

Computer Vision

Week 1

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Australian National University

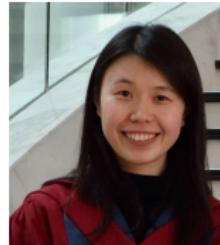
Semester 1, 2024

Course Staff: Lecturers



Dylan Campbell
Convener

Tuesday 10:30–11:30am (W7–12)
B149 Brian Anderson Building



Miaomiao Liu
Convener

Monday 4–5pm (W1–6)
B158 Brian Anderson Building



Weijian Deng
Guest Lecturer

Course Staff: Tutors



Dian Lu



Yiran Wang



Xinlei Niu



Jinguang Tong



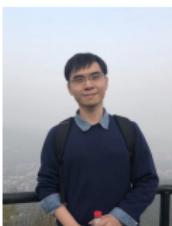
Hoang Nguyen



MingJun Zhang



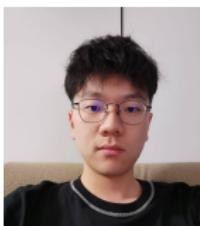
Enze Tao



Qinyu Zhao



Sam Bahrami



Jiahao Zhang



Yue Yin



Yexin Mao



Xinghao Li



Jiahao Ma



Yasong Dai



Chaoyue Xing



Han Xu



Bhavesh Sharma

Course Overview

- ▶ An introductory-level course on computer vision, designed for final-year comp/eng undergraduate and masters students
- ▶ **Computer vision:** a sub-field of artificial intelligence that seeks to extract information from images and videos
- ▶ **Prerequisites:**
 - ▶ ENGN2228 (Signals and Systems) or
 - ▶ COMP2120 (Software Engineering) or
 - ▶ COMP3600 (Algorithms) or
 - ▶ COMP3670 (Introduction to Machine Learning) or
 - ▶ Masters (Eng, MMLCV, MCOMP, VCOMP)
- ▶ **Assumed knowledge:**
 - ▶ Basic calculus, linear algebra and basic probability theory
 - ▶ Entry-level programming in either Matlab, Python or C/C++

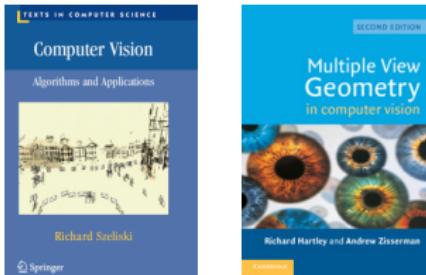
Course Logistics

- ▶ **Lectures:** 9–10:30am Tuesday & Friday (Manning Clark Hall)
- ▶ **Labs:** start Week 2, **1.5h** per week, sign up on MyTimetable
 - ▶ **First 30 minutes** is a **tutor consultation session**
 - ▶ **Following 1.5 hours** is the **lab**
- ▶ **Wattle:** announcements, handouts, assignments
- ▶ **Ed Discussion:** announcements, Q&A [[link on Wattle](#)]

E.g., for a lab scheduled from 2:00–4:00PM, we have:

Time	Activity
2:00PM–2:30PM	Tutor Drop-in Session
2:30PM–4:00PM	Lab

Course Logistics (2)



Reference textbooks:

- ▶ Szeliski, *Computer Vision: Algorithms and Applications 2nd Edition*, Springer, 2022, szeliski.org/Book
- ▶ Hartley & Zisserman, *Multiple View Geometry in Computer Vision 2nd Edition*, Cambridge University Press, 2004

Other resources:

- ▶ Conference proceedings for computer vision and machine learning, including CVPR, ICCV, ECCV, NeurIPS, ICLR
- ▶ Online computer vision and deep learning courses

Course Logistics (3)

- ▶ **Assessment:**
 - ▶ Lab Assignments (3×15%)
 - ▶ CLab 1 report due end of Week 4 (15/03/2024)
 - ▶ CLab 2 report due end of Week 7 (19/04/2024)
 - ▶ CLab 3 report due end of Week 11 (17/05/2024)
 - ▶ Submit via Turnitin on Wattle
 - ▶ Final Exam (55%)
 - ▶ Covers all aspects of the course
 - ▶ Permitted: a single double-sided A4 page (handwritten or printed) containing notes made by the student

