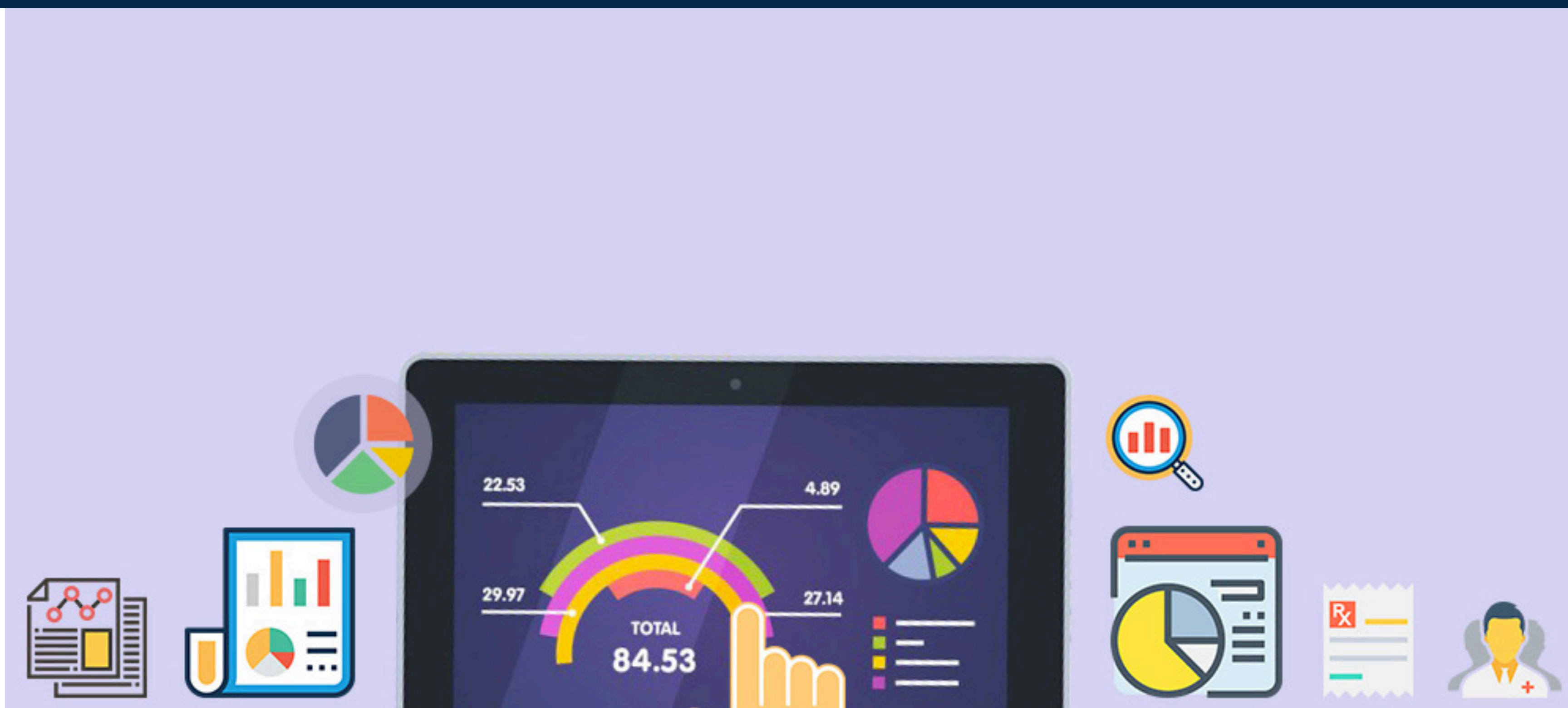
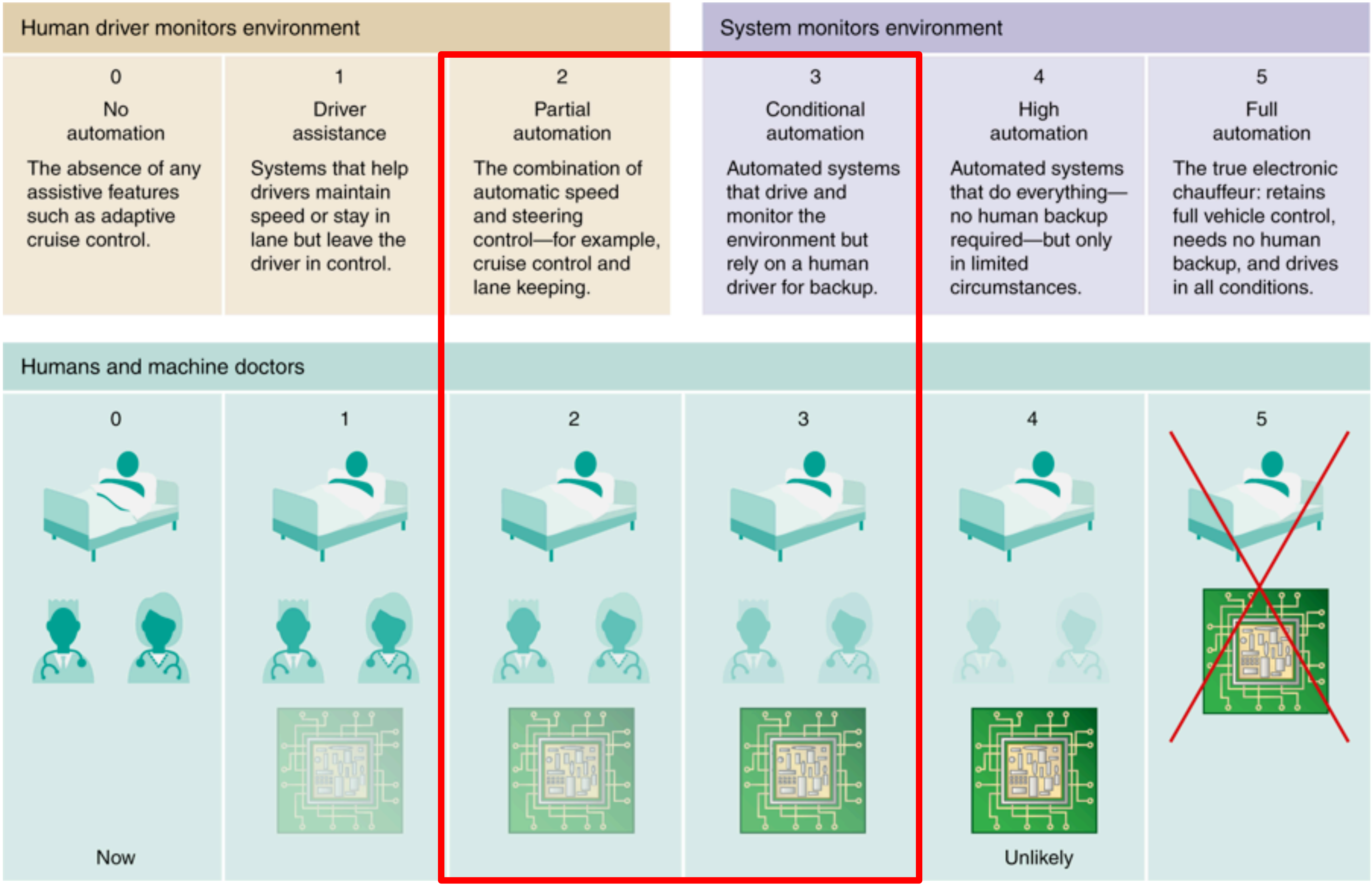
Machine Learning for Medical Coding in Health Care Surveys

