

Deep Learning

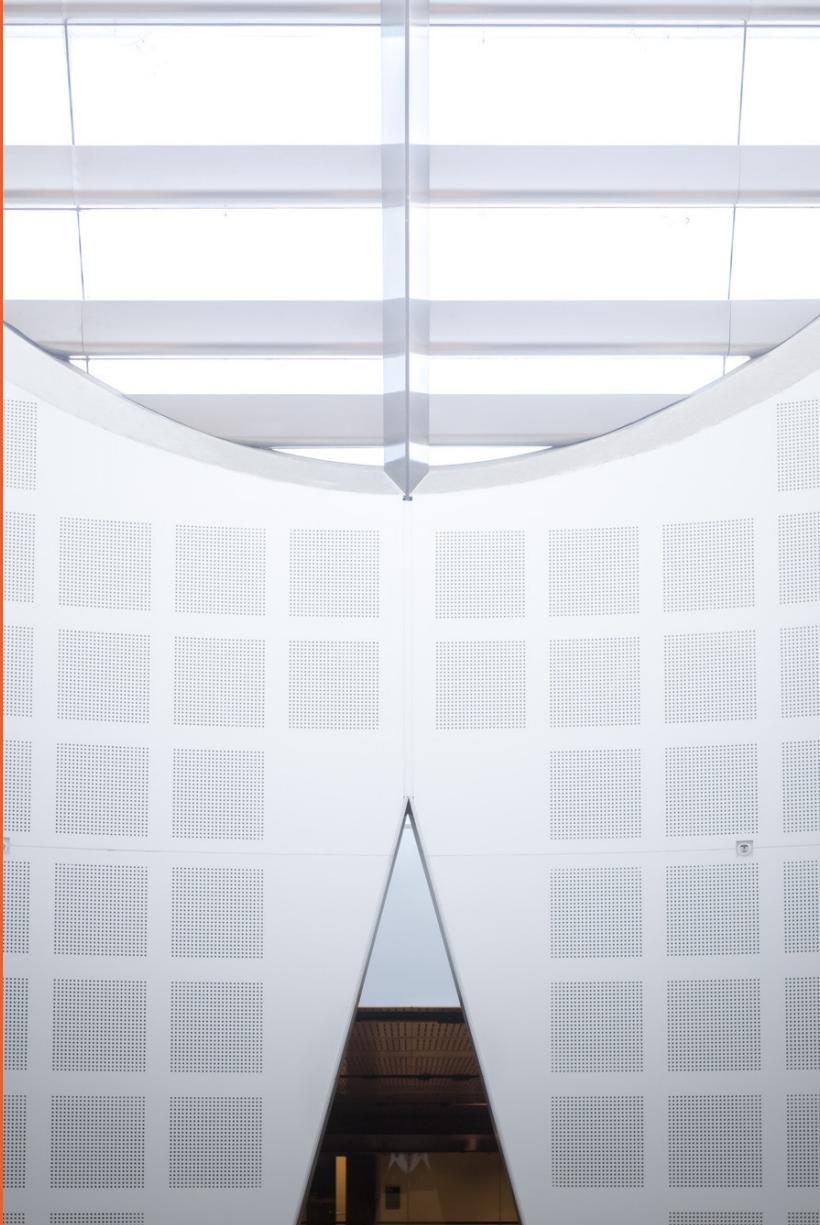
COMP 5329

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School of Computer Science



THE UNIVERSITY OF
SYDNEY



AI's Big Breakthroughs in 2021

OpenAI's DALL·E

- A 12-billion parameter version of GPT-3 trained to generate images from text descriptions.

TEXT PROMPT an illustration of a baby daikon radish in a tutu walking a dog

AI-GENERATED IMAGES



Edit prompt or view more images+

TEXT PROMPT an armchair in the shape of an avocado....

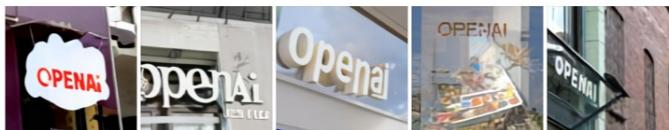
AI-GENERATED IMAGES



Edit prompt or view more images+

TEXT PROMPT a store front that has the word 'openai' written on it....

AI-GENERATED IMAGES



Edit prompt or view more images+

It uses a dataset of text-image pairs and is a transformer language model that receives both the text and the image as a single stream of data containing up to 1280 tokens. It can render an image from scratch and also alter aspects of an image using text prompts.

AI's Big Breakthroughs in 2021

Meta's SEER (SElf-supERvised)

- A billion-parameter self-supervised computer vision model that can learn from any random group of images on the internet.



