

# 50.039 Theory and Practice of Deep Learning

## W13S1 – End and Review

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# Some admin stuff

## Final exam

- Content will be everything from W1 to W12 included.
- Similar format as MidTerm.
- Details for exam (location, assignments, etc.) to be sent via email.

## Regarding your project

- No extension will be given (have to give grades to OSA!)
- And want to be able to see your projects before presentations and discussions on W13.
- Check schedule for presentation timeslots.

# So this is the end

What's next?

# Develop a deeper understanding of...

## Improving training procedures (W2++)

At the moment, mostly using gradient descent algorithms to train our models...

Many different directions have been considered, for instance:

- Using Forward-Forward (2022 proposal from Hinton, to replace our conventional backprop?): <https://arxiv.org/abs/2212.13345>
- Training AIs to train other AIs?: “learning to learn” or “meta-learning”  
Curious?: <https://machinelearningmastery.com/meta-learning-in-machine-learning/>

# On top of everything we have seen...

## **Advanced Computer Vision (W4++ and W10++)**

Consider enrolling for the Computer Vision Term 7 course for more advanced concepts on CV, such as:

- More advanced loss functions like triplet loss,
- Advanced architectures like Siamese networks,
- Video data models,
- Etc.

<https://istd.sutd.edu.sg/undergraduate/courses/50035-computer-vision>

# Develop a deeper understanding of...

## **Advanced word embedding and NLP problems (W5++ and W8++)**

Many more mechanisms when it comes to embedding and language related problems.

- E.g. more advanced embeddings
- Typical tasks in NLP (chatbots, context propagation, sentiment analysis, translation, etc.)
- Go for the Term 7 NLP course!

<https://istd.sutd.edu.sg/undergraduate/courses/50040-natural-language-processing>

# Develop a deeper understanding of...

## **Advanced attacks and Defense mechanisms (W6++)**

Many more mechanisms when it comes to attacking and defending a Neural Network, e.g. new types of attacks, such as:

- Poisoning attacks (attempt to poison the dataset so the NN cannot re-train properly, especially if online learning is used),
- Weights changes (attempt to change a small subset of the weights of the NN to prevent it from working in certain ways),
- Etc.

<https://www.comp.nus.edu.sg/~reza/courses/cs6231/>

# Develop a deeper understanding of...

## **Advanced Graph Neural Networks (W9++)**

We barely scratched the surface of Graph Theory. If you need to study a new math theory, let it be graph theory!

- Good graph theory course here:

<https://ocw.mit.edu/courses/mathematics/18-217-graph-theory-and-additive-combinatorics-fall-2019/>

- More advanced problems and concepts on Graph Neural Networks in lectures 1-9 of course here:

<https://www.cs.ox.ac.uk/teaching/courses/2020-2021/advml/>



# Develop a deeper understanding of...

## **Advanced Graph Neural Networks (W9++)**

Also, keep in mind that Neural Networks are graphs...

- So technically, we could build a Neural Network, which receives another Neural Network as its input...!
- What could be the uses for such a technique?
- Meta-learning? (i.e. training an AI to train another AI?!)  
<https://machinelearningmastery.com/meta-learning-in-machine-learning/>

# Develop a deeper understanding of...

## **Advanced Generative Models (W10++)**

- Advanced GANs, operating on other types of data than just images (sound, text, etc.)
- Very good online course here:

<https://cs236g.stanford.edu/>

- Any good course about advanced diffusion models and advanced generative models (Dall-E and MidJourney) would also be worth considering.

<https://www.fast.ai/posts/part2-2023.html>

- Might be covered in **Term 7 Computer Vision?**

# Develop a deeper understanding of...

## Advanced Reinforcement Learning (W11++)

Barely scratched the surface about Reinforcement Learning.

- Currently considering to create a Reinforcement Learning elective course at SUTD for Term 8. Any thoughts?
- Otherwise, the reference course on RL is the one from David **Sliver** (the man behind AlphaGo!)

