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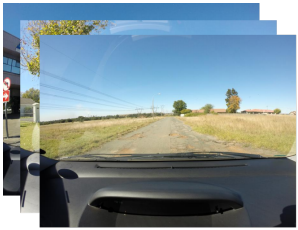
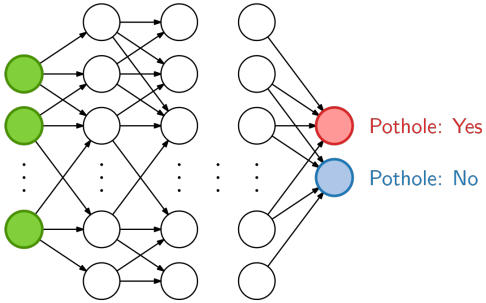
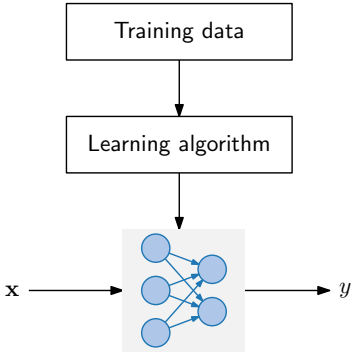
Machine learning with limited resources

Herman Kamper, E&E Engineering

What is machine learning?



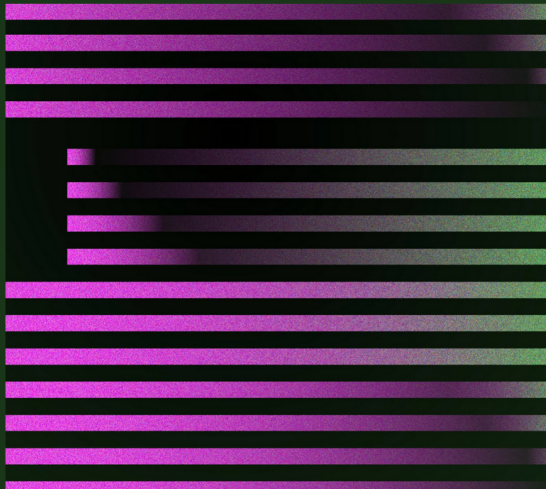




Introducing ChatGPT

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests.

Try ChatGPT ↗ Read about ChatGPT Plus



Larger and larger models

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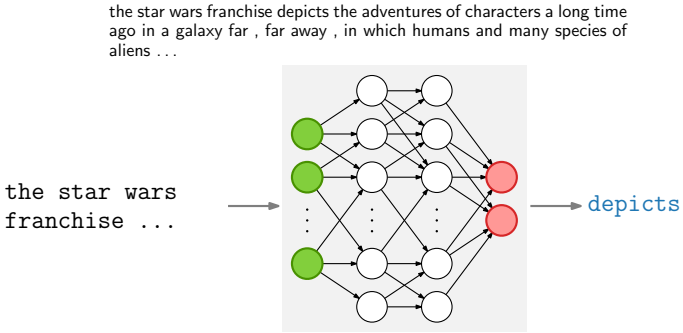
These models are still trained to map inputs to outputs:

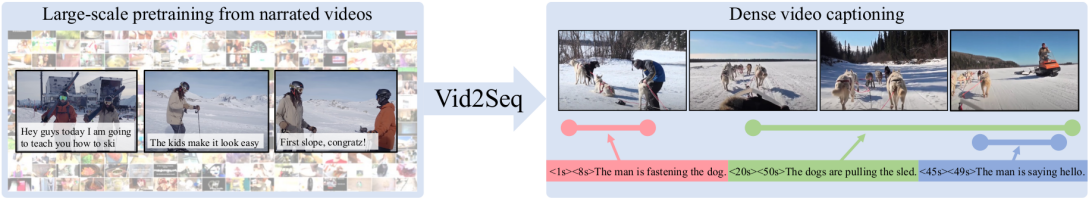


But the models are exploding in size:

- GPT-4 has a trillion parameters

Large models in several modalities

- Text processing: ChatGPT, GPT-3.5, GPT4, LLaMA, PaLM
- Speech processing: Whisper, WavLM, HuBERT
- Computer vision: ResNet, CLIP, Dall-E
- Video: Vid2Seq



Machine learning with limited resources

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I want to use machine learning to solve task X. This task isn't directly solved by one of the available models.

Machine learning with limited resources

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Two resource problems:

1. My **computational resources** aren't big enough.
   (You might have a big enough machine/GPU to load an existing model, but the machine will probably not be big enough to train the model.)
2. I don't have enough **labelled training data** for the problem I want to solve.
   (GPT-3 was trained on roughly 500B tokens.)