After pretraining on a billion random, unlabeled and uncurated public Instagram images, SEER outperformed the most advanced, state-of-the-art self-supervised systems, reaching 84.2 percent top-1 accuracy on ImageNet. SEER also outperformed state-of-the-art supervised models on downstream tasks, including low-shot, object detection, segmentation, and image classification.

AI's Big Breakthroughs in 2021

GitHub Copilot

OpenAI and Microsoft's GitHub Copilot is an AI pair programmer for writing better code. Based on OpenAI Codex, the new AI system is trained on open-source code, contextualising a situation using docstrings, function names, preceding code and comments to determine and generate the most relevant code.

You can describe a function in plain English in a comment and then convert it to actual code.

Get suggestions for whole lines or entire functions right inside your editor.

**Artificial Intelligence:
Human Intelligence
Exhibited by Machines.**

Artificial Intelligence

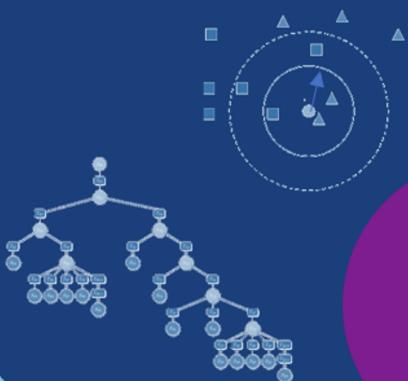
Logical Systems

$$\begin{aligned}A \vee B &= \neg(\neg A \wedge \neg B) \\A \Rightarrow B &= \neg A \vee B \\&= \neg(A \wedge \neg B) \\A \oplus B &= (A \wedge \neg B) \vee (\neg A \wedge B) \\&= \neg[(A \wedge \neg B) \wedge \neg(\neg A \wedge B)] \\A \equiv B &= (A \wedge B) \vee (\neg A \wedge \neg B) \\&= \neg[(A \wedge B) \wedge \neg(\neg A \wedge \neg B)]\end{aligned}$$

Knowledge-Based Systems



Machine Learning



Deep Learning



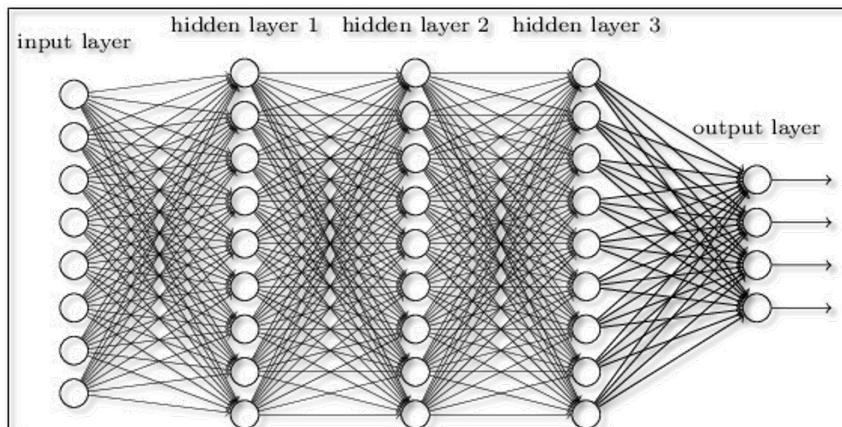
**Machine Learning :
An Approach to
Achieve Artificial
Intelligence**

**Deep Learning: A
Technique for
Implementing Machine
Learning**

What is Deep Learning?

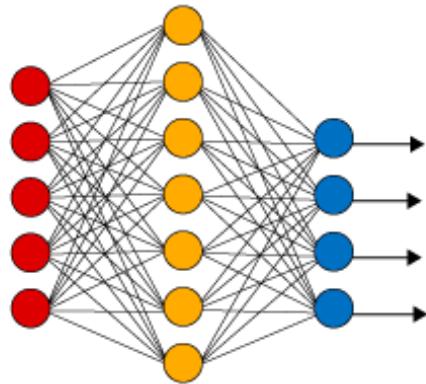
The short answers

1. ‘Deep Learning’ means using a **neural network** with **several layers of nodes** between input and output
2. the series of layers between input & output to do feature identification and processing in a series of stages, just as our brains seem to.