Course Logistics (4)

- ▶ **Academic integrity:**
 - ▶ We will be using Turnitin for the submission of written work
 - ▶ We reserve the right to ask you to orally explain your work (see ANU policy on plagiarism <https://www.anu.edu.au/students/academic-skills/academic-integrity>)
 - ▶ More on this later
- ▶ **Late policy:**
 - ▶ Late submission **not permitted**. If assessment tasks are submitted without an extension after the due date, a mark of **zero** will be awarded.

Course Logistics (5)

- ▶ **Grievance resolution:**
 - ▶ You can contact the course staff in the first instance
 - ▶ Alternatively, contact the Dean of Students for advice
 - ▶ If unresolved, you can lodge a formal complaint:
[http://www.anu.edu.au/students/contacts/
student-complaint-resolution](http://www.anu.edu.au/students/contacts/student-complaint-resolution)
- ▶ **Generative AI:**
 - ▶ The use of Generative AI Tools (e.g., ChatGPT) is **permitted** in this course, given that **proper citation** and **prompts** are provided, along with a **description** of how the tool contributed to the assignment. Guidelines regarding appropriate citation and use can be found on the ANU library website (<https://libguides.anu.edu.au/generative-ai>).
Marks will reflect the contribution of the student rather than the contribution of the tools.

Computer Vision: A Prelude

Vision: an extraordinary sense

David Marr

"to know what is where, by looking"

Why vision?



Credit: Pixar

Why vision?

Our senses:

- ▶ hearing
- ▶ smell
- ▶ taste
- ▶ sight (70%)

Why vision?

Our senses:

- ▶ hearing
- ▶ smell
- ▶ taste
- ▶ sight (70%)
- ▶ touch
- ▶ balance

Why vision?

Our senses:

- ▶ hearing
- ▶ smell
- ▶ taste
- ▶ sight (70%)
- ▶ touch
- ▶ balance

- ▶ echo
location
- ▶ electric field
- ▶ magnetism



Why vision?

- ▶ Information dense
- ▶ Inexpensive (camera)
- ▶ Passive



But what does a computer see?

Output:

- ▶ A harbour...
 - ▶ ... with dozens of boats;
 - ▶ ... the water is calm and glassy;
 - ▶ ... there are vertical masts;
 - ▶ ... with mountains in background;
 - ▶ ... and a blue sky with a touch of cloud

But what does a computer see?



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- ▶ A harbour...
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Weekly Study Plan

Weekly Study Plan: Overview

Wk	Starting	Lecture	Lab	Assessment
1	19 Feb	Introduction	X	
2	26 Feb	Low-level Vision 1	1	
3	4 Mar	Low-level Vision 2	1	
		Mid-level Vision 1		
4	11 Mar	Mid-level Vision 2	1	CLab1 report due Friday
		High-level Vision 1		
5	18 Mar	High-level Vision 2	2	
6	25 Mar	High-level Vision 3 ¹	2	
	1 Apr	Teaching break	X	
	8 Apr	Teaching break	X	
7	15 Apr	3D Vision 1	2	CLab2 report due Friday
8	22 Apr	3D Vision 2	3	
9	29 Apr	3D Vision 3	3	
10	6 May	3D Vision 4	3	
		Mid-level Vision 3		
11	13 May	High-level Vision 4	X	CLab1 report due Friday
12	20 May	Course Review	X	

¹No lecture on Friday, public holiday

Weekly Study Plan: Part A

Wk	Starting	Lecture	By
1	19 Feb	Introduction to computer vision and image formation	Miaomiao
2	26 Feb	Low-level vision: image formation, representation and processing	Miaomiao
3	4 Mar	Low-level vision: image filtering Mid-level vision: edge detection, image features	Miaomiao
4	11 Mar	Mid-level vision: image features High-level vision: introduction	Miaomiao
5	18 Mar	High-level vision: deep neural networks	Miaomiao
6	25 Mar	High-level vision: deep neural networks	Miaomiao