Assessing Viability of Multi-label Classification of Verbatim Text for the NAMCS & NHAMCS-ED 2016-17 Surveys

Emily Hadley*, Rob Chew, Jason Nance, Peter Baumgartner, Rita Thissen, David Plotner, Christine Carr, Aerian Tatum



Automation Maturity Model



From Topol (2019) in ***Nature Medicine***

Challenges of Manual Medical Coding

Patient 123456

Reason for Visit Text
Vertigo and dizziness

↓

Reason for Visit Code
1225.0

Medical coding is…

- Essential
- Complex
- Labor-intensive

Research Question

Can machine learning help address the challenges of manual coding?

Data – Methods – Results – Discussion

Data

Sources of Verbatim Text

National Ambulatory Medical Care Survey (NAMCS)	National Hospital Ambulatory Medical Care Survey – Emergency Department (NHAMCS-ED)
Annual, nationally rep. survey of non-federally employed office-based physicians primarily engaged in direct patient care	Annual, nationally representative survey on utilization and provision of ambulatory care services in hospital emergency departments

2016 – 2017 survey data used for this project

Medical Coding Example

Patient 123456

Reason for Visit Text	Reason for Visit Code
Vertigo and dizziness	1225.0

Up to 5 reasons for visit

Cause of Injury Text	Cause of Injury Code
Struck by falling object	W20.8xxA

Up to 3 causes of injury, truncated to first three characters

Diagnosis Text	Diagnosis Code
Acute post traumatic headache, intractable	G44.311

Up to 5 diagnoses, truncated to first three characters

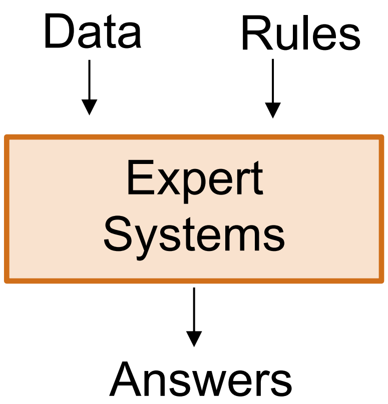
Methods

Expert Systems vs. Statistical Natural Language Processing

Two overarching schools of thought for Automated Computer Coding:

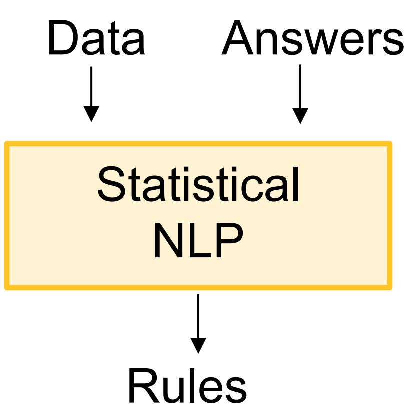
Expert Systems

- Designed to reason about a problem much as a human expert would
- Create rules to match response strings to an entry in a dictionary
- Requires expert knowledge and can be expensive to develop / maintain



Statistical Natural Language Processing (NLP)

- Designed to treat classification as an optimization problem
- Uses labeled examples to “learn” effective rules
- Often requires a large amount of high-quality labeled data



Classification Model Development

- 80% of data for training models, 20% for evaluation
- Multi-label text classification

Multi-Class **Text Classification**	***Multi-Label*** **Text Classification**
Assigns a single class to a set of input text	Assigns zero to many classes for a given set of input text

- Models Considered:
  - Random Forests
  - Support Vector Machines
  - Multi-label k-Nearest Neighbors
  - Logistic Regression
- Best model based on precision and recall: **Logistic Regression**

Comparing Model Predictions to Humans

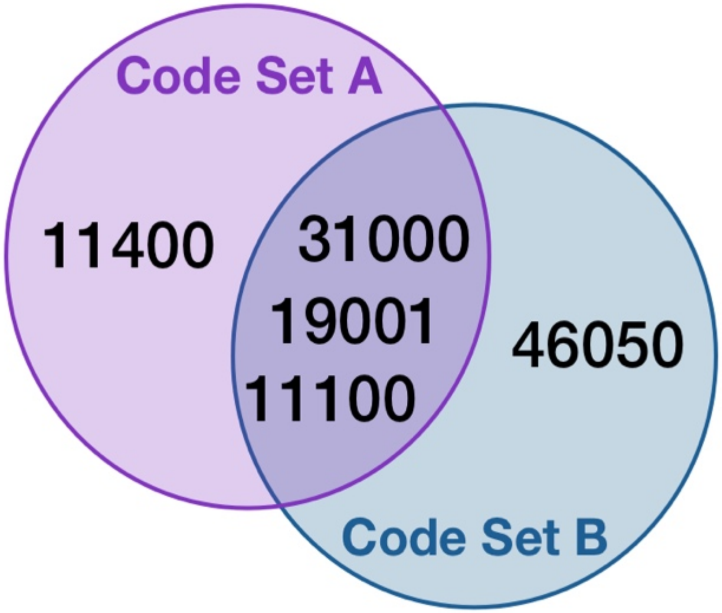
Jaccard Score

How many codes exist in both sets ÷ how many codes are in either set?

