Building Machine Learning Systems on Microsoft Azure Cloud Virtual Machines

Cheng-Hao Cai, Jing Sun, Gillian Dobbie

School of Computer Science
University of Auckland
chenghao.cai@auckland.ac.nz

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Introduction

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Motivation

▶ Machine Learning (ML) techniques are widely used in industry.

▶ Popular ML techniques include:

  ➢ Neural Networks

  ➢ Decision Trees

  ➢ Support Vector Machines

  ➢ Hidden Markov Models

  ➢ etc.

▶ ML applications: voice recognition, face recognition, machine translation, weather prediction, etc.

Motivation

► Most ML techniques require very powerful computers to run.

► For example, to build a voice recognition system, you may need a neural network with thousands of neurons and millions of neural connections.

► Using a computer with hundreds of CPUs, you still need several days to train the neural network.

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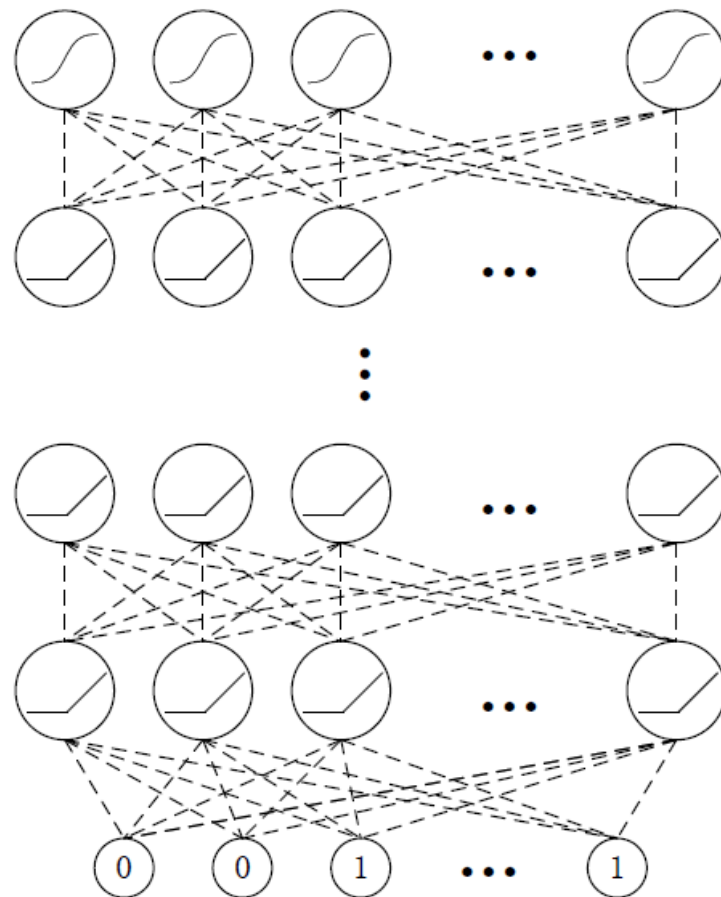
Research Questions

- ► How to build large ML systems?

- ► How to use large ML models when hardware resources are limited?