<https://deepmind.com/learning-resources/-introduction-reinforcement-learning-david-silver>

And <https://www.davidsilver.uk/teaching/>

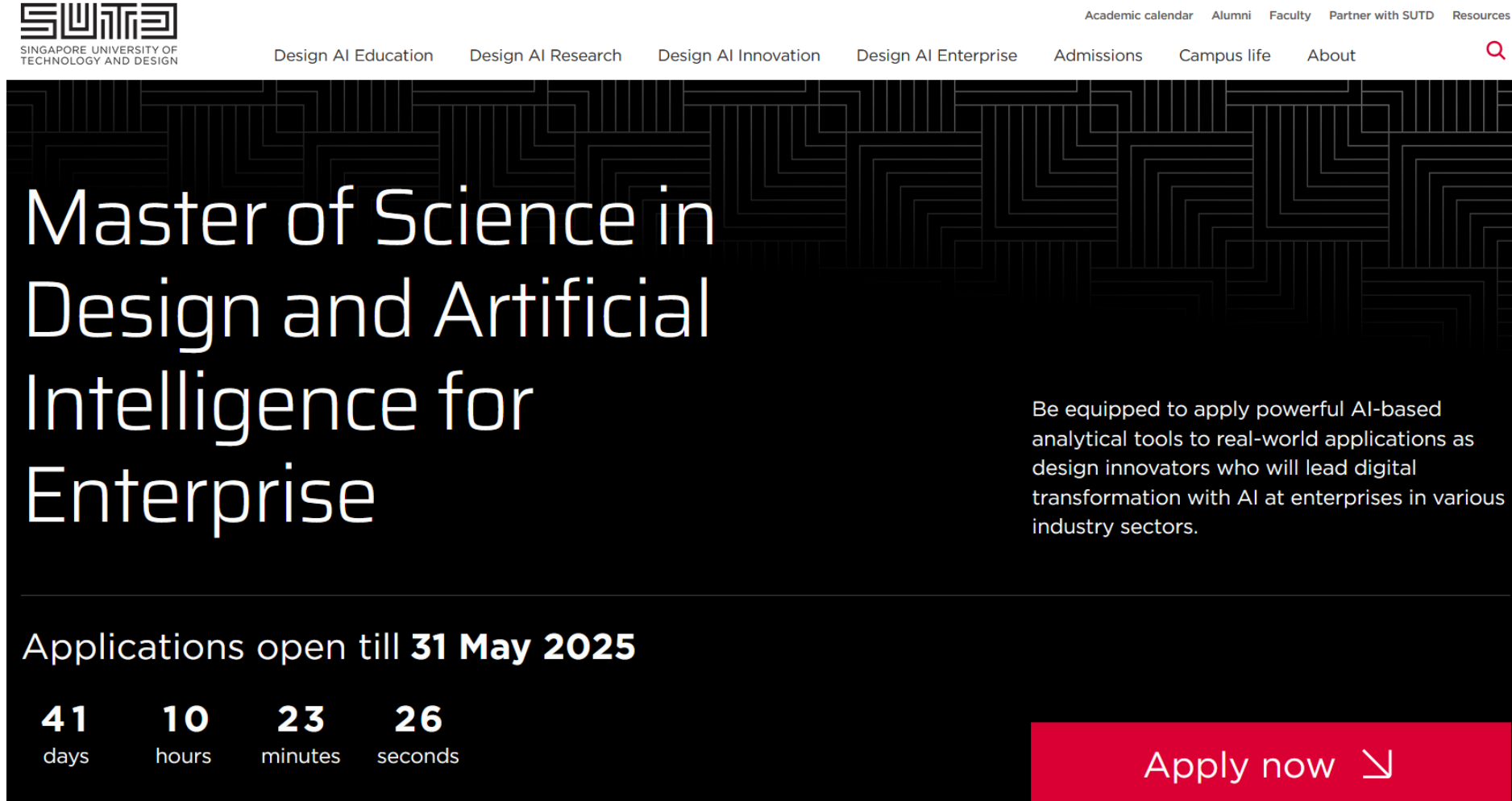
# Develop a deeper understanding of...

## **Advanced Interpretability, physics-informed NNs (W12++)**

- Rather an ongoing field in research at the moment.
- Not that many courses out there, but worth keeping an eye out...

