Exploring the Impact of Evolutionary Computing based Feature Selection in Suicidal Ideation Detection

Ramit Sawhney, Rajiv Ratn Shah, Vedant Bhatia, Chin-Teng Lin, Sagar Aggarwal and Mukesh Prasad

UNIVERSITY OF TECHNOLOGY, SYDNEY

MIDAS@IIITD
Multimodal Digital Media Analysis Lab

Problem Formulation

- Suicidal ideation, also known as suicidal thoughts, is thinking about, considering, or planning suicide. The range of suicidal ideation varies from fleeting thoughts, to extensive thoughts, to detailed planning.
- This paper proposes a diverse set of features and investigates into feature selection using the Firefly algorithm to build an efficient and robust supervised approach to classifying tweets with suicidal ideation

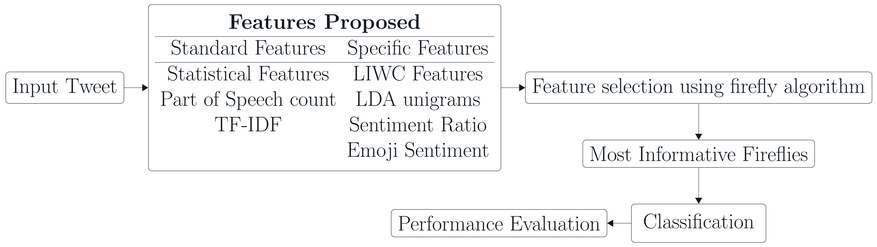
Suicide Ideation

- Depression and other mood disorders are considered to be the primary source for suicidal ideation; however many other mental disorders, family and life events also play an important role and may increase the risk of suicidal ideation.
- Annotation of tweets with suicidal ideation was performed on the basis of a binary criterion: *Does this text imply self-harm inflicting tendencies or suicidal intent?*
- Tweets displaying a serious tendency of self harm, discussing past and future attempts at suicide are said to display suicidal ideation, as opposed to flippant mentions of suicide and tweets of support or condolence

Related Work

- Despite growing work in the field, there is a very limited work which employs feature extraction coupled with feature selection methods for binary classifiers that separate text related to suicide from text that clearly indicates the author exhibiting suicidal intent
- There have been successful models used for sentence level classification (even those which employ evolutionary computation models), however, ones that are successful for being able to learn to separate suicidal ideation from depression as well as less worrying content such as reporting of a suicide, memorial,campaigning, and support. etc, require a greater analysis to select more specific features and methods to build an accurate and robust model
- The drastic impact that suicide has on surrounding community coupled with the lack of specific feature selection based methods to handle the high dimensional data used to train robust suicidal ideation classification models is the driving motivation for the work presented in this paper
- Positioning the work from a clinical perspective, existing suicide detection systems, prevention chat bots and social media based surveillance can benefit from the proposed methodology. Existing studies highlight the immense impact such automatic identification of concerning content can play in impacting millions of lives.

Methodology



The following hyper parameters were used for firefly algorithm:

Parameter	Value
Epoch	200
Agents	20
k	0.12
Light absorption α	1
Attractiveness β	0.2

- Binary Firefly Algorithm maximizes accuracy while minimizing number of features - used as wrapper over 4 classifiers using their feedback to tune feature selection

Results and Discussion

Three datasets were prepared for the task: **SCO** (Suicide-related Communication Only), **UNI** (SCO + tweets with no hashtag), **H** (Held-out test set).

Dataset SCO					
Algorithm	A	P	R	F1	α
Random Forest	78.27	80.21	77.36	78.76	0.0
SVM	75.21	73.21	72.43	72.81	0.0
LR	74.02	71.92	71.21	0.0	
XGBoost	78.91	79.53	81.29	80.13	0.0
RNN	77.31	73.12	75.62	75.01	-
LSTM	81.32	78.83	80.25	79.94	-
CNN-LSTM	83.01	82.47	84.34	83.57	-
BURNMULTI (*P. Burnap et al., 2017*)	82.46	83.83	82.94	83.41	44.6
Random Forest + Binary Firefly Algorithm	83.18	87.12	84.73	85.91	39.1
SVM + Binary Firefly Algorithm	82.01	81.92	79.23	80.94	40.3
LR + Binary Firefly Algorithm	80.43	75.29	77.41	76.82	41.9
XGBoost + Binary Firefly Algorithm	81.38	82.98	84.38	83.63	38.9

Dataset UNI					
Algorithm	A	P	R	F1	α
Random Forest	82.33	84.85	83.71	84.28	0.0
SVM	76.02	78.21	75.34	77.90	0.0
LR	74.35	71.44	73.25	72.59	0.0
XGBoost	79.23	81.52	84.13	82.91	0.0
RNN	71.24	73.12	68.42	70.23	-
LSTM	75.84	77.24	79.93	79.01	-
CNN-LSTM	80.97	83.49	84.11	83.92	-

Dataset UNI					
BURNMULTI	79.85	80.32	82.42	81.15	30.2
Random Forest + Binary Firefly Algorithm	88.82	89.21	87.44	88.32	33.7
SVM + Binary Firefly Algorithm	80.85	83.21	78.38	82.46	31.8
LR + Binary Firefly Algorithm	78.96	75.92	79.23	77.42	35.3
XGBoost + Binary Firefly Algorithm	83.48	82.98	85.54	84.11	32.9

RESULTS FOR DATASET H; TEST SET

Classifier trained on Dataset SCO					
	A	P	R	F1	α
Random Forest	69.63	75.31	68.19	71.57	0.0
Random Forest + Binary Firefly Algorithm	74.27	81.23	72.91	76.84	22.5
Random Forest + RFE	70.34	73.21	70.01	71.94	27.5
XGBoost	70.31	74.42	70.01	72.31	0.0
XGBoost + Binary Firefly Algorithm	73.13	80.42	73.51	76.62	23.1
XGBoost + RFE	71.26	74.93	70.35	72.74	30.3
CNN-LSTM	72.74	81.13	78.48	79.75	-
BURNMULTI	71.92	77.21	65.31	72.26	25.3
Classifier trained on Dataset UNI					
Random Forest	75.31	73.19	75.12	74.14	0.0
Random Forest + Binary Firefly Algorithm	78.93	79.31	80.03	79.66	26.7
Random Forest + RFE	76.08	77.83	78.32	78.12	41.3
XGBoost	74.38	72.93	73.49	73.13	0.0
XGBoost + Binary Firefly Algorithm	78.85	78.93	79.72	79.57	29.4
XGBoost + RFE	76.28	74.53	77.21	75.83	39.6
CNN-LSTM	77.63	80.13	78.37	79.03	-
BURNMULTI	75.69	75.27	76.73	75.98	24.1

Error Analysis

Some limitations and scope for improvement in the proposed methodology are:

- Tweets with multiple mood swings are difficult for the model and humans alike
- An inability to link contexts of multiple sentences and the lack of explicit suicidal ideation opposed to the suicidal language used for training causes misclassification of tweets e.g. *"I lost my baby. Signing off.."*
- Heavily weighted penalty function improves computation time and accuracy but loses rare features causing misclassification of subtle suicidal ideation
- The cumulative emoji sentiment feature may mislead the classifier in rare cases e.g. *"I should really kill myself today :) :(:) :(I can't anymore :P :("*

Conclusion

- The inclusion of feature selection via wrapper based Firefly algorithm to Random Forest classifiers for the identification of suicide ideation leads to significantly improved results
- A qualitative error analysis highlights the challenges and limitations associated with Swarm Intelligence based feature selection for suicide ideation detection