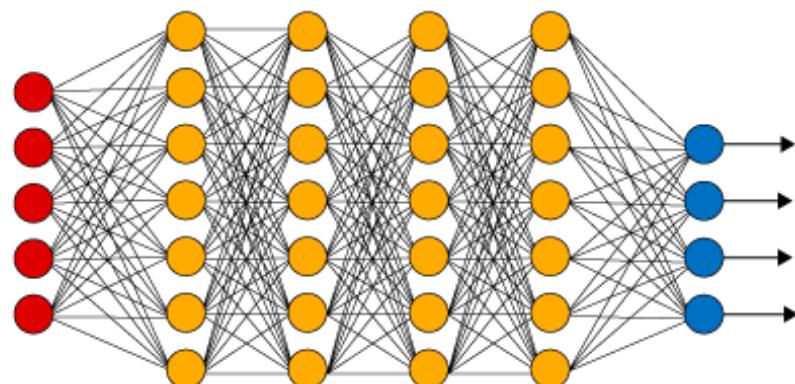


What is Deep Learning?

Simple Neural Network



Deep Learning Neural Network



● Input Layer

● Hidden Layer

● Output Layer

We have always had good algorithms for learning the weights in networks with 1 hidden layer;

But these algorithms are not good at learning the weights for networks with more hidden layers

Image credit to becominghuman.ai

What to Learn?

<https://canvas.sydney.edu.au/courses/39700/pages/course-contents>

- 1. Introduction**
- 2. Multilayer Neural Networks**
- 3. Optimization for Deep Models**
- 4. Regularization for Deep Models**
- 5. Convolutional Neural Networks**
- 6. Neural Network Architectures**
- 7. Recurrent Neural Networks**
- 8. Holiday**
- 9. Transformer Neural Networks**
- 10. Graph Convolutional Networks**
- 11. Deep Learning Applications**
- 12. Deep Generation Models**
- 13. Review**

Online Lectures and Tutorials

- **Lecture:** Friday 18:00 – 20:00
- **Tutorial:** Online tutorials and in-person tutorials (*from the 2nd week*)

zoom

Your current Time Zone and Language are (GMT+11:00) Canberra, Melbourne, Sydney, English ↗

All My Zoom Meetings/Recordings

Upcoming Meetings	Previous Meetings	Personal Meeting Room	Cloud Recordings
<input type="checkbox"/> Show my course meetings only			
Start Time			
Tomorrow (Recurring) 6:00 PM	COMP5329 Deep Learning	880 3469 1513	<button>Start</button>
Thu, Mar 3 (Recurring) 5:00 PM	COMP5329 Deep Learning - TUT 04 Host Gary Jiajun Huang	853 7647 7628	<button>Join</button>
Thu, Mar 3 (Recurring) 5:00 PM	COMP5329 Deep Learning - TUT 03 Host Gary Jiajun Huang	861 4254 0406	<button>Join</button>
Thu, Mar 3 (Recurring) 5:00 PM	COMP5329 Deep Learning - TUT 02 Host Gary Jiajun Huang	869 8193 6887	<button>Join</button>

In-person tutorials:
University of Sydney
Business School. ABS
Seminar Room 1080,
1100, 1140, 2250,
3230

- **Teaching Assistant:** Mr Gary Jiajun Huang <jhua7177@uni.sydney.edu.au>

Ed Discussion

<https://edstem.org/au/courses/7706/discussion/>

ed THE UNIVERSITY OF SYDNEY COMP5329 – Discussion

New Thread

Search

Public

Welcome to COMP5329 and First Q&A

General Gary Huang STAFF 12d 28 23

This Week

Pre-trained models

Lectures Yansen Araujo Da Fonseca 15h 2 (1 new)

11 others online

1 COURSES COMP5329 Final Exam Review 2

CATEGORIES General Lectures Labs Quizzes Assignments Social

12 days ago in General

Gary Huang STAFF 12 days ago in General

UNPIN STAR WATCH VIEWS 702

Welcome to COMP5329 and First Q&A #1

Dear Students

Welcome to COMP5329 - Deep Learning. I hope you can enjoy this course and learn a lot about Deep learning.

We're using Ed Discussion for class Q&A.

This is the best place to ask questions about the course, whether curricular or administrative. You will get faster answers here from staff and peers than through email.

Here are some tips:

- Search before you post
- Heart questions and answers you find useful
- Answer questions you feel confident answering
- Share interesting course related content with staff and peers

The following section is the first Q&A, and feel free to ask more in the comment.

[Regarding Lectures]

- **Are Week 1 contents examinable?**
No. The topics of Week 1 show you how researches in deep learning look like. All the topics are published in the top-ranking conference. You require enough deep learning background to understand them (like at the end of this semester!).
- **Will the lecture recordings be on canvas?**
Yes, we will provide the recordings for all lecture and tutorials.
Tip: click the cloud recording option in the zoom page to find the recordings.

[Regarding Assessments]

COMP5329 Reference book

Goodfellow I J, Bengio Y, Courville A, *Deep Learning*.
MIT Press, 2016.