- ► Applications of ML models?
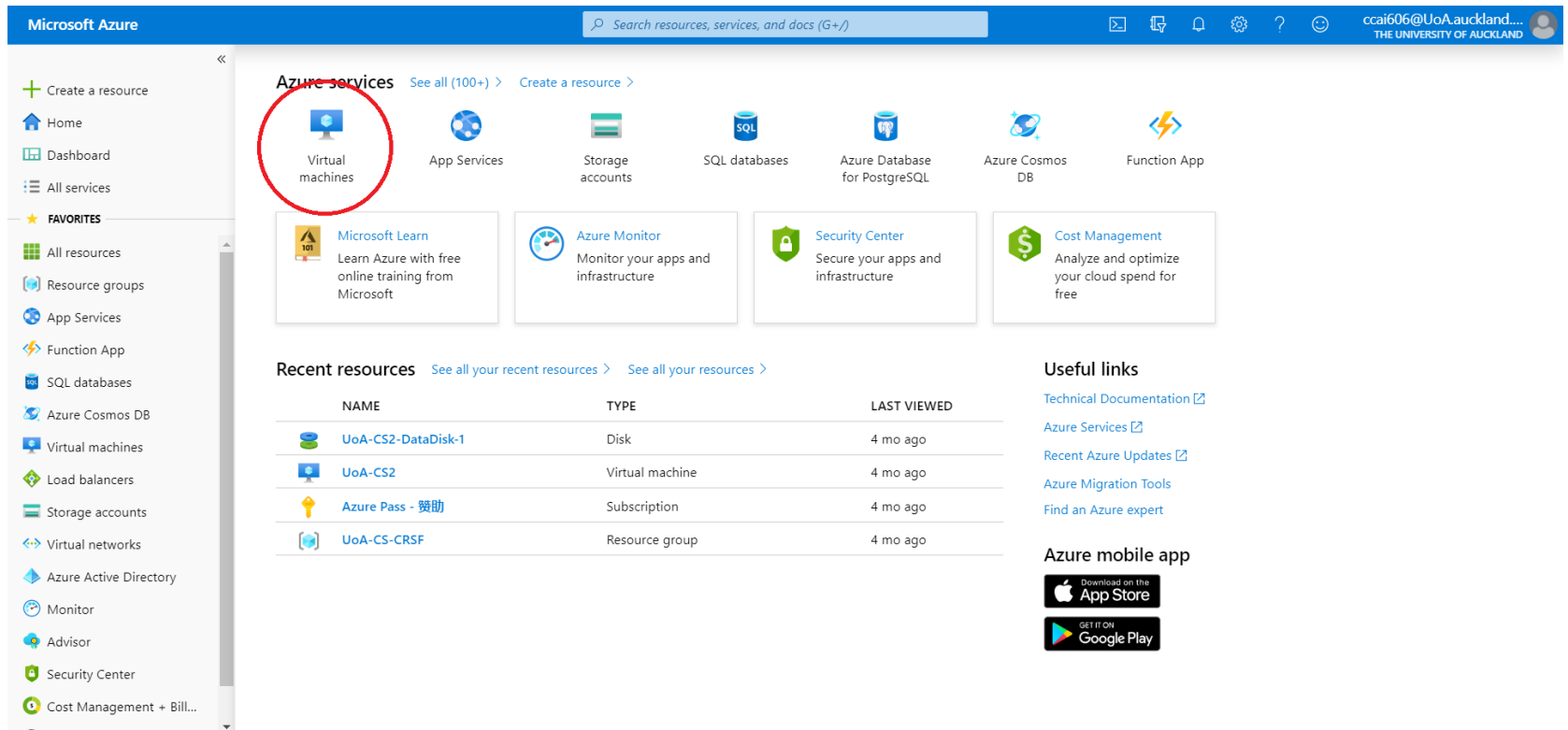
Our Solutions

- ► We run large ML models on Microsoft Azure Virtual Machines (VM).

- ► We build ML-based voice recognition systems.

- ► We apply ML techniques to automatic program repair.

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Microsoft Azure Cloud VMs

Microsoft Azure Cloud VMs

► In Microsoft Azure Cloud, VMs can be set up:

Microsoft Azure Cloud VMs

► Azure VMs include different operating systems:

Microsoft Azure Cloud VMs

► Configurations of CPUs and memory can be changed:

Microsoft Azure Cloud VMs

► Extra disk spaces can be added into VMs:

Microsoft Azure Cloud VMs

► For each Azure VM, an IP of remote access is automatically created:

Project 1
Automatic Voice Recognition

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Automatic Speech Recognition

► Automatic Speech Recognition (ASR) is the use of machines to convert human speeches to texts.

► ASR has been used in many applications:

   ➢ Siri

   ➢ Amazon Alexa

   ➢ automatic subtitle generator

   ➢ etc.

► Problems with ASR: accents, background noise, professional words, etc.