Weekly Study Plan: Part B

Wk	Starting	Lecture	By
7	15 Apr	3D vision: introduction, camera model, single-view geometry	Dylan
8	22 Apr	3D vision: camera calibration, two-view geometry (homography)	Dylan
9	29 Apr	3D vision: two-view geometry (epipolar geometry, triangulation, stereo)	Dylan
10	6 May	3D vision: multiple-view geometry	Weijian
		Mid-level vision: optical flow, shape-from-X	Dylan
11	13 May	High-level vision: self-supervised learning, detection, segmentation	Dylan
12	20 May	Course review	Dylan



ACADEMIC INTEGRITY

GENERAL INFORMATION

Academic Integrity is taken seriously at ANU!

The [Academic Integrity Rule 2021](#) (Rule) is a legal document that the University uses to promote academic integrity, and manage breaches of the academic integrity principle.

[Click here](#) to learn more about the academic integrity rules.

All students are expected, both individually and collectively and to the best of their ability, to advance the pursuit, dissemination and application of knowledge ethically, and by behaving honestly and responsibly, and with respect and fairness, in scholarly practice.

The **academic integrity principle** is the principle that every student of the University:

- (a) is committed to engaging in academic work in ways that are consistent with, and actively support, academic integrity; and
- (b) upholds this commitment by behaving honestly, responsibly and ethically, and with respect and fairness, in scholarly practice.





ACADEMIC INTEGRITY

GENERAL INFORMATION

We are all responsible for maintaining a culture of Academic Integrity at ANU.

We have an obligation to be informed of and to understand the requirements of academic integrity and the academic integrity principle. **Being uninformed of or misunderstanding the requirements of academic integrity will never be an excuse for a breach of academic integrity.**

How do I know about the Academic Integrity Rules?

As a student, you are expected to undertake the online **Academic Integrity modules on Wattle** before submitting your first piece of assessment. These modules will guide you to a successful academic journey with integrity.

A culture of Academic Integrity starts with you. How to report and foster academic integrity?

We cannot ignore situations in which we have any evidence that someone has breached academic integrity, and must deal with the situation in an appropriate way as stated in the Student Code of Conduct (item 11, reporting). **Contact your course convenor, the teaching staff or the Sub Dean (Academic Integrity).** If you need further assistance, please contact education.cecc@anu.edu.au. Your identity will be kept confidential.



ACADEMIC INTEGRITY

while (integrity) knowledge++;

How do I acknowledge other people's work in my code?

Include in comments next to the code you reuse, the URL, author and date you extracted the code, and a brief explanation of whether you adapted the code or used it as-is (see real-world examples below).

Example 1

In describing the class *PluginProxyUtil* in the Apache Project source code, the developer cites the source as a post in a forum and includes the URL, author and date. **Don't forget to indicate whether or not you modified the code (be clear and explain the changes in the comments).**

```
/**  
 * A utility class that gives applets the ability to detect proxy host settings.  
 * This was adapted from a post from Chris Forster on 20030227 to a Sun Java forum here:  
 * http://forum.java.sun.com/thread.jspa?threadID=364342&tstart=120  
 [...]  
 */
```

Example 2

In the function *OutputTraceToStream* in the Google Chrome *stack_trace_win* source code, the developer cites the source code as the Microsoft Developer Network and includes a URL:

```
// Code adapted from MSDN example:  
http://msdn.microsoft.com/en-us/library/ms680578\(VS.85\).aspx
```

Note that when you use code from an open-source project, you need both to attribute the source and follow the terms of any open-source license that applies to the code you are using.

Source: Academic Integrity at MIT/Writing code <https://integrity.mit.edu/handbook/writing-code> retrieved in February 2023.





ACADEMIC INTEGRITY

while (integrity) knowledge++;

Plagiarism is the appropriation of the ideas or expressions of another without relevant and appropriate acknowledgment.

It is considered plagiarism if you have copied someone else's work, including another student's paper, recycled some of your own work, or taken material directly from another source and made it appear to be your own.

