

Quantum Long Short-Term Memory in Detecting Fatigue

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Motivation:

Detect fatigue early in running patterns to prevent musculoskeletal injury

- Develop robust machine learning (ML) algorithm
- Compare Classical & Quantum Long Short-Term Memory (LSTM) Neural Network (NN)

Data:

- Raw data collected on Inertial Measurement Units
- Feature extraction and selection from various auto machine learning algorithms

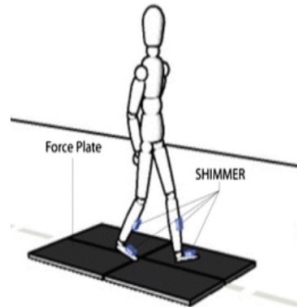


Fig 1: Graphic of methodology [1]

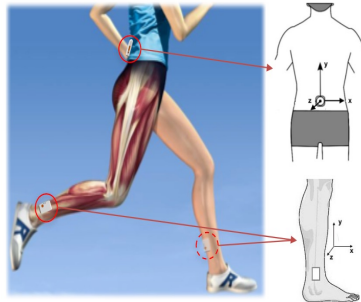


Fig 2: Shimmer3 IMU mounting locations [1]

Ongoing Research:

- Classical LSTM: Recurrent Neural Network (RNN)
 - Connections create cycles between nodes
- LSTM good for temporal and sequential data

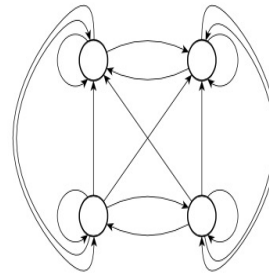


Fig 7: Fully recurrent neural network [4]

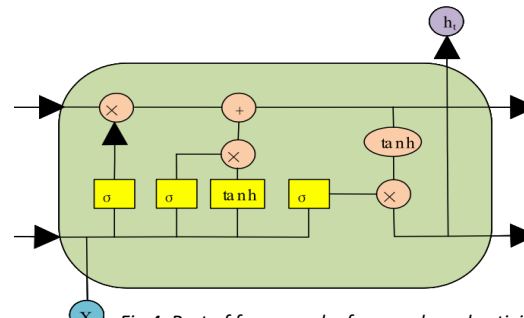


Fig 4: Part of framework of sensor-based activity recognition using LSTM [2].

Future Research:

- Quantum computing improves processing power
- Expand classical LSTM into quantum equivalent [4]
- Compare classical and quantum accuracy and speed

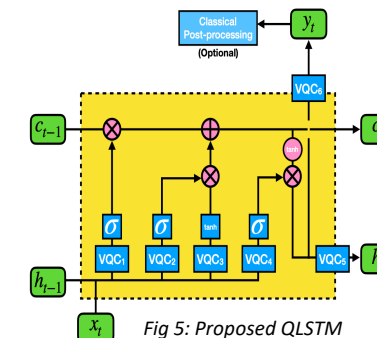


Fig 5: Proposed QLSTM architecture [3]

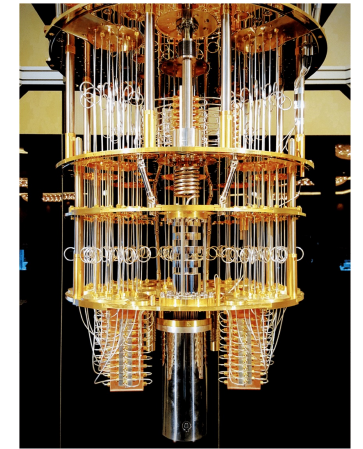


Fig 8: Quantum computer developed by IBM (photograph by Lars Plougmann via Flickr)

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- [1] C. Buckley, "Classifying Running Fatigue using Wearable Sensor Technology".
- [2] Y. Hu et al., "Harmonic Loss Function for Sensor-Based Human Activity Recognition Based on LSTM Recurrent Neural Networks," IEEE Access, vol. 8, pp. 135617–135627, 2020, doi: 10.1109/ACCESS.2020.3003162.
- [3] S. Y.-C. Chen, S. Yoo, and Y.-L. L. Fang, "Quantum Long Short-Term Memory," in ICASSP 2022 - 2022 IEEE ICASSP, Singapore, Singapore: IEEE, May 2022, pp. 8622–8626, doi: 10.1109/ICASSP43922.2022.9747369.
- [4] R. C. Staudemeyer and E. R. Morris, "Understanding LSTM -- a tutorial into Long Short-Term Memory Recurrent Neural Networks." arXiv, Sep. 12, 2019. Accessed: Jun. 12, 2023. [Online]. Available: <http://arxiv.org/abs/1909.09586>