Machine learning with limited resources

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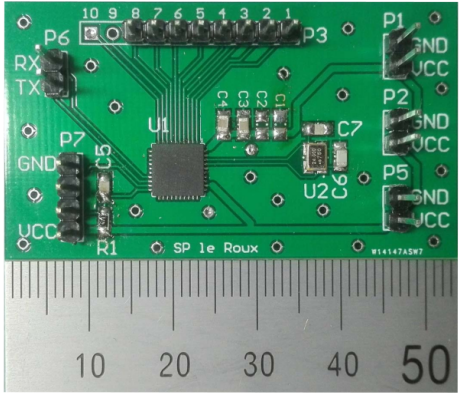
This talk will look at a number of examples of how we are tackling these two problems at Stellenbosch University.


(a)


(b)


10 9 8 7 6 5 4 3 2 1
P3
P6
RX
TX
P7
GND
VCC
U1
C4
C3
C2
C1
C7
C5
C6
U2
R1
SP le Roux
P1
P2
P5
GND
VCC
10
20
30
40
50

Machine learning with limited compute

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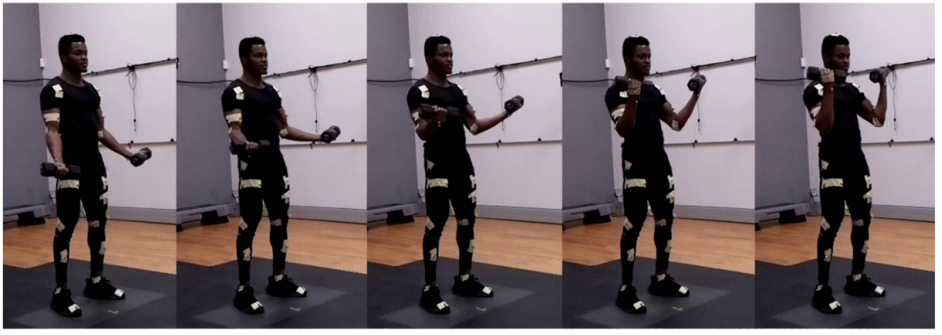
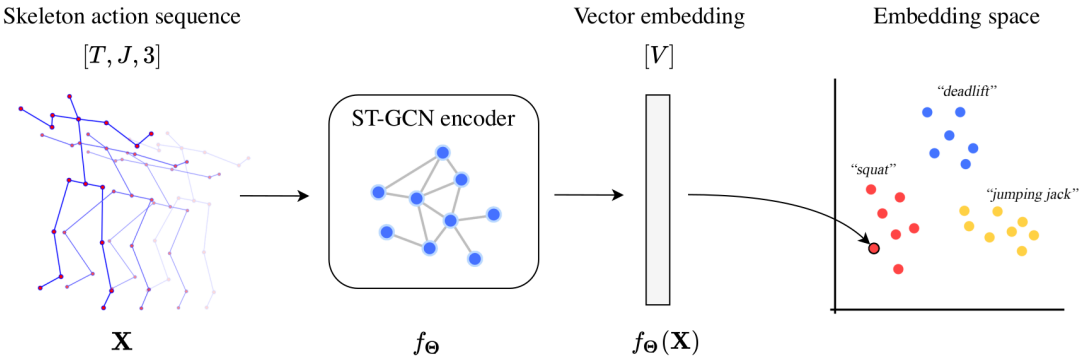
THE ENERGY CONSUMED DURING THE CALCULATION OF INDIVIDUAL FEATURES ON THE MSP430FR5739 WITH $V_{cc} = 2$V AND $f = 23.722$MHz

