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AUTOMATIC PSYCHOLOGICAL TEXT ANALYSES

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1 Background

- **Schema therapy** by Young [1]
- Short Schema Mode Index (SMI) questionnaire
  - 14 schema modes
  - 118 questions
  - 3-6 therapy sessions
- **Natural language processing for cognitive therapy: extracting schemas from thought records [2]**
  - Did not use SMI schemas.
  - Did not aim to achieve optimal performance with any of the explored models
- **Schema mode assessment through a conversational agent [3]**
  - Text analysis algorithm used is lacking.
  - Barely predicts 2 of 7 schema modes**.**

2 Research Question

How well can a schema be automatically classified from a text using RNN?

1. What **pre-processing** steps on the data are necessary for an optimal classification by RNN?
2. What are the optimal **hyper-parameters** in the RNN model?
3. `What are the differences between the results of three methods, **RNN, KNN and SVM**?

3 Method

- Dataset
  - recent emotional story
  - 7 schemas: 67 questions
  - 72% train, 8% validation and 20% test
- **Preprocessing**
- Classifier
  - one input embedding layer
  - one bidirectional hidden layer,
  - one dropout layer
  - one output layer
- Three models
  - **binary** classification **multilabel** model
  - **binary** classification **per-schema** model
  - **ordinal** classification **per-schema** model
- Talos hyper-parameter **optimization**

4 Results

Binary Multilabel model

- Average **accuracy** of 69% (59% - 92%)
- Average **F1-score** of 0.49

Binary Per-Schema model

Schema	Before	After
Vulnerable	0.64	0.63
Angry	0.64	0.62
Impulsive	0.79	0.73
Happy	0.73	0.65
Detached	0.66	0.61
Punishing	0.79	0.77
Healthy	0.92	0.91

Table 3: Accuracy Per-Schema Model Optimization

Schema	Before	After
Vulnerable	0.36	0.38
Angry	0.15	0.48
Impulsive	0.00	0.17
Happy	0.84	0.77
Detached	0.00	0.36
Punishing	0.03	0.34
Healthy	0.96	0.95
Micro avg	0.66	0.66
Macro avg	0.33	0.49
Weighted avg	0.54	0.63
Samples avg	0.70	0.66

Table 4: F1-Score Per-Schema Model Optimization

- Average **accuracy** of 72% (64% - 92%)
- Average **F1-score** of 0.49 (0.17 - 0.95)

Ordinal Per-Schema

- Average **Spearman correlation** of 0.15

RNN, KNN and SVM

Schema	SVM	kNN	RNN
Vulnerable	0.078	0.13	0.28
Angry	0.023	0.08	0.18
Impulsive	0.0033	0.12	0.042
Happy	0.12	0.06	-0.057
Detached	-0.090	0.08	0.24
Punishing	0.074	0.09	0.27
Healthy	0.020	0.06	0.09

Table 7: Comparison between SVM, kNN and RNN using Spearman Correlation

Schema	SVM	kNN	RNN
Vulnerable	0.27	0.34	0.38
Angry	0.38	0.40	0.48
Impulsive	0.07	0.13	0.17
Happy	0.75	0.80	0.77
Detached	0.18	0.35	0.36
Punishing	0.2	0.22	0.34
Healthy	0.93	0.96	0.95
micro avg	0.63	0.66	0.66
macro avg	0.40	0.46	0.49
weighted avg	0.57	0.62	0.63
samples avg	0.66	0.68	0.66

Table 6: Comparison between SVM, kNN and RNN using F1 Score

- **F1-score** and **Spearman correlation**: RNN

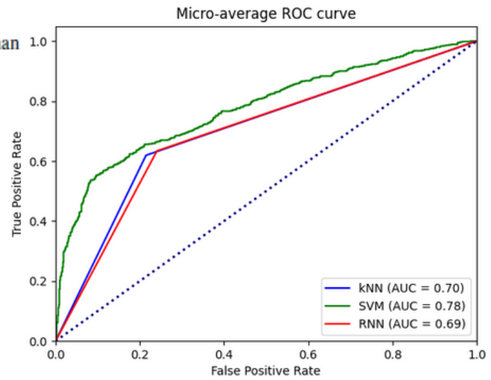

Figure 10: Micro avg curves for RNN, KNN and SVM

- SVM best micro average curve
- All macro average curves similar

5 Limitations

- Biased dataset
  - punishing: 21% is labelled as 1 and 79% is labelled as 0
  - healthy: 92% of the dataset is labelled as 1, the remaining is labelled as 0.
- Low Correlation
- Small dataset

6 Conclusion

1. What **pre-processing** steps on the data are necessary for an optimal classification by RNN?
   - removing data instances that do not contain information for classification
   - lower-casing
   - splitting of contractionsr
   - removal of stopwords,
   - removal of unnecessary white space
   - lemmatization
2. What is the optimal **hyper-parameters** in the RNN model

Model	Binary Multilabel	Binary Per-Schema	Ordinal Per-Schema
hidden latyer units	300	200	300
dropout value	0.5	0.1	0.1
optimization function	Adam	rmsprop	Adam
batch size	32	32	32

Table 12: Final hyper-parameters

3. Comparison RNN, KNN and SVM
   - RNN best according to **F1-score** and **Spearman Correlation**
- **binary** classification: **sufficient**
- **ordinal** classification: **poor**

7 Future improvements

- Balancing dataset
- Bigger dataset
- Manual labelling
- SMI over more stories for periodic schema classification
- Exlore other hyper-parameters

References: [1] J. E. Young, J. S. Klosko, and M. E. Weishaar, Schema Therapy: A Practitioner's Guide. Guilford Press. [2] F. Burger, M. A. Neerincx, and W.-P. Brinkman, "Natural language processing for cognitive therapy: extracting schemas from thought records." [3] D. Allaart, "Schema mode assessment through a conversational agent."