

The Dark-Machines Group

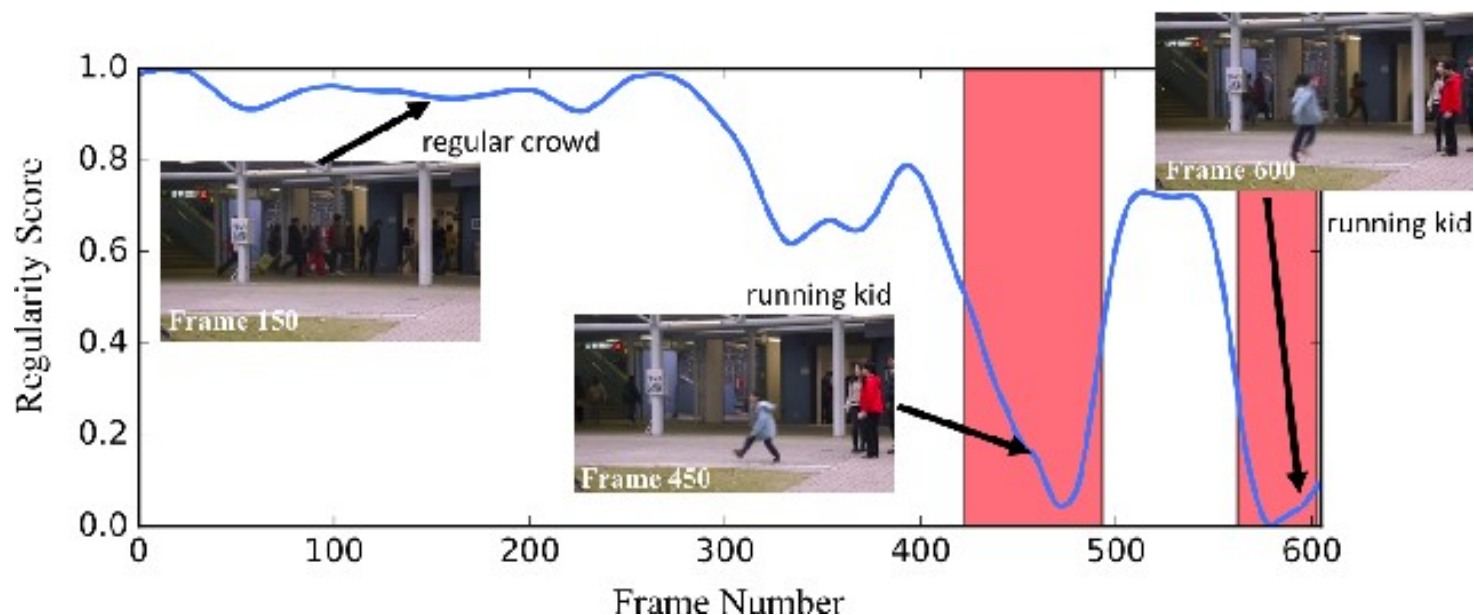
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An Overview

- **A group of academics and PhD students working on Dark Matter detection using machine learning**
- **Create and curate datasets in order to model detector events**
- **Many different projects including:**
 - Generative models as event simulators
 - Particle track reconstruction
 - Anomaly detection (AD)
- **Queen Mary contributes most with AD**

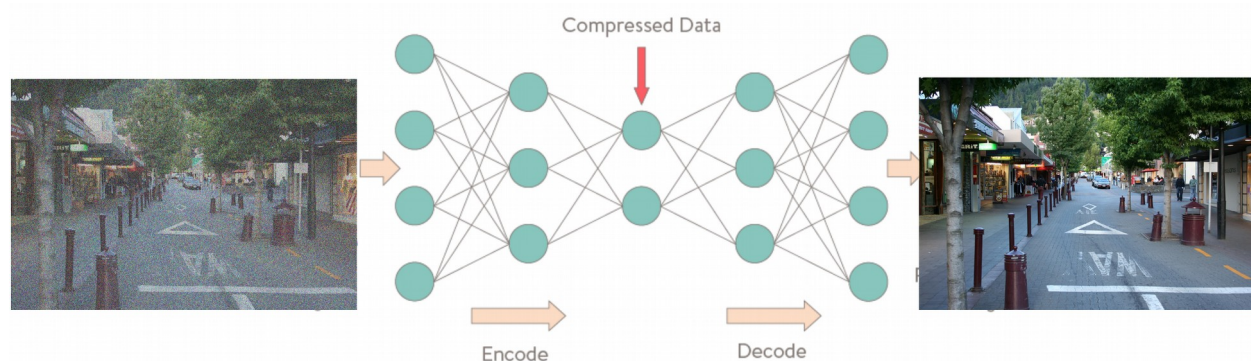
Anomaly Detection

- **Anomaly detection is used when looking for events or data that differ significantly from the general distribution**
- **This is usually done using an Autoencoder (AE)**
 - Specifically at QM, a Variational Autoencoder (VAE)



Autoencoder

- Reduce data dimensions by learning how to ignore noise in data
- Comprised of an encoder, bottleneck, decoder and some reconstruction loss function
- Similar to Neural Nets in structure and training method (back-propagation)
- Can be used for AD, data compression and denoising images



VAEs for Anomaly Detection

- **Train the model (unsupervised) on the background data without including any signal**
- **Results in our model being good at recognising background but will report a large loss when fed signal data, hence an anomaly**
- **VAEs are generally better for AD because they are more focused on the relationship between datasets, rather than pure decon- and reconstruction**

The Future

- **Hackathon!**
- **More study into anomaly detection methods such as normalizing flows**
- **Finding Dark Matter...maybe**

<https://darkmachines.org/>