LeCun Y, Bengio Y, Hinton G. Deep learning[J]. nature, 2015, 521(7553): 436-444.

- **We will use PyTorch in labs.** PyTorch documentation can be found at <https://pytorch.org/docs/stable/index.html>

COMP5329 Reference book

Applied Math and Machine Learning Basics:

2 Linear Algebra	27		
2.1 Scalars, Vectors, Matrices and Tensors	27	3.6 The Chain Rule of Conditional Probabilities	52
2.2 Multiplying Matrices and Vectors	30	3.7 Independence and Conditional Independence	52
2.3 Identity and Inverse Matrices	31	3.8 Expectation, Variance, and Covariance	53
2.4 Linear Dependence, Span, and Rank	32	3.9 Information Theory	54
2.5 Norms	34	3.10 Common Probability Distributions	57
2.6 Special Kinds of Matrices and Vectors	35	3.11 Useful Properties of Common Functions	62
2.7 Eigendecomposition	37	3.12 Bayes' Rule	64
2.8 Singular Value Decomposition	39	3.13 Technical Details of Continuous Variables	64
2.9 The Moore-Penrose Pseudoinverse	40	3.14 Structured Probabilistic Models	65
2.10 The Trace Operator	41	3.15 Example: Naive Bayes	68
2.11 Determinant	42		
2.12 Example: Principal Components Analysis	42	4 Numerical Computation	74
3 Probability and Information Theory	46	4.1 Overflow and Underflow	74
3.1 Why Probability?	46	4.2 Poor Conditioning	75
3.2 Random Variables	48	4.3 Gradient-Based Optimization	76
3.3 Probability Distributions	49	4.4 Constrained Optimization	85
3.4 Marginal Probability	51	4.5 Example: Linear Least Squares	87
3.5 Conditional Probability	51		
		5 Machine Learning Basics	89
		5.1 Learning Algorithms	89
		5.2 Example: Linear Regression	97
		5.3 Generalization, Capacity, Overfitting and Underfitting	99
		5.4 The No Free Lunch Theorem	104
		5.5 Regularization	106
		5.6 Hyperparameters, Validation Sets and Cross-Validation	108
		5.7 Estimators, Bias, and Variance	110
		5.8 Maximum Likelihood Estimation	118
		5.9 Bayesian Statistics and Prior Probability Distributions	121
		5.10 Supervised Learning	128
		5.11 Unsupervised Learning	131
		5.12 Weakly Supervised Learning	134
		5.13 The Curse of Dimensionality and Statistical Limitations of Local Generalization	135

Goodfellow I J, Bengio Y, Courville A, *Deep Learning*. MIT Press, 2016.

Assessment Overview

- **Assignment 1: 20%**
 - Week-7 (8-April)
 - Groups of 2 or 3 students
 - Classification task
- **Assignment 2: 20%**
 - Week-12 (20-May)
 - Groups of 2 or 3 students for Competition Track
 - Groups of 2 or 3 students for Research Track
- **Final exam: 60%**
 - date to be defined

Call for research track abstracts for Assignment 2 (see Canvas)

- This research track calls for brave new ideas on deep learning. In this track, you are encouraged to propose and investigate new algorithms or problems in deep learning.
- You must not use the project (e.g. your capstone or SSP project) that you have already done or are currently doing in other units to participate in this track.
- An extended abstract (up to one page) to highlight the importance and novelty of your research problem, the major idea of your candidate solution, the feasibility of the proposed research, and the expected experimental achievements (if applicable).
- 10 groups will be selected.
- Abstract Submission Deadline: Week 4 (18 March)
- Abstract Decision: Week 6 (1 April)

Expectations

- Students attend scheduled classes, and devote an *extra* 6-9 hrs per week
 - doing assessments
 - preparing and reviewing for classes
 - revising and integrating the ideas
 - practice and self-assess
- Students are responsible learners
 - Participate in classes, constructively
 - Respect for one another (criticize ideas, not people)
 - Humility: none of us knows it all; each of us knows valuable things
 - Check Canvas site at least once a week!
 - Notify academics whenever there are difficulties
 - Notify group partners honestly and promptly about difficulties

Special Consideration (University policy)

- If your performance on assessments is affected by illness or misadventure
- Follow proper bureaucratic procedures
 - Have professional practitioner sign special USyd form
 - Submit application for special consideration online, upload scans
 - Note you have only a quite short deadline for applying
 - http://sydney.edu.au/current_students/special_consideration/
- Also, notify coordinator by email as soon as *anything begins to go wrong*
- There is a similar process if you need special arrangements eg for religious observance, military service, representative sports