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Voice Recognition System with the Kaldi toolkit

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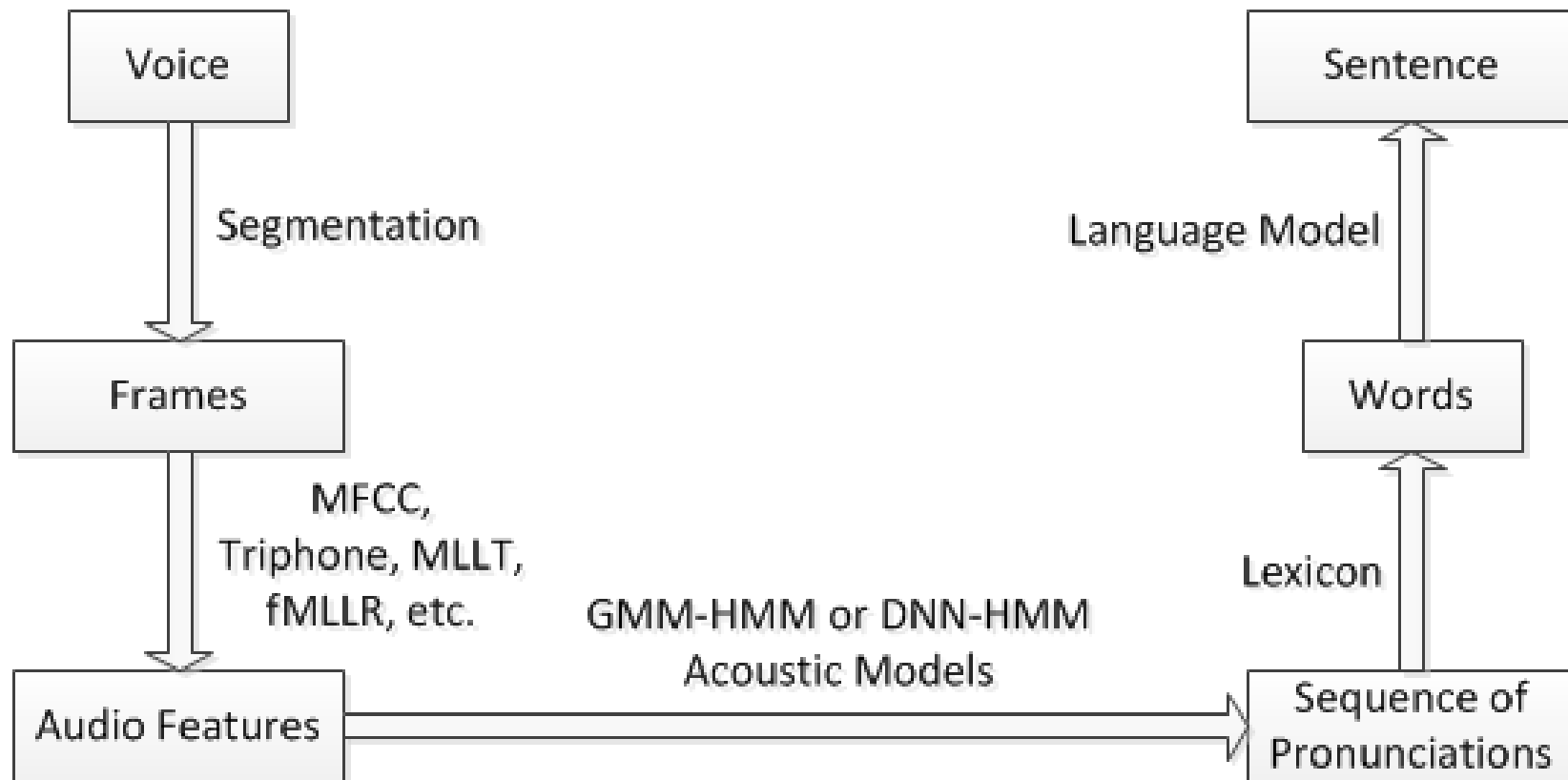
Example Results - Noisy Test Data

Kaldi's Output: "DENOUNCE STANDING AND FEATURE HAS BEEN TANTALIZED IT'S ALWAYS BEEN IMPORTANT HOW PEOPLE IT IS A TROUBLE I CALMLY AND SEVERAL KINDS OF OCCUPIED THE PEACH IT IS IMPORTANT TO ALL OF THEM EVERY TROUBLE GROUP WITHIN THIS ROCK TO BELIEVE THAT IT IS THAT TAKEN PLACE COULD DO SO BUT THERE WHILE HE CUT TOO HAS BEEN USED TO KILOMETER WALKING TRACK WHICH ZIGZAGS TO THE PEAK AS POLARIZED THE COMMUNITY AND THOSE WHO WANT TO GET GOOD AND THOSE DEFIANTLY AND PACED A A LAUGHS A GREEDY RANGE IS ONE OF THE HORSE BAYS BEST KNOWN MINORIES LAST YEAR THE VINEYARD SPENT THREE HUNDRED THOUSAND DOLLARS CREATING THE TRACK ON NEIGHBOURING LAND OLD CONSENT FROM THE HASTINGS DISTRICT COUNSEL TO CUT THE FACE OF THE MOTHER BUT EVERY LETTER THAT HE WE PAULLINUS SAYS NO ONE HAD BOTHERED CONSULTING WITH LOCAL MONEY"