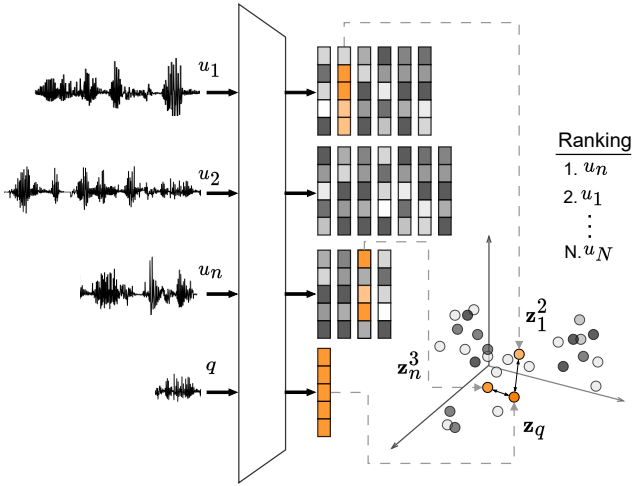
Feature	Time (ms)	Clock Cycles	Current (mA)	E_f (µJ)
Max	0.142	3377	2.129	0.606
Min	0.147	3496	2.068	0.609
Mean	1.322	31368	2.143	5.666
Mean distance between axes	1.960	46501	2.077	8.141
Standard deviation	8.254	195792	2.005	33.093
Variance	16.518	391844	2.006	66.274
Skewness	19.365	459381	1.938	75.063
Kurtosis	20.927	496435	1.840	77.011
Energy in 1 Hz bins	28.118	667021	1.793	100.818
Energy in the whole signal	29.170	691977	1.803	105.175
Pairwise correlation between axes	26.086	618818	2.082	108.617
Average signal magnitude	34.989	830016	2.094	146.534
Spectral entropy	58.287	1382696	1.958	228.287



Machine learning with limited data



Hate-speech detection in radio broadcasts



Limited compute and limited data

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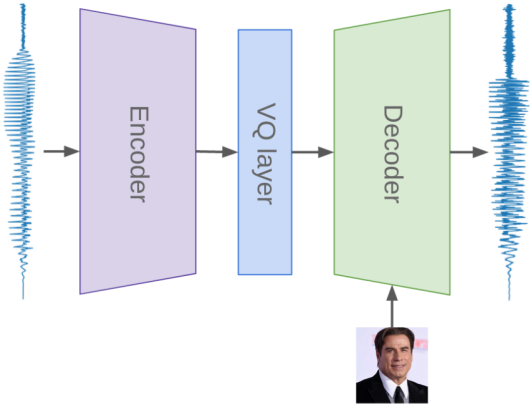
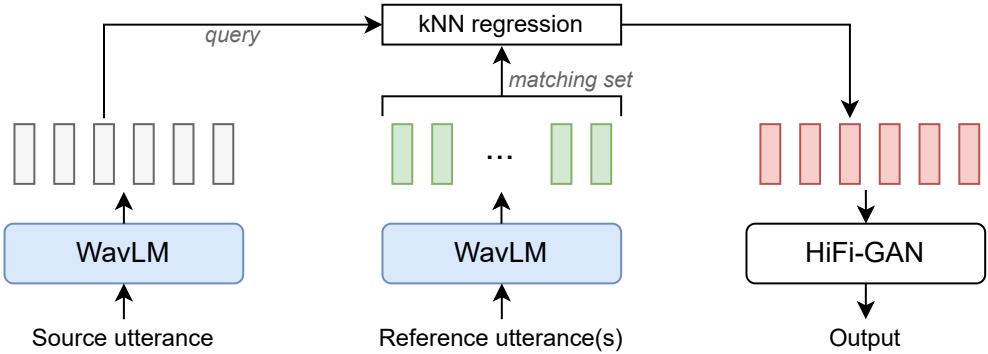


Limited compute and limited data



https://interspeech2023blind.github.io/knn-vc/

Structured MSc in machine learning and AI

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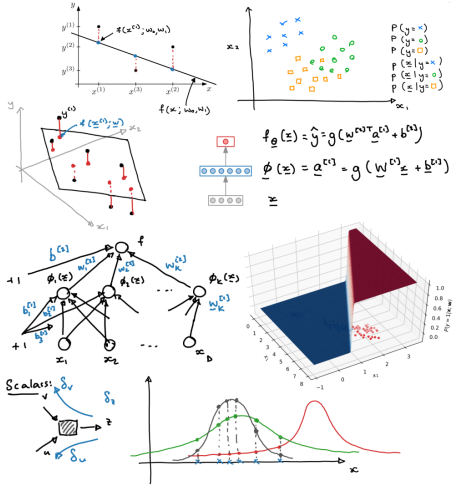
- Mathematics for ML
- Foundations of Deep Learning
- Probabilistic Modelling and Reasoning
- Applied ML at Scale
- Computer Vision
- Natural Language Processing
- Reinforcement Learning
- Sequence Modelling
- Advanced Probabilistic Modelling
- Optimisation for ML
- Monte Carlo Methods
- AI and the Brain
- Advanced Topics in ML and AI
- Research project

https://mlai.sun.ac.za/

IntroML: Short-course

- 2/3 days in-person in Stellenbosch
- Will cover the fundamentals
- Linear regression to neural networks
- Machine learning methodology (train, val, test)
- All practicals in Python
- Planned for spring 2023



Expression of interest: `kamperh@sun.ac.za`

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