Late assessments in COMP5329

- Suppose you hand in work after the deadline:
- If you have not been granted special consideration or arrangements
 - A penalty of 5% of the maximum marks will be taken per day (or part) late. After ten days, you will be awarded a mark of zero.
 - *e.g. If an assignment is worth 40% of the final mark and you are one hour late submitting, then the maximum marks possible would be 38%.*
 - *e.g. If an assignment is worth 40% of the final mark and you are 28 hours late submitting, then the maximum marks possible marks would be 36%.*
- Warning: submission sites get very slow near deadlines
- Submit early; you can resubmit if there is time before the deadline

Academic Integrity (University policy)

- “The University of Sydney is unequivocally opposed to, and intolerant of, plagiarism and academic dishonesty.
 - Academic dishonesty means seeking to obtain or obtaining academic advantage for oneself or for others (including in the assessment or publication of work) by dishonest or unfair means.
 - Plagiarism means presenting another person’s work as one’s own work by presenting, copying or reproducing it without appropriate acknowledgement of the source.” [from site below]
- <http://sydney.edu.au/elearning/student/EI/index.shtml>
- Submitted work is compared against other work (from students, the internet, etc)
 - Turnitin for textual tasks (through Canvas), other systems for code
- Penalties for academic dishonesty or plagiarism can be severe
- Complete self-education AHEM1001 (required to pass INFOxxxx)

COMP5329: Resources

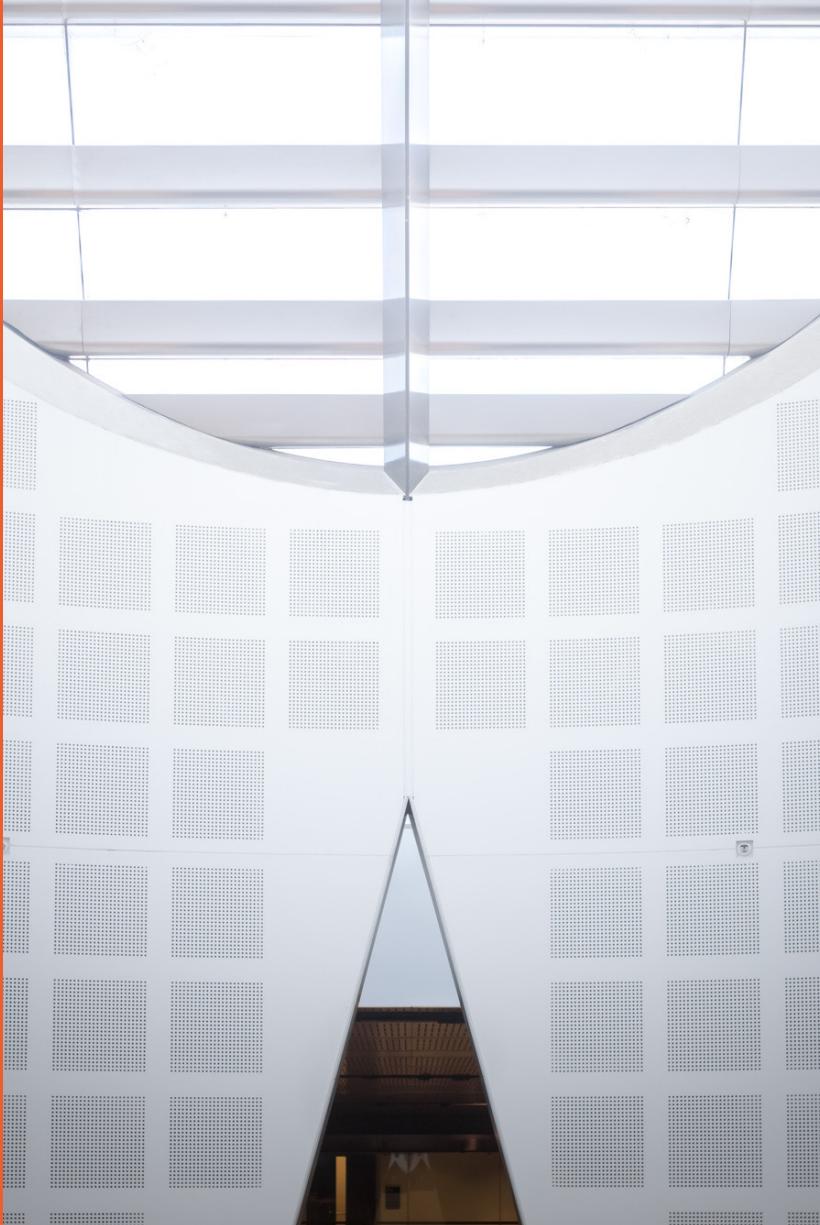
- Canvas: <https://canvas.sydney.edu.au/>
 - Login using Unikey and password
 - Link to Units website: <https://sydney.edu.au/units/>
 - Official schedule, list of learning outcomes, etc
 - Copies of slides
 - Lab instructions
 - Assignment instructions
 - Lecture videos
 - *Submit official assignment work here;*
 - see your grades; etc
- Discussion forum: on edstem