# Our new SUTD MSc in AI!

Still open for application  
(31 May 2025!):  
<https://www.sutd.edu.sg/programme-listing/master-of-science-in-design-and-artificial-intelligence-for-enterprise/>



The screenshot shows the SUTD website header with the logo and navigation links: Academic calendar, Alumni, Faculty, Partner with SUTD, Resources, Design AI Education, Design AI Research, Design AI Innovation, Design AI Enterprise, Admissions, Campus life, and About. The main content area features a dark background with a white geometric pattern. The title 'Master of Science in Design and Artificial Intelligence for Enterprise' is prominently displayed in white. Below the title, a paragraph describes the program: 'Be equipped to apply powerful AI-based analytical tools to real-world applications as design innovators who will lead digital transformation with AI at enterprises in various industry sectors.' A countdown timer shows 'Applications open till 31 May 2025' with a breakdown of 41 days, 10 hours, 23 minutes, and 26 seconds. A red button with the text 'Apply now' and a right-pointing arrow is located at the bottom right.

SUTD  
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Design AI Education Design AI Research Design AI Innovation Design AI Enterprise Admissions Campus life About

## Master of Science in Design and Artificial Intelligence for Enterprise

Be equipped to apply powerful AI-based analytical tools to real-world applications as design innovators who will lead digital transformation with AI at enterprises in various industry sectors.

Applications open till **31 May 2025**

**41** days **10** hours **23** minutes **26** seconds

Apply now ↘

# On top of everything we have seen...

## **More concepts, problems and architectures on Computer Vision**

- Also, always good to go for an image processing course to understand typical image transformation and problems out there.

[https://www.coursera.org/learn/image-processing?ranMID=40328&ranEAID=\\*GqSdLGGurk&ranSiteID=.GqSdLGGurk-GV4LxEnPMuMd1.8y4AurRA&siteID=.GqSdLGGurk-GV4LxEnPMuMd1.8y4AurRA&utm\\_content=10&utm\\_medium=partners&utm\\_source=linkshare&utm\\_campaign=\\*GqSdLGGurk](https://www.coursera.org/learn/image-processing?ranMID=40328&ranEAID=*GqSdLGGurk&ranSiteID=.GqSdLGGurk-GV4LxEnPMuMd1.8y4AurRA&siteID=.GqSdLGGurk-GV4LxEnPMuMd1.8y4AurRA&utm_content=10&utm_medium=partners&utm_source=linkshare&utm_campaign=*GqSdLGGurk)

# On top of everything we have seen...

**Bayesian and Statistical Learning (Variational AutoEncoders were 101, more on diffusion models).**

- A good entry point for Bayesian Deep Learning

<https://medium.com/@ODSC/introduction-to-bayesian-deep-learning-f7568f524c90>

- Lectures 10-End

<https://www.cs.ox.ac.uk/teaching/courses/2020-2021/advml/>

# On top of everything we have seen...

**A bit of advanced optimization and game theory never hurts...**

- Especially when trying to optimize two cooperating or competing neural networks! (GANs, actor-critic, etc.)
- Great courses here:

<https://oyc.yale.edu/economics/econ-159>

And

<https://online.stanford.edu/courses/soe-ycs0002-game-theory>



# On top of everything we have seen...

**CUDA masters are the king of the world these days...**

- BigTech companies are looking for experts that can help with machine learning and custom GPU implementations
- The most obvious way to learn is from Nvidia courses themselves, some give certifications, but it is an investment...

<https://developer.nvidia.com/cuda-education-training>



## CUDA Education & Training

### Accelerate Your Applications

Learn using step-by-step instructions, video tutorials and code samples.

- Accelerated Computing with C/C++
- Accelerate Applications on GPUs with OpenACC Directives
- Accelerated Numerical Analysis Tools with GPUs
- Drop-in Acceleration on GPUs with Libraries
- GPU Accelerated Computing with Python

# On top of everything we have seen...

**Could computing is also very valuable...**

- Similarly, a certification in AWS or Microsoft Azure or Google Cloud for cloud computing machine/deep learning is of high value these days!
- **Ongoing AWS certification run in the 50.055 MLOps, likely to be reconducted next year?**



# On top of everything we have seen...

## **Quantum is the next best thing?**

Quantum computers are expected to be the next big thing in Computer Science in general.

- This will also apply to AI/ML/DL...
- This means we will get to train larger networks, faster. (This is currently a limit for many applications these days).
- Picking up on quantum computing is never a bad idea (but careful, possibly the most difficult topic out there!)

