Self-Supervised Transformers for Activity Classification using Ambient Sensors

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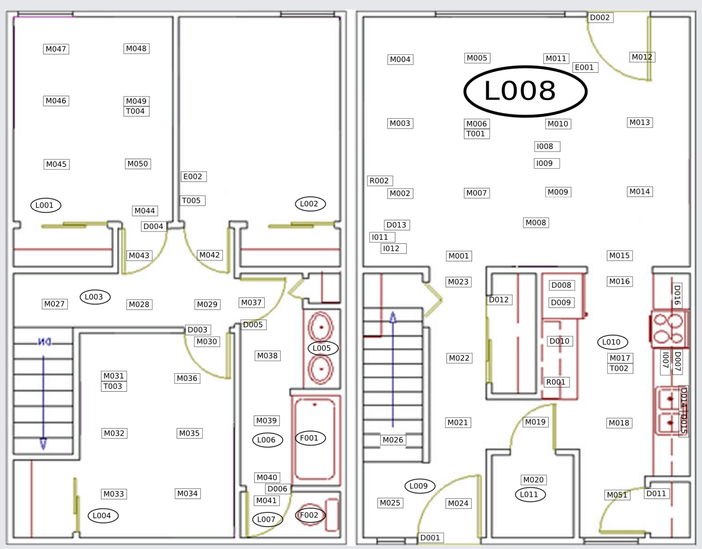
Background

- Analysis shows the number of people requiring senior case is increasing considerably fast.
- Multidisciplinary research is essential to support caregiving in a non-intrusive manner.
- We aim to use ambient sensor data for activity classification.

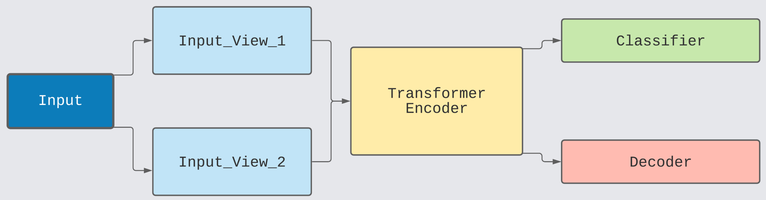
Ambient Sensor Environment

- Data is collected by researchers in a purpose made facility using ambient sensors, including binary PIR motion detectors and utilities consumption.
- Activities are performed by a single candidate, specifically day to day tasks like cooking and washing.
- Activities are recorded by researchers for data annotation, used in this context for classification.



Self-Supervised Approach

- Self-supervised learning uses a contrastive loss to determine whether two samples are different views from the same sample or from different samples.
- Instead of using contrastive loss as empirical self-supervised models, we propose designing the model as a hybrid autoencoder and binary classifier model.



- In self-supervised learning a batch is traditionally made up of two different views x^i and x^j of the same input x, thus resulting in $2N$ data points. Instead of using x^i and x^j as the target reconstruction, we use x.
- Let L_a be an l_2 distance between the input x and the reconstruction y, let L_c be a binary classification loss, then the loss of the proposed model is formally defined as $L = \gamma * La + Lc$ where γ is a scale factor and $0 \leq \gamma \leq$.
- The output of the encoder is randomised so that half is fed to the classifier and the other half is randomised, then concatenated and fed as a single feature vector.
- By training using a classification loss we allow the model to learn more sparse representations useful for classification, which is our primary goal.
- This approach can also be applied to other models like CNN.

Social Impact

- In partnership with private care facilities and researchers focussing on environment analysis in senior case, we aim to support the drive to improve dementia care and applied research in this work.
- The deployment of novel systems to provide detailed analysis to caregivers is an output of this research project.
- By recognising transitions in behaviour, carers and medical professionals can detect signs of illness, enabling automation processes for informing carers and improving the level of care being provided.

Future Work

- We aim to extend this work to perform prediction using larger unsupervised datasets to identify and prevent accidents and incidents in senior care facilities.
- This includes the consideration of clustering events and prioritising activities in a temporal hybrid model.

Collaborating Organisations