WHS Induction

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General Housekeeping – Use of Labs

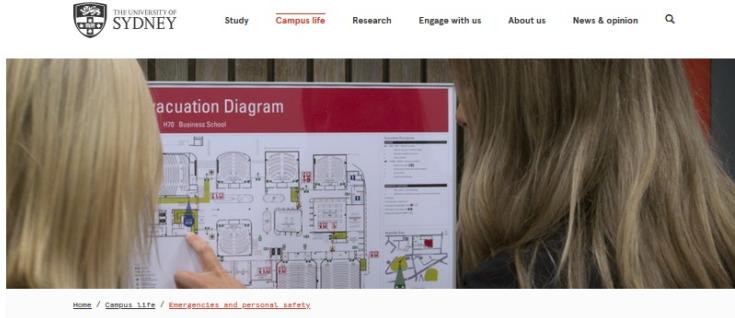
- Keep work area clean and orderly
- Remove trip hazards around desk area
- No food and drink near machines
- No smoking permitted within University buildings
- Do not unplug or move equipment without permission



EMERGENCIES – Be prepared



<https://sydney.edu.au/campus-life/safety-security.html>



[Home](#) / [Campus life](#) / [Emergencies and personal safety](#)

← Home

← Campus life

Accommodation

What's on

Health, wellbeing and success

Clubs and societies

Getting to campus

Sports and fitness

Food, shops and bars

Emergencies and personal safety

Maps and location

Life in Sydney

University

Emergencies and personal safety

Procedures to follow in the case of an emergency

We're committed to keeping our students, staff and visitors safe.

Emergencies can occur at any time for a variety of reasons. Be prepared to respond independently, particularly if working after hours. Watch our [video on emergency procedures](#) and read our [tips for staying safe on campus](#).

In an emergency

[1. Dial triple zero \(000\)](#)

[2. Call Campus Security on 9351 3333](#)

Counselling, support and reporting services

If you have witnessed or been involved in a critical incident, whether on or off campus, and would like to talk to a counsellor:

Students should contact the University's [Counselling and Psychological Services](#) on 8627 8433 or 8427 8437 (9am to 5pm, Monday to Friday).

SHARE



Safer communities on campus

Our commitment to building a safer campus



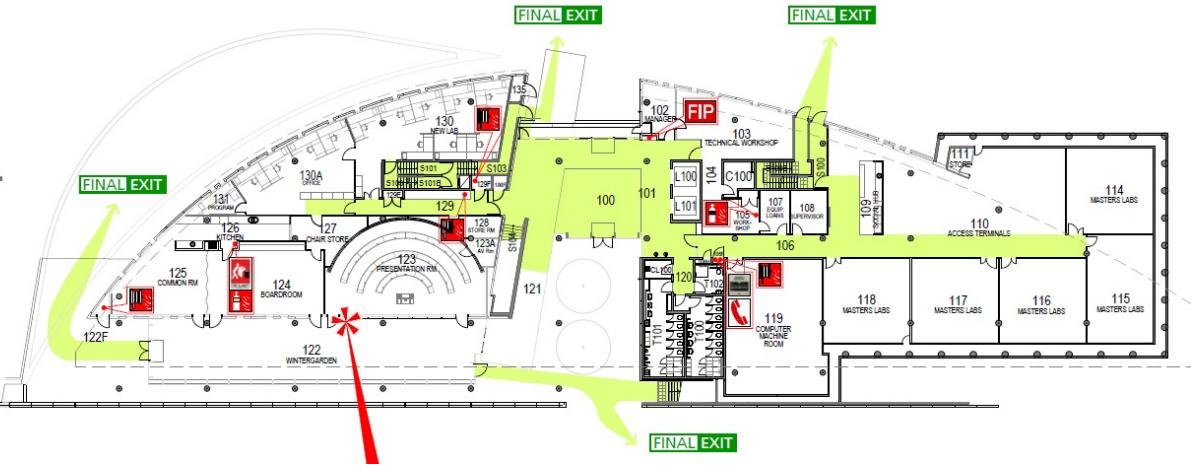
Emergency alerts

Find out about our system

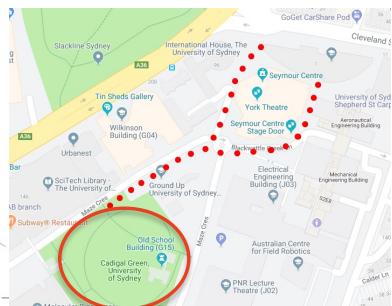


EMERGENCIES

WHERE IS YOUR CLOSEST SAFE EXIT ?



