CIFellows 2020-2021

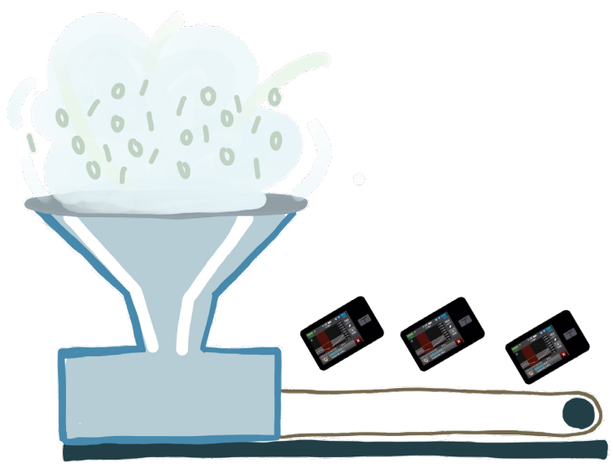
Computing Innovation Fellows

BlockRQA: A Novel Tool for Automatic Pattern Detection Across Multivariate and Mixed-Type Time-Series Data

Dr. Taisa Kushner, Dr. Clara Mosquera-Lopez, Dr. Peter Jacobs, Oregon Health & Science University

What you have:
Lots of time series data that characterize different features about a system (eg. multiple wearable sensors + text records)

What you need:
The ability to **detect patterns** across the potentially correlated time series (eg. find complex behavioral patterns that lead to adverse health outcomes, and target them for intervention)

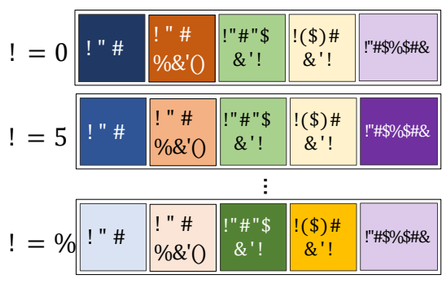


What this project proposes:
A **new methodology** (rooted in recurrence quantification analysis) **for automatically identifying these patterns**!

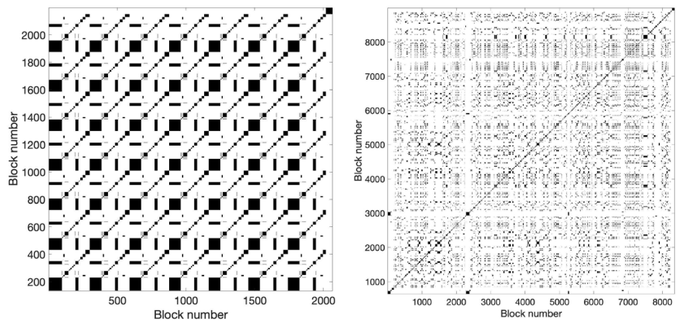
Benefits
- **Guaranteed** to detect all patterns.
- Works well on **small, highly variable data** where other methods fail
- Includes the ability to **easily cluster** "similar but not exact" patterns
- **Easy to implement, easy to interpret**.

Algorithm Overview

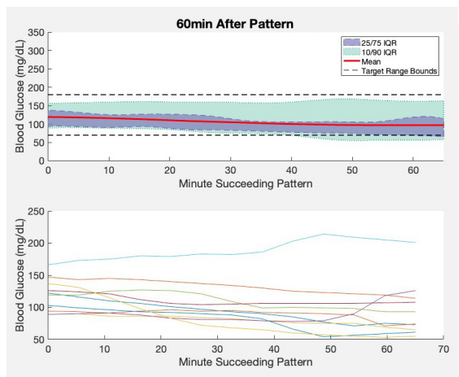
Base-and-Block data transformation



Block-based recurrence plot construction & pattern extraction



Pattern scoring, clustering and analysis



Length	40min
CGM	euglycemic, no change
CGM slope	flat 35min, then downtrend 5min
activity	none
basal IOB	<70% of set basal
bolus IOB	autobolus present

Results on Novel Clinical Study Data for Type-1 Diabetes Control

	Mean ± deviation
Total number of patterns	332.8 ± 52.3
Percent of data with at least one pattern	57.2 ± 6.7
Unique patterns leading to hypoglycemia	42.7 ± 42.6
Patterns leading to hypoglycemia	
Average hypoglycemia risk – top 3 patterns	0.63 ± 0.24
Average hypoglycemia risk – all patterns	0.30 ± 0.06
Occurrences per pattern	8.5 ± 4.1
Pattern length (minutes)	57.3 ± 12.3
Proportion of hypoglycemic events with preceding patterns	61 ± 16

Characteristic (per individual)	Mean ± deviation
Continuous Days of Data	29.5 ± 1.3
Number of Binned CGM	7309 ± 1475
Number of Boluses	421 ± 259
Hypoglycemic Events	24 ± 21

CRA Computing Research Association

CCC Computing Community Consortium Catalyst

NSF

OHSU OREGON HEALTH & SCIENCE UNIVERSITY