Code Set A
[31000, 19001, 11400 , 11100]
Code Set B
[31000, 19001, 46050, 11100]

In Both
[31000, 19001, 11100]
(size=3)
In Either
[31000, 19001, 11100, 11400, 46050]
(size=5)

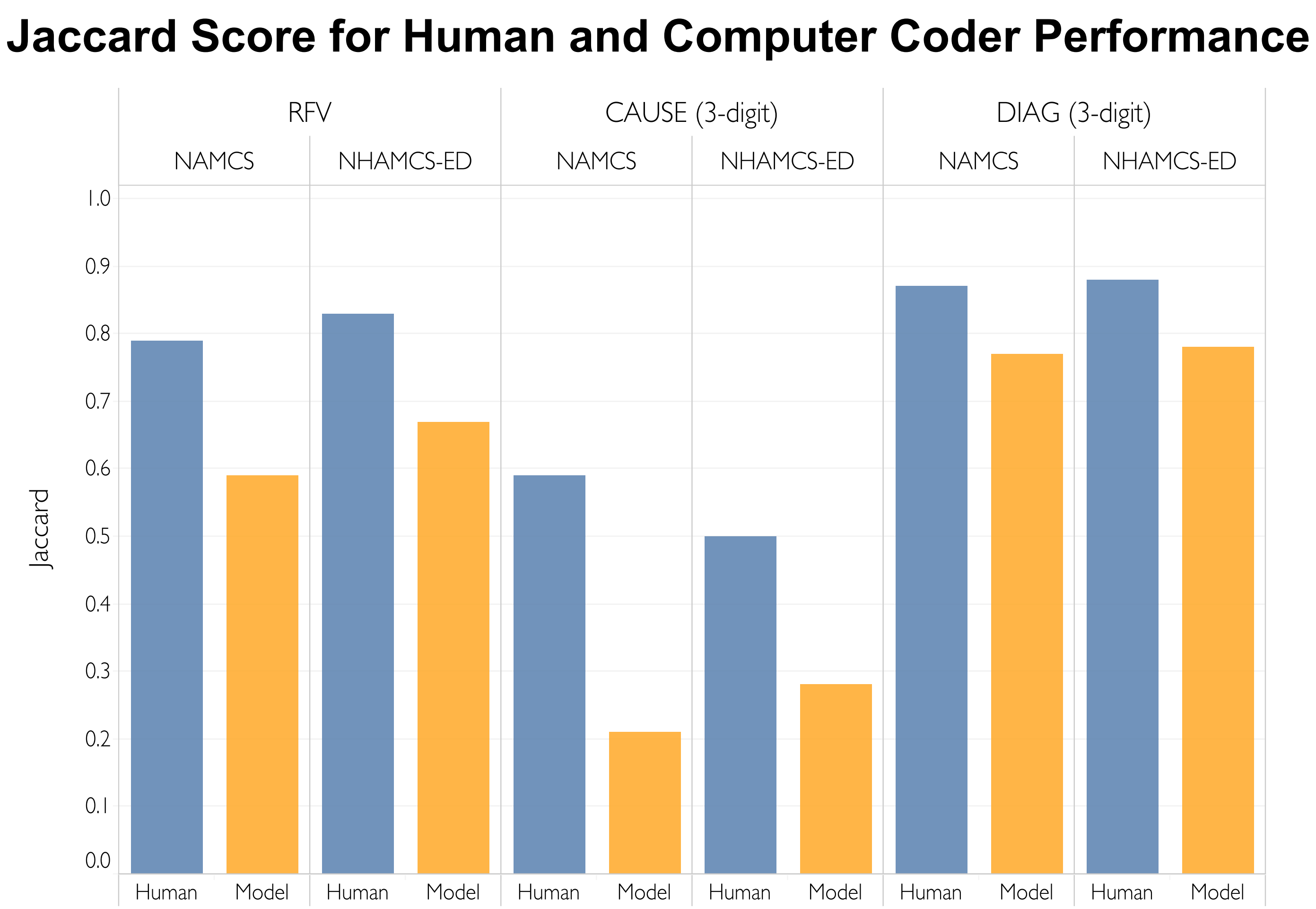
Jaccard Score: 3 ÷ 5 = **0.6**



Can be applied when code sets come from two coders or from a coder and a predictive model.

Results

Performance Comparisons



- Humans consistently outperform the model
- Model performs well on both *Reason for Visit* and *Diagnosis* tasks
- Both humans and model perform worst on *Cause of Injury*

Performance by Medical Code

Performance on Individual Truncated ICD-10-CM Codes

- Points above the line are codes where model outperforms humans
- Humans and model both tend to perform well on the most frequent codes

Discussion

Potential Implementation Use Cases

Recommendation System

Software double-codes every record as a support system for human coders

Software displays recommended codes for each record, improving human coder efficiency

Acknowledgements

- National Center for Health Statistics
- HealthCare Resolution Services
- RTI Project Staff
- RTI Center for Data Science

RTI International

delivering **the promise of science**
for global good

RTI INTERNATIONAL

Emily Hadley
Data Scientist
ehadley@rti.org