**Assembly Area:
Cadigal Green**



EMERGENCIES

Evacuation Procedures

ALARMS



BEEP... BEEP...

Prepare to evacuate

1. Check for any signs of immediate danger.
2. Shut Down equipment / processes.
3. Collect any nearby personal items.



WHOOP... WHOOP...

Evacuate the building

1. Follow the **EXIT** exit signs.
2. Escort visitors & those who require assistance.
3. DO NOT use lifts.
4. Proceed to the assembly area.

EMERGENCY RESPONSE

1. Warn anyone in immediate danger.

2. Fight the fire or contain the emergency, if safe & trained to do so.

If necessary...

3. Close the door, if safe to do so.

4. Activate the **"Break Glass"** Alarm



or



5. Evacuate via your closest safe exit.



EXIT

6. Report the emergency to 0-000 & 9351-3333

MEDICAL EMERGENCY

- If a person is seriously ill/injured:

1. **call an ambulance 0-000**
2. **notify the closest Nominated First Aid Officer**

If unconscious– send for Automated External Defibrillator (AED)
AED locations.

NEAREST to CS Building (J12)

- Electrical Engineering Building, L2 (ground) near lifts
- Seymour Centre, left of box office
- Carried by all Security Patrol vehicles



3. **call Security - 9351-3333**
4. **Facilitate the arrival of Ambulance Staff (via Security)**



Nearest Medical Facility

University Health Service in Level 3, Wentworth Building

First Aid kit – SIT Building (J12)

kitchen area adjacent to Lab 110

School of Computer Science Safety Contacts

CHIEF WARDEN

Greg Ryan
Level 1W 103
9351 4360
0411 406 322



FIRST AID OFFICERS



Julia Ashworth
Level 2E Reception
9351 3423



Will Calleja
Level 1W 103
9036 9706
0422 001 964



Katie Yang
Level 2E 237
9351 4918

**Orally REPORT all
INCIDENTS
& HAZARDS
to your SUPERVISOR**

OR

Undergraduates: to Katie Yang
9351 4918

Coursework

Postgraduates: to Cecille Faraizi
9351 6060
or Keiko Narushima
8627 0872

CS School
Manager:

Priyanka Magotra
8627 4295

Assistance

- There are a wide range of support services available for students: <https://sydney.edu.au/campus-life/health-wellbeing-success.html>
- Please make contact, and get help
- You are not required to tell anyone else about this
- If you are willing to inform the unit coordinator, they may be able to work with other support to reduce the impact on this unit
 - eg provide advice on which tasks are most significant

DISABILITY SERVICES

Do you have a disability?

- You may not think of yourself as having a 'disability' but the definition under the **Disability Discrimination Act** is broad and includes temporary or chronic medical conditions, physical or sensory disabilities, psychological conditions and learning disabilities.
- The types of disabilities we see include:
 - anxiety, arthritis, asthma, asperger's disorder, ADHD, bipolar disorder, broken bones, cancer, cerebral palsy, chronic fatigue syndrome, crohn's disease, cystic fibrosis, depression, diabetes, dyslexia, epilepsy, hearing impairment, learning disability, mobility impairment, multiple sclerosis, post traumatic stress, schizophrenia , vision impairment, and much more.
- Students needing assistance must register with Disability Services –
 - it is advisable to do this as early as possible.
- <http://sydney.edu.au/study/academic-support/disability-support.html>

Do you have a disability?

You may not think of yourself as having a 'disability' but the definition under the **Disability Discrimination Act**

(1992) is broad and includes temporary or chronic medical conditions, physical or sensory disabilities, psychological conditions and learning disabilities.

The types of disabilities we see include:

Anxiety // Arthritis // Asthma // Autism // ADHD

Bipolar disorder // Broken bones // Cancer

Cerebral palsy // Chronic fatigue syndrome

Crohn's disease // Cystic fibrosis // Depression

Diabetes // Dyslexia // Epilepsy // Hearing impairment //

Learning disability // Mobility impairment // Multiple sclerosis // Post-traumatic stress // Schizophrenia //