Your ideas, your argument and your analysis are the most important aspects of your work.

Examples

"The code I used in my assignment was pulled from StackOverflow but I didn't realise I had to reference an online post."
[Plagiarism]

"I failed this course before. So I reused my own assignments as I thought I could reuse them."
[Self-Plagiarism]

"I used several sources to solve this assignment. There's a mix of my ideas and parts of others. I thought it was considered mine."
[Plagiarism]

**Note that the examples are not intended to be comprehensive but rather illustrative of common breaches of academic integrity.*



ACADEMIC INTEGRITY

while (integrity) knowledge++;

Collusion and Collaboration are not the same thing.

Never misrepresent someone else's knowledge, ideas, or outputs as your own.

The nature and extent of interaction (collaboration) must be formally acknowledged such that the specific contribution of the author (or authors for a group project) can be unambiguously distinguished from the contribution of non-authors. **Unacknowledged collaboration may be collusion, which is a breach of the Academic Integrity Principle.**

Examples

"I discussed the assignment with a friend, but I forgot to acknowledge their contribution to my assignment."
[Collusion]

*"I discussed the **individual assignment** with a friend and acknowledged their contribution to my assignment."*
[Collusion]

*"I discussed the **group assignment** with my teammates and acknowledged each one's contribution to the assignment."*
[Collaboration]

*Note that the examples are not intended to be comprehensive but rather illustrative of common breaches of academic integrity.



ACADEMIC INTEGRITY

while (integrity) knowledge++;

Contract Cheating

Contract Cheating is submission of an academic output that is prepared or drafted in part or in full by a person who is not acknowledged in the output as an author or co-author of the output; both the person writing the output and the person submitting the output are guilty of Contract Cheating.

Contract cheating is so serious that **it may result in criminal prosecution** under Australian Commonwealth Government legislation.

No matter how much pressure you are under, engaging in this is far worse than failure to submit an assignment.

Examples

"I used a solution taught by an online tutoring company. I thought it was ok."
[Contract Cheating]

"I bought notes and tutorial answers from a friend who has taken this course before."
[Contract Cheating]

"I used a social network to find someone and paid them to do the assignment for me"
[Contract Cheating]

*Note that the examples are not intended to be comprehensive but rather illustrative of common breaches of academic integrity.



ACADEMIC INTEGRITY

while (integrity) knowledge++;

Other common cases of breaches

Examples

"During my research project, I received advice from experts/workshop staff about a design decision, but I forgot to acknowledge them."

[Collusion, Plagiarism]

"I cited and referred to that source once in my research report, and it felt repetitive and unnecessary to refer to it each time. I expected the reader to know where those ideas come from."

[Plagiarism]

"I reused pieces of my previous assignments in my final research project. I did not know I had to acknowledge my own work."

[Improperly Recycling Work]

"The results of my research project were no better than state of the art, so I made up data and reported better results."

[Falsification/Data Fabrication]

Partial or total recycling of previous work is only allowed when expressly approved in the Class Summary and/or Wattle. Scaffolding assessments are an example where reuse is permitted.

Do not forget to cite your previous work (as unpublished if not previously published), following the referencing style adopted in your report.

*Note that the examples are not intended to be comprehensive but rather illustrative of common breaches of academic integrity.





ACADEMIC INTEGRITY

while (integrity) knowledge++;

The Use of Generative AI Tools

Generative AI tools (e.g. ChatGPT, Co-Pilot) are computer programs that use machine learning algorithms to generate new and original data or content. They can be used to generate text, images, music, or videos that are not explicitly programmed but are learned from a large dataset of examples.

► OpenAI. (2023, February 16). What are Generative AI tools? [Response to a question]. Retrieved from <https://github.com/openai/gpt>

Can I use Generative AI Tools?*

- > Use of generative AI tools is allowed unless expressly prohibited in the Class Summary/Wattle and Assignment Sheet.
 - > You must acknowledge and cite the use of any Generative AI tools in your work.
 - > Uncited use of generative AI tools is considered a potential breach of the Academic Integrity Rules.
- *Note that this is an evolving space and recommendations and rules related to the use of generative AI tools are subject to change.
Always ask if you are not sure whether the use of these generative AI tools is allowed.