Standard Answer: "DEEMED AN OUTSTANDING LAND FEATURE HAS BEEN VANDALISED IT S ALWAYS BEEN IMPORTANT TO OUR PEOPLE IT IS A TRIBAL ICON AND SEVERAL TRIBES HAVE OCCUPIED THE PEAK AND IT IS IMPORTANT TO ALL OF THEM EVERY TRIBAL GROUP WITHIN THIS ROHE BELIEVES THAT IT IS A TAPU PLACE IT IS SACRED BUT THEIR WAHI TAPU HAS A NEW KM WALKING TRACK WHICH ZIGZAGS TO THE PEAK IT HAS POLARISED THE COMMUNITY THOSE WHO WANT TO KEEP IT AND THOSE DEFIANTLY OPPOSED MAN TIKA TONU ALL U E TIKA TONU U E TIKA TONU ATU KI A KOE E TAMA CRAGGY RANGE IS ONE OF THE HAWKE S BAY S BEST KNOWN WINERIES LAST YEAR THE VINEYARD SPENT   CREATING THE TRACK ON NEIGHBOURING LAND IT SOUGHT CONSENT FROM THE HASTINGS DISTRICT COUNCIL TO CARVE THE FACE OF TE MATA BUT IWI LEADER NGAHIWI TOMOANA SAYS NO ONE BOTHERED CONSULTING WITH LOCAL MAORI"

Natural Voice vs Audio Book Voice

WERs of the **MDL-NZ-70** Model
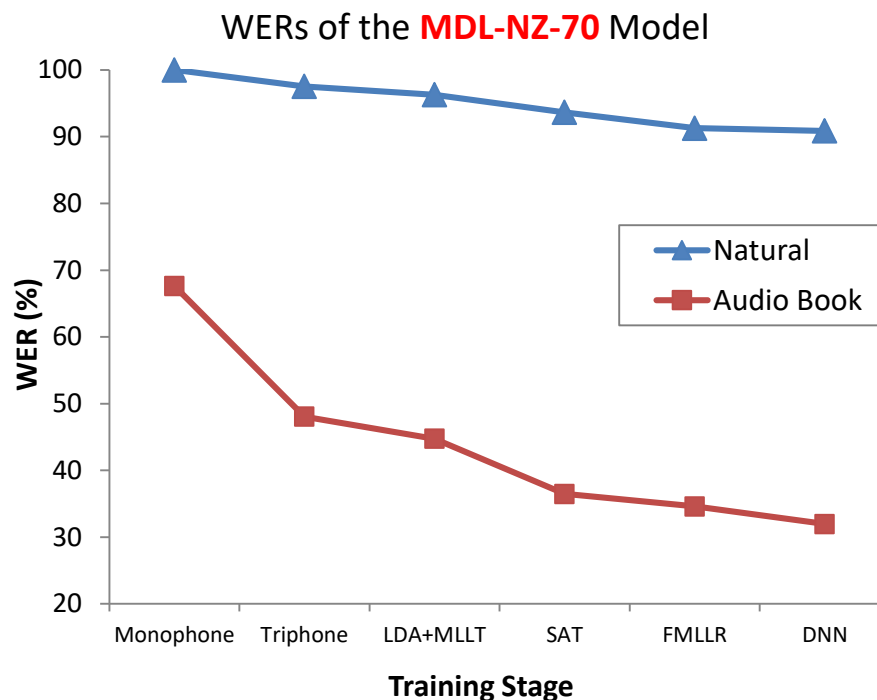
▶ Natural --- The test set of natural voice of movies, games, etc.

▶ Audio Book --- The test set of audio book voice from LibriSpeech.

▶ Finding: Natural voice is difficult to be recognised.

Project 2
Automated Program Repair

Automated Program Repair

► Software engineers write computer programs every day.