<https://towardsdatascience.com/dont-ask-what-quantum-computing-can-do-for-machine-learning-cc44feeb51e8>

<https://pennylane.ai/qml/whatisqml.html>

# On top of everything we have seen...

## More stuff

- Advanced Probability and Statistics (a.k.a. Statistical Learning) is always a great plus...  
<https://www.statlearning.com/>
- Neuroscience should probably be part of any serious AI curriculum...  
[NeuroAI] Barron et al., “What insects can tell us about the origins of consciousness”, 2015.  
[Kurzweil] R. Kurzweil, “How to Create a Mind: The Secret of Human Thought Revealed”, 2012.  
[Marcus] G. Marcus, “The Future of the Brain”, 2014.

Etc.

# On top of everything we have seen...

## More stuff

Many more courses available for free/cheap out there...

- [https://www.linkedin.com/posts/endritrestelica\\_ai-artificialintelligence-activity-7069768595978776576-Cvsk/](https://www.linkedin.com/posts/endritrestelica_ai-artificialintelligence-activity-7069768595978776576-Cvsk/)
- [https://www.linkedin.com/posts/amanc\\_artificialintelligence-machinelearning-ai-activity-7052863983908753408-OPfM/](https://www.linkedin.com/posts/amanc_artificialintelligence-machinelearning-ai-activity-7052863983908753408-OPfM/)

Possibly the best repo ever created on GitHub for CS stuff...

- <https://github.com/Developer-Y/cs-video-courses>

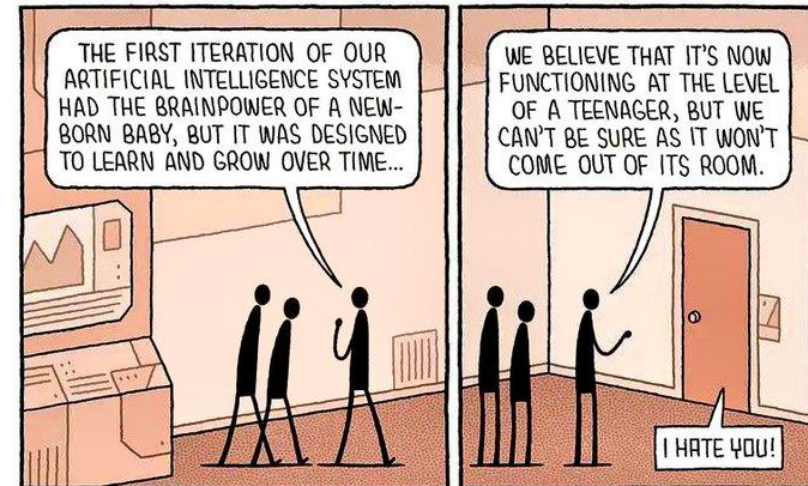
# Debates about AGI

**AGI:** Artificial General Intelligence, naming the idea of an AI that would match all the cognitive abilities of a human.

- At the moment, definitely a dream, but the ultimate goal.
- Very active discussion topic after ChatGPT has been released.
- ChatGPT is nowhere near AGI, but is it a big step in that direction?

**I'm staying out of this debate!  
(Still watching it unfold though  
\*popcorn\*)**

<https://openai.com/blog/planning-for-agi-and-beyond>



TOM GAULD for NEW SCIENTIST

# The important message is...

Your learning should not stop after SUTD...

Keep learning to stay up to date, this is a very fast evolving field...

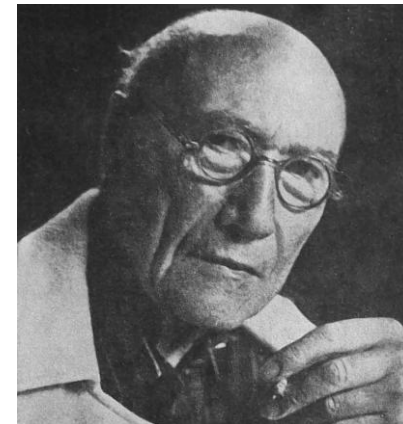
So, good luck on your continuing studies!

# More importantly

**DL/AI is a very active and fast-paced field.**

- Keep your watchlist of papers and authors up to date.
- I have mentioned researchers, which I believe are among the most notable influencers of the Deep Learning community.
- Will be adding some more names on the next slides.

