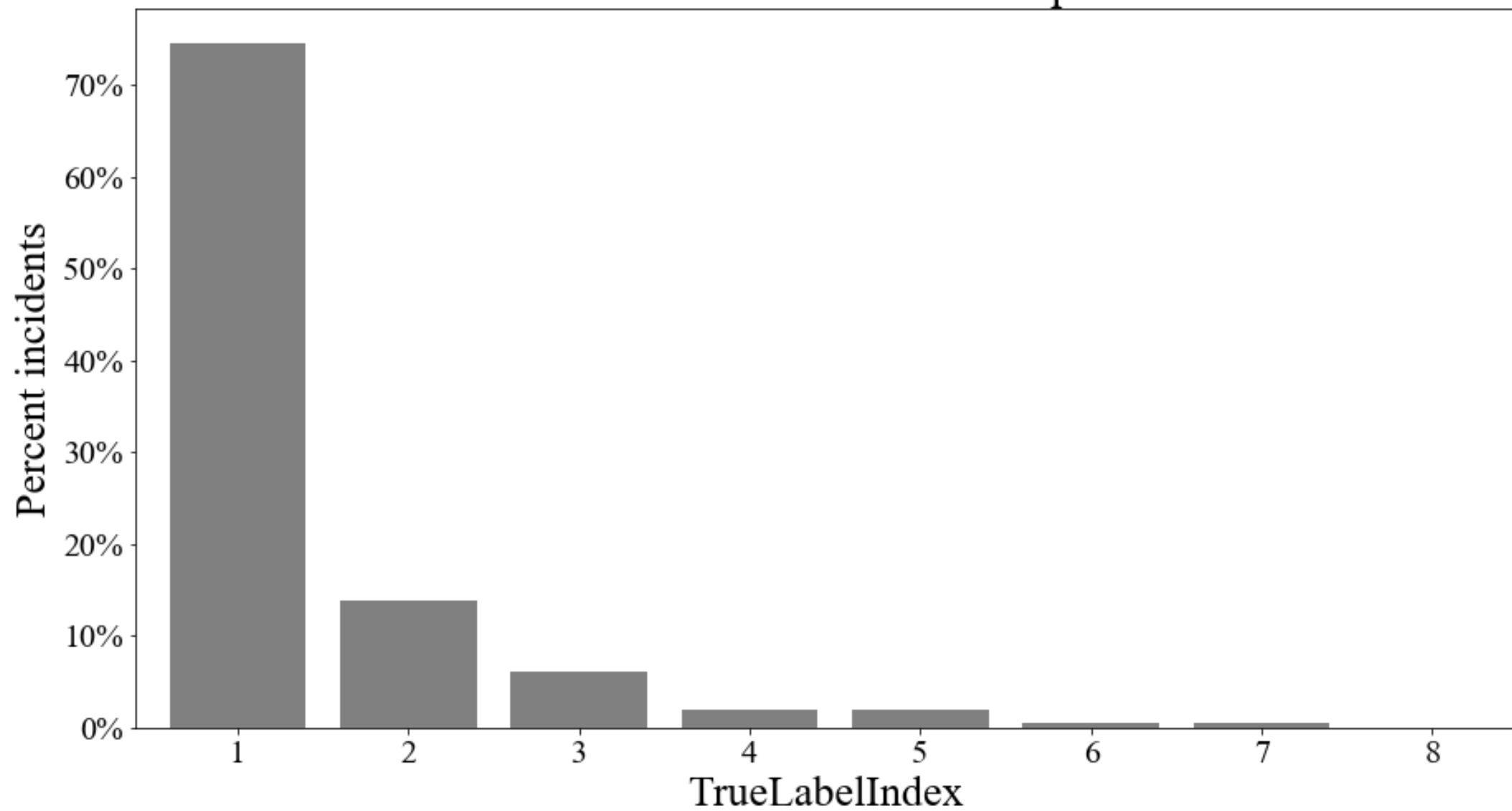
Data element: Problem type
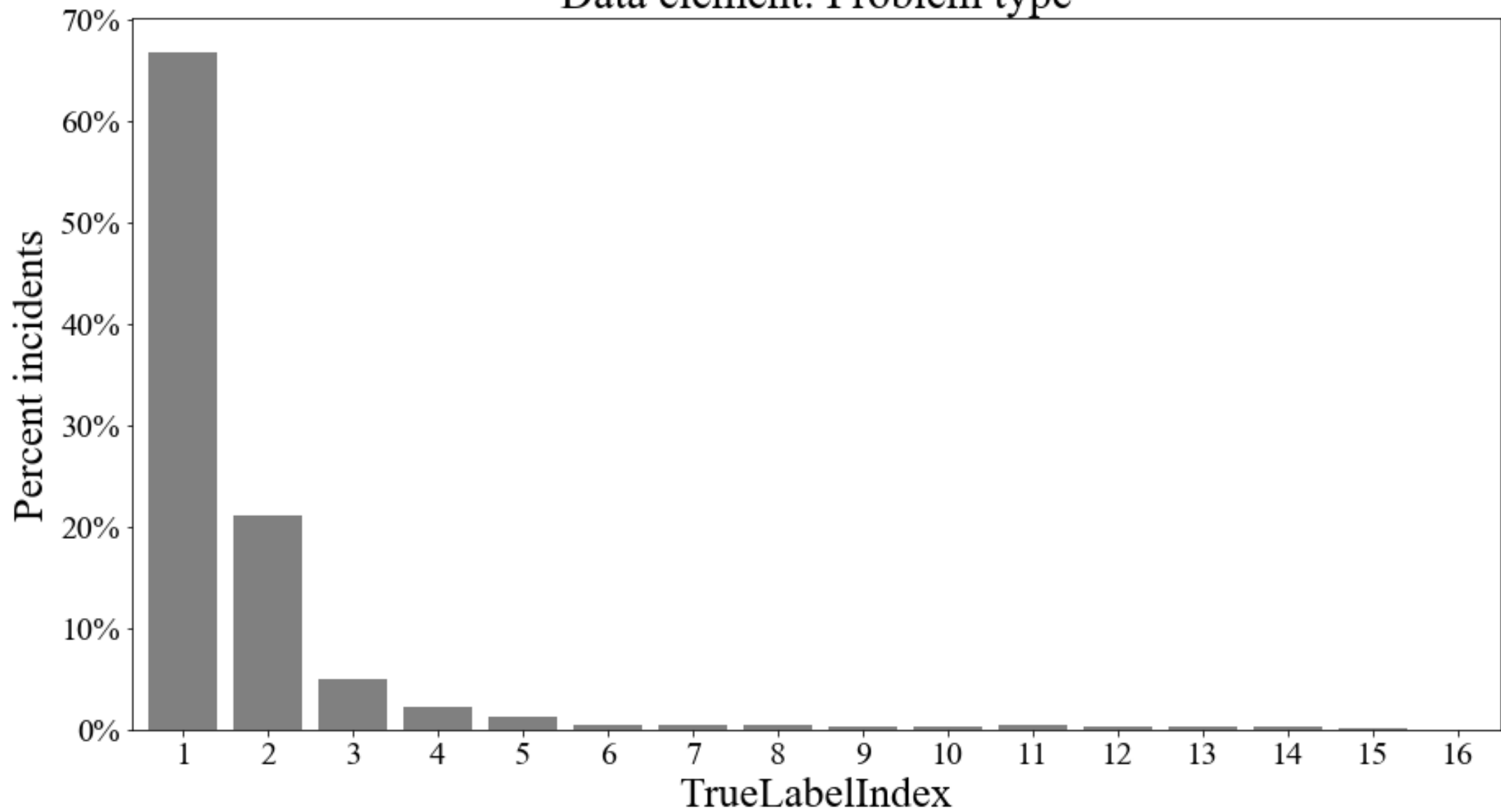
Data element: Contributing factors

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