► After writing programs, engineers are responsible for repairing faulty programs.

► The manual repair of faulty programs often reduces the efficiency of software development.

► Can we automate program repair processes?

Automated Program Repair

► The first step of automated program repair is to make computers understand how programs run.

► State transitions can represent program running processes.

► For example, if we have a program "inc1": PRE x > 0 & x < 6 THEN x := x + 1 END. Valid executions and invalid executions are shown in the following state diagram:
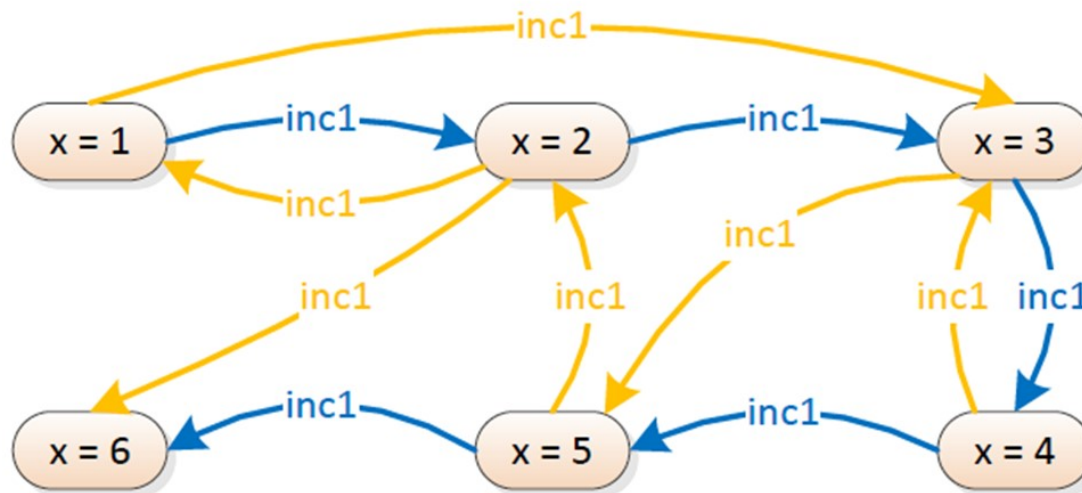
► ML models can learn to identify valid executions and invalid executions.

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Automated Program Repair

► Results of state transition learning:

Subject	# Examples	ROC-AUC				
		BNB	*LR*	*SVM*	*RF*	*Silas*
M01	24530	0.615	0.619	1.000	1.000	1.000
M02	22500	0.722	0.736	0.984	0.996	0.990
M03	4608	0.729	0.691	0.965	1.000	1.000
M04	10202	0.660	0.668	0.936	1.000	1.000
M05	15360	0.640	0.645	0.997	0.999	0.999
M06	14160	0.584	0.593	0.999	0.999	0.999
M07	4550	0.663	0.654	0.725	0.965	0.995
M08	2024	0.673	0.709	0.905	0.998	0.988
M09	14580	0.536	0.539	0.994	0.999	0.999
M10	6592	0.625	0.636	0.993	1.000	0.998
M11	15860	0.848	0.868	0.930	0.997	0.995
M12	20976	0.566	0.563	0.996	1.000	1.000
M13	10210	0.536	0.532	0.621	0.999	1.000
M14	11918	0.802	0.814	0.997	1.000	0.997
M15	1944	0.777	0.837	0.844	0.999	0.988
M16	2456	0.642	0.666	0.850	0.999	0.999
M17	9056	0.679	0.735	0.956	0.998	0.996
M18	51384	0.783	0.822	0.995	1.000	0.998
Average	242910	0.682	0.697	0.962	**0.998**	**0.998**
Classification Accuracy		0.636	0.652	0.902	**0.981**	**0.983**

► M01 - 18: programs

► ROC-AUC: a degree of ML model performance

► BNB - Bernoulli naive Bayes classifiers,

► LR - logistic regression classifiers

► SVM - support vector machines

► RF - random forests (normal)

► Silas - random forests (high performance)

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Conclusion

► ML techniques require considerable computational resources to run.

► We used Microsoft Azure Cloud VMs to build ML systems.

► We built an automatic voice recognition system on an Azure VM.

► We built an ML-based automated program repair system on an Azure VM.

► In the future, we look forward to using better ML techniques to improve the two projects.

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