*“A good professor should have this constant concern: teaching his students how to continue without him.”*  
– André Gide, Nobel Prize of Literature in 1947





# More big names to follow

Dumping them here

# Add these researchers, companies and research groups to your watchlist

- **Demis Hassabis**: Co-founder of **DeepMind**, **AlphaGo**. Several contributions in **Reinforcement Learning**.  
<https://scholar.google.com/citations?hl=en&user=dYpPMQEAAAAJ>
- **Alex Graves**: Professor at **University of Toronto**. Several contributions in **Reinforcement Learning**.  
<https://scholar.google.co.uk/citations?user=DaFHynwAAAAJ&hl=en>
- **Michael I. Jordan**: Professor at **UC Berkeley**, co-inventor of LDA.  
<https://scholar.google.com/citations?user=yxUduqMAAAAJ&hl=fr>
- **Terrence Sejnowski**: Professor at **UC San Diego**, **Boltzmann machines**.  
<https://scholar.google.ca/citations?user=m1qAiOUAAAAJ&hl=en>

# Add these researchers, companies and research groups to your watchlist

- **Peter Norvig**: **Director of Research** at **Google**, co-author of the other Bible of Deep Learning  
<https://scholar.google.com/citations?user=Ol0vcWgAAAAJ&hl=en>  
<http://aima.cs.berkeley.edu/>
- **Stuart Russell**: **Professor** at **UC Berkely**, co-author of the other Bible of Deep Learning  
<https://scholar.google.com/citations?user=2oy3OXYAAAAJ&hl=en>
- **Francois Chollet**: **Researcher** at **Google**. The man behind the **Keras** framework and **Xception**.  
<https://scholar.google.com/citations?user=VfYhf2wAAAAJ&hl=en>

# Add these researchers, companies and research groups to your watchlist

- **Trevor Hastie**: Professor at Stanford, co-author of the Bible of Statistical Learning.  
<https://scholar.google.ca/citations?user=tQVe-fAAAAAJ&hl=en>  
<https://hastie.su.domains/ElemStatLearn/download.html>
- **Robert Tibshirani**: Professor at Stanford, co-author of the Bible of Statistical Learning. Inventor of the LASSO algorithm.  
[https://scholar.google.ca/citations?user=ZpG\\_cJwAAAAAJ&hl=en](https://scholar.google.ca/citations?user=ZpG_cJwAAAAAJ&hl=en)
- **Vladimir Vapnik**: Retired Professor, inventor of SVMs and many other concepts. Worked with Yann LeCun at Facebook AI.  
<https://scholar.google.com/citations?user=vtegaJgAAAAAJ&hl=fr>

# Add these researchers, companies and research groups to your watchlist

- **Fred Cummins**: Professor at **University College Dublin**, contributions to **LSTMs** and **NLP**.  
<https://scholar.google.com/citations?user=E-vg2zQAAAAJ&hl=fr>
- **Andrej Karpathy**: Former Director of AI at **Tesla**. Many contributions to Computer Vision (**Imagenet**) and NLP (**RNNs**).  
(Probably better to follow him than Elon Musk.)  
<https://scholar.google.com/citations?user=l8WuQJgAAAAJ&hl=fr>
- **Li Fei-Fei**: Professor at **Stanford**. Many contributions to Computer Vision (**Imagenet**).  
<https://scholar.google.com/citations?user=rDfyQnIAAAAAJ&hl=fr>
- **Pieter Abbeel**: Professor at **UC Berkeley**, and a leading researcher in reinforcement learning and robotics.  
<https://scholar.google.com/citations?user=vtwH6GkAAAAJ&hl=en>

# Add these researchers, companies and research groups to your watchlist

- **Anil K. Jain**: Professor at **Michigan State University**. Many contributions to Computer Vision and Statistical Learning.  
<https://scholar.google.com/citations?user=g-ZXGsAAAAJ&hl=fr>
- **Jitendra Malik**: Professor at **UC Berkeley**. Many contributions to Computer Vision and Statistical Learning.  
<https://scholar.google.com/citations?user=oY9R5YQAAAAJ&hl=fr>
- **Sebastian Thrun**: **Stanford**, cool stuff on **robotics**.  
<https://scholar.google.com/citations?user=7K34d7cAAAAJ&hl=fr>
- **Daphne Koller**: **CEO** at **InSight**, some cool **courses on Coursera**, she might be the co-founder of Coursera (?).  
<https://scholar.google.com/citations?user=5lqe53IAAAAAJ&hl=en>