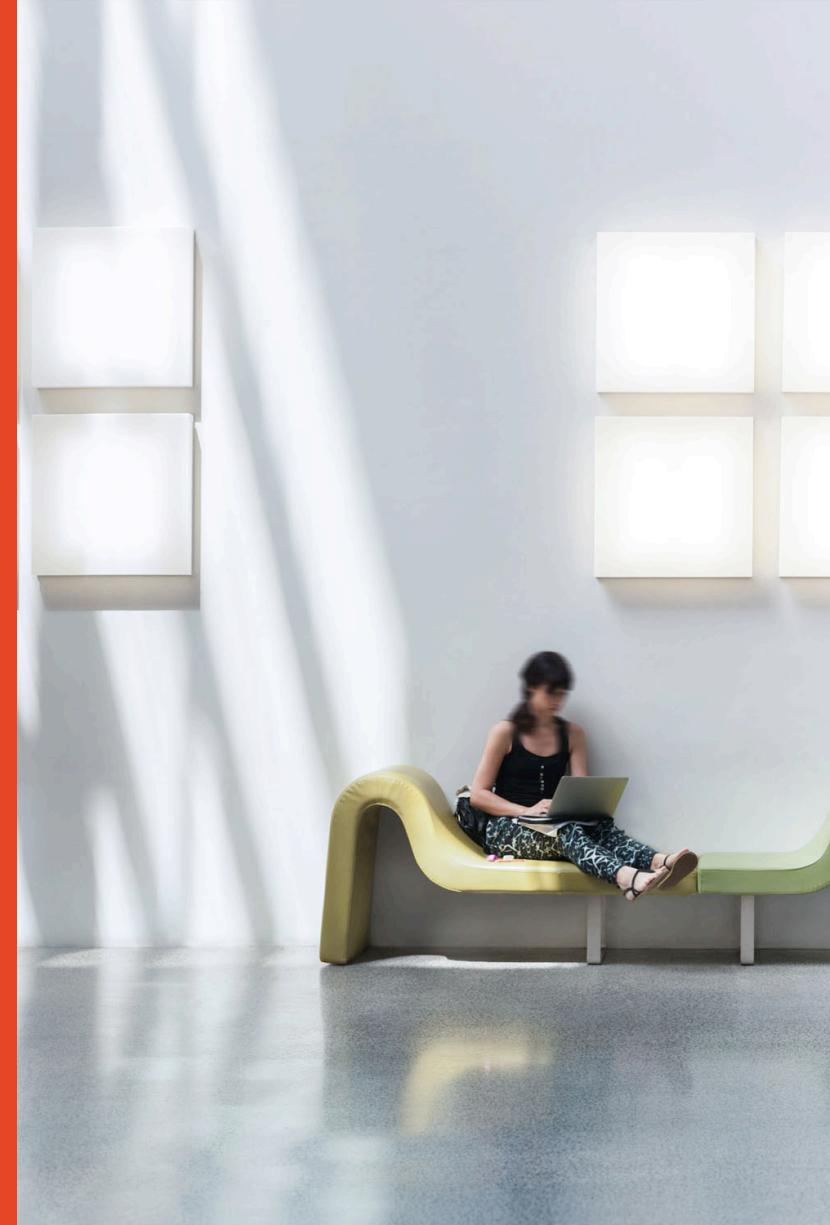
Vision impairment
and much more.

Students needing assistance must register with Disability Services. It is advisable to do this as early as possible. Please contact us or review our website to find out more.



THE UNIVERSITY OF
SYDNEY

Disability Services Office
sydney.edu.au/disability
02-8627-8422



Other support

- Learning support
 - <http://sydney.edu.au/study/academic-support/learning-support.html>
- International students
 - <http://sydney.edu.au/study/academic-support/support-for-international-students.html>
- Aboriginal and Torres Strait Islanders
 - <http://sydney.edu.au/study/academic-support/aboriginal-and-torres-strait-islander-support.html>
- Student organization (can represent you in academic appeals etc)
 - <http://srcusyd.net.au/> or <http://www.supra.net.au/>
- Please make contact, and get help
- You are not required to tell anyone else about this
- If you are willing to inform the unit coordinator, they may be able to work with other support to reduce the impact on this unit
 - eg provide advice on which tasks are most significant

Advice

- Metacognition
 - Pay attention to the learning outcomes in Canvas
 - Self-check that you are achieving each one
 - Think how each assessment task relates to these
- Time management
 - Watch the due dates
 - Start work early, submit early
- Networking and community-formation
 - Make friends and discuss ideas with them
 - Know your tutor, lecturer, coordinator
 - Keep them informed, especially if you fall behind
 - Don't wait to get help
- Enjoy the learning!

Invited talks

- Jiajun Huang - "On Positive-Unlabeled Classification in GAN"
- Yanxi Li - "Neural Architecture Dilation for Adversarial Robustness"
- Mingkai Zheng - "ReSSL: Relational Self-Supervised Learning with Weak Augmentation"
- Dũng Đinh Anh - "Graphical Discriminative Embedding GAN for tabular data"