Examples

"I used a generative AI tool and acknowledged it in my report. The assignment sheet mentioned that it was not allowed, but I missed that part."
[NOT OK]

"I did not properly cite the parts of my work where I used Generative AI tools."
[NOT OK]

"I acknowledged and cited all parts of the assignment where I used generative AI tools. The assignment sheet did not mention it was not allowed."
[OK]

*Note that the examples are not intended to be comprehensive but rather illustrative of common breaches of academic integrity.





ACADEMIC INTEGRITY

while (integrity) knowledge++;

We understand **almost all people who breach academic integrity don't want to**, but do so because they feel under pressure (such as running out of time, lack of confidence, not knowing where to start) and **see cheating or otherwise breaching academic integrity as their only way out. It isn't. It never is!**

We can help you! How to get help?

- » Contact your course convenor or course teaching staff if you have any questions about your assignments and academic integrity. They are there to support you.
- » Visit the ANU Academic Skills Web page and book an appointment to discuss academic integrity, referencing, time management, best practice principles, among others. They will offer the right guidance.
- » Get support from the Access & Inclusion staff to ensure you have all the conditions to perform at your best (eligibility applies). They can arrange extra support for you.
- » Get help from ANU Counselling staff, the Dean of Students, the Associate and Sub-Dean (Academic Integrity), Student Association and other relevant staff. **We are all here for academic integrity!**





ACADEMIC INTEGRITY

while (integrity) knowledge++;

In summary:

Academic dishonesty is a serious matter and is not tolerated.

Severe penalties may apply for violations of academic integrity rules.

Always acknowledge others' work.

Don't hesitate to ask for help!

Report any academic dishonesty, we are all responsible for academic integrity.

Academic dishonesty will affect your learning, confidence, development of new skills, future career and personal and institutional reputation.

References

Academic Integrity Rules (2021)

<https://www.legislation.gov.au/Details/F2021L00997>

Academic Integrity: Best Practice Principles for Learners

<https://services.anu.edu.au/learning-teaching/academic-integrity/academic-integrity-best-practice-principles-for-learners>



CECC

CLASS REPRESENTATIVES

Class Student Representation is an important component of the teaching and learning quality assurance and quality improvement processes within the ANU College of Engineering, Computing and Cybernetics (CECC).

Each semester, we put out a call for Course Representatives for all ANU College of Engineering, Computing and Cybernetics (CECC) courses. Students can nominate themselves for one or more of the courses they are enrolled in.



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Roles and responsibilities:

The role of Student Representatives is to provide ongoing constructive feedback on behalf of the student cohort to Course Conveners and to Associate Directors (Education) for continuous improvements to the course.

- Act as the official liaison between your peers and convener.
- Be available and proactive in gathering feedback from your classmates.
- Attend regular meetings, and provide reports on course feedback to your course convener
- Close the feedback loop by reporting back to the class the outcomes of your meetings.

Note: Class representatives will need to be comfortable with their contact details being made available via Wattle to all students in the class.

For more information regarding roles and responsibilities, contact:

ANUSA CECC representatives (sa.cecc@anu.edu.au).





Why become a class representative?

- **Ensure students have a voice** to their course convener, lecturer, tutors, and College.
- **Develop skills sought by employers**, including interpersonal, dispute resolution, leadership and communication skills.
- **Become empowered**. Play an active role in determining the direction of your education.
- **Become more aware of issues influencing your University** and current issues in higher education.
- **Course design and delivery**. Help shape the delivery of your current courses, as well as future improvements for following years.

**Want to be a class representative?
Nominate today!**

Please nominate yourself to your course convener by end of Week 2



***We need one rep per course code (COMP4528 / COMP6528 / ENGN4528 / ENGN6528)**

Break

Introduce yourself to your neighbour – 5 minutes

Have they used ChatGPT/Bard or Dall-E/Stable Diffusion?