# Add these researchers, companies and research groups to your watchlist

- **Andrew Ng: Professor at Stanford**, co-creator of **Coursera**. Has one of the best online courses on Deep Learning.  
<https://scholar.google.com/citations?user=mG4imMEAAAJ&hl=en>
- **Jeremy Howard: Research Scientist at University of San Francisco**, a good scout for notable research papers on Twitter and **TED talks**.  
<https://scholar.google.com/citations?user=ZWdEJ54AAAAJ&hl=en>
- **Yaser S. Abu-Mostafa: Professor at CalTech**, one of the best professors for Deep Learning out there.  
<https://dblp.org/pid/69/3008.html>
- **Rachel L. Thomas: University of San Francisco, FastAI**, some great TED conferences on AI and Deep Learning.  
<https://scholar.google.com/citations?user=BDsAYUsAAAAJ&hl=en>

# Also worth subscribing to a few free newsletters about AI/DL

- The Batch newsletter by DeepLearning.ai (<https://www.deeplearning.ai/the-batch/>)
- The Algorithm by MIT Tech Review (<https://www.technologyreview.com/newsletter-preferences/>)
- The TLDR; newsletter (<https://tldr.tech/>)
- The NLP Newsletter (<https://www.ruder.io/nlp-news/>)
- The AlphaSignal newsletter (<https://alphasignal.ai/>)

Some Medium subscription never hurts (sometimes nice, easy and accessible discussions about AI).

But most seriously though, go for Twitter and follow people.



# Some additional reading (from my reading list)

- <https://www.youtube.com/watch?v=-u6Ektrvk2U>
- [https://www.linkedin.com/posts/amanc\\_artificialintelligence-machinelearning-activity-7106125333799571457--dH5](https://www.linkedin.com/posts/amanc_artificialintelligence-machinelearning-activity-7106125333799571457--dH5)
- <https://x.com/SimonPrinceAI/status/1712801009741815965?t=FDL7a74we3RzC7FTFnMXOQ&s=19>
- [https://www.linkedin.com/posts/mehdi-zareb\\_a-visual-into-to-deep-learning-activity-7139288250514317312-mpGG/](https://www.linkedin.com/posts/mehdi-zareb_a-visual-into-to-deep-learning-activity-7139288250514317312-mpGG/)
- [https://www.linkedin.com/posts/eric-vyacheslav-156273169\\_just-came-across-the-most-comprehensive-llm-activity-7146153808933400576-laP9/](https://www.linkedin.com/posts/eric-vyacheslav-156273169_just-came-across-the-most-comprehensive-llm-activity-7146153808933400576-laP9/)

# Some additional reading (from my reading list)

- [https://x.com/matdmiller/status/1743856339493757262?t=5JF\\_O0GEkDyAZNH4XGNOAw&s=19](https://x.com/matdmiller/status/1743856339493757262?t=5JF_O0GEkDyAZNH4XGNOAw&s=19)
- [https://www.linkedin.com/posts/imarpit\\_ai-generatieveai-programming-activity-7240571936735399936-Epo1/](https://www.linkedin.com/posts/imarpit_ai-generatieveai-programming-activity-7240571936735399936-Epo1/)
- [https://www.linkedin.com/posts/fethifilali\\_state-of-ai-report-ugcPost-7251272468336693249-H8FS/](https://www.linkedin.com/posts/fethifilali_state-of-ai-report-ugcPost-7251272468336693249-H8FS/)

**Let me know if you have some reading suggestions to share!**

# Cracking the Deep Learning interview

Most BigTech companies out there will test you on your CS/DL skills upon applying to positions/jobs in their companies.

- Train!
- Many flashcards with typical AI/ML/DL questions and tasks given in technical interviews at BigTech companies.
- <https://www.algoexpert.io/machine-learning/product>
- <https://www.mlexpert.io/>

# Cracking the Deep Learning interview

More importantly, polish your GitHub with some nice ML/AI/DL projects that you can show and discuss in interviews!

- Document your codes and notebooks over the summer break!
- Many problems out there, easily investigated.
- <https://twitter.com/0xbnomial/status/1523256409529667584?t=YWXdKryCUrrJSCKWLiT4Tg&s=03>
- Other possible idea: Find one problem for each concept we discussed each week this term and make a repo/project about it!