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Personalized k-fold Cross-validation Analysis with Transfer from phasic to tonic Pain Recognition with X-ITE Pain Database

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Automated Pain Recognition

- Enables reliable pain assessment for patients with cognitive and verbal impairments
- Ensures equal pain management to all patients
- Examples of previous pain recognition databases:
    - BioVid
    - SenseEmotion
    - UNBC-McMaster

X-ITE database

- Multiple pain models
- Different pain stimuli
    - Intensity
    - Duration

X-ITE database

- Heat
  - Phasic electro (5 seconds)
  - Tonic heat (60 seconds)
- Electro
  - Phasic heat (5 seconds)
  - Tonic electro (60 seconds)
- 3 intensity levels

Machine Learning

- Random Forest
- Dense Neural Network

Random Forest

Subset	Average Accuracy
Phasic electro	91.8%
Tonic electro	85.3%
Phasic heat	82.1%
Tonic heat	79.2%

Figure: Random Forest Scores

- *271 trees in the foreset and 861 maximum number of nodes for each tree. 10-fold Cross-validation was used to make sure each model was not over-fitting the data of each subset.
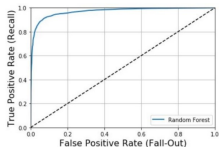
Random Forest Cross-validation

Figure: Phasic Electro
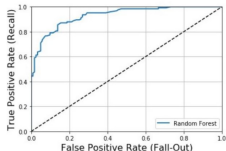Cross-Validation Results

Figure: Tonic Electro
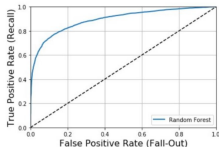Cross-Validation Results
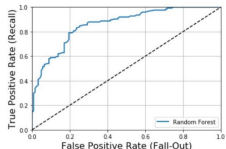

Figure: Phasic Heat
Cross-Validation Results

Figure: Tonic Heat
Cross-Validation Results

Personalized Random Forest Cross-validation

Subset	Average Accuracy
Phasic electro	92.0%
Tonic electro	87.3%
Phasic heat	82.0%
Tonic heat	77.1%

Figure: Personalized Random Forest Scores

Personalized Dense Neural Network

- one flatten input layer
- one hidden dense layer with:
    - 133 neurons
    - Scaled Exponential Linear Unit activation function
    - LeCun normal kernel initializer
- one output layer with sigmoid activation function
- AlphaDropout with a rate of 0.2 between each hidden layer
- first 217 features

Personalized Dense Neural Network

Subset	Average Accuracy
Phasic electro	90.1%
Tonic electro	81.5%
Phasic heat	82.5
Tonic heat	73.6

Figure: Personalized Dense neural network Scores
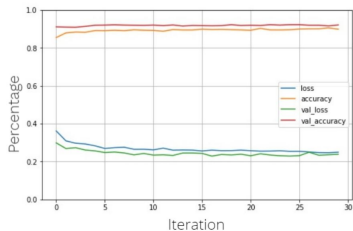
Transfer from Phasic to Tonic

Figure: Transfer Dense neural network Scores

Transfer from Phasic to Tonic

Model	Average Accuracy	Average Loss
Random Forest	62.3%	N/A
Dense Neural Network	65.2%	2.4328
Personalized Dense Neural Network	63.9%	2.4900

Figure: Phasic electro to tonic electro transfer accuracy

Discussion and Conclusion

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- Results

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- Results
- Comparison and Added Value

Discussion and Conclusion

- Results
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- Limitations

Discussion and Conclusion

- Results
- Comparison and Added Value
- Limitations
- Future Work

Questions?

References I

[1] Gruss, Sascha, et al. "Multi-modal signals for analyzing pain responses to thermal and electrical stimuli." JoVE (Journal of Visualized Experiments) 146 (2019): e59057.

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Database