



Doing Good Research and Experiments!

Dual-Degree orientation for CVIT Group
<https://tinyurl.com/2023CVIT-DDWorkshop>

May 27th, 2023

Slides by Vladlen Kotlun (Intel)

Doing (Good) Research



- Welcome to the CV community! [Good Citizen workshop @ CVPR 2018](#)
- What is Research?
- Ways to contribute
- Picking an area (work with your advisors on this)
- Publications
- On high standards
- Work ethic
- Ethics

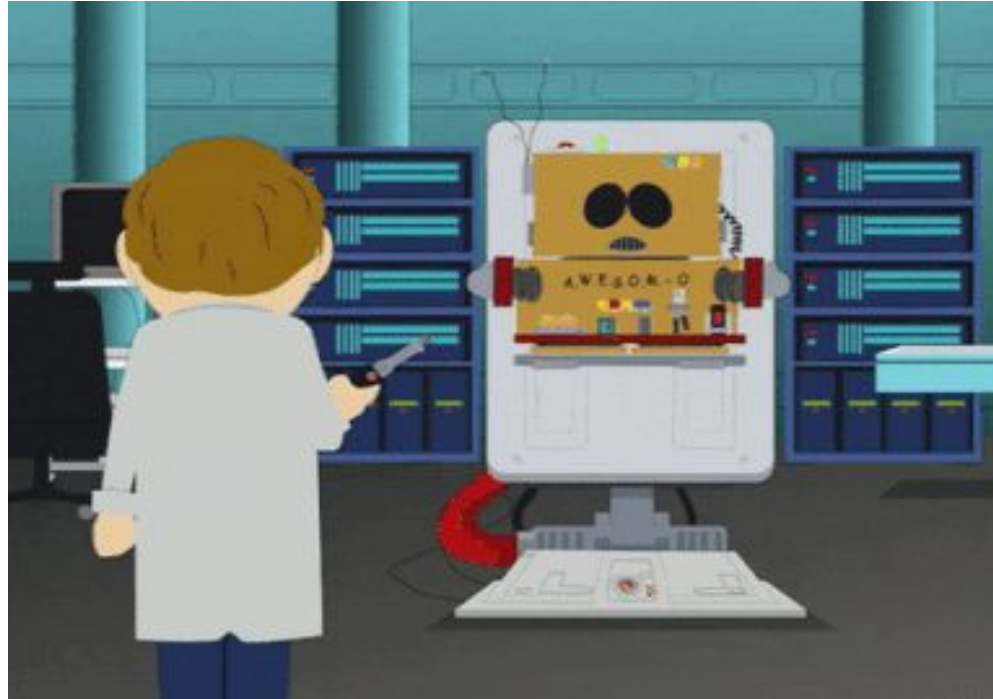
Best Practices in ML

[Link to the document](#)



- Research Attitude
 - This is not coursework
 - Creating new information is not easy
 - Celebrate the small wins
 - Adopt the scientific method
- Never forget ML 101 (even when you are experienced)
 - When working with a new dataset
 - When working with a new model
 - Loss functions and plots
 - Closing the loop
- [check out the doc]

Experiments



Wonderful Twitter threads by [Jia-Bin Huang](#)



Doing research with your advisor / mentor / collaborators

- [How to work with your advisor\(s\)?](#)
- [How to meet with your advisors/mentors?](#)
- [How to share your progress with your mentors/collaborators?](#)
- [How to do research with my mentors effectively?](#)

Writing well

- [How to write clear and concise sentences?](#)
- [How to write a paper that looks like a good one?](#)
- [How to create a good table?](#)



How to Read a Paper

How to Read a Paper

- The first pass: Quick scan
- The second pass: Figures and Tables
- The third pass: Re-implement or understand link between code and math

In general

- Read critically, understand strengths and weaknesses (unstated assumptions)
- Think of what could be improved
- Learn not just the content, but also



Tracking experiments with **W**and**B**

B.Tech@IIIT-H orientation for CVIT Lab

May 27th, 2023

Agenda

Introduce the audience to WandB and its key features, to explain the benefits of experiment tracking in machine learning, and to show you how to use WandB to improve your workflow.



Introduction- experiment tracking



What is WandB?



Let's see some **code**



- - - - - BREAK - - - - -



Overview of WandB sweep



Overview, applications and functionality in WandB website

Introduction

Experiment tracking and **WandB**.



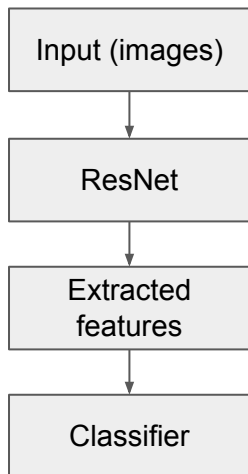
What do we mean by experiment tracking.

Improve your machine learning workflow

- Experiment tracking:
Experiment tracking refers to the process of systematically logging and organizing experiments in order to better understand the outcomes of different machine learning models and algorithms.
- Importance of experiment tracking in machine learning
Experiment tracking is critical for machine learning practitioners as it enables them to keep track of their work and reproduce their results. This is particularly important in complex projects where multiple people are working on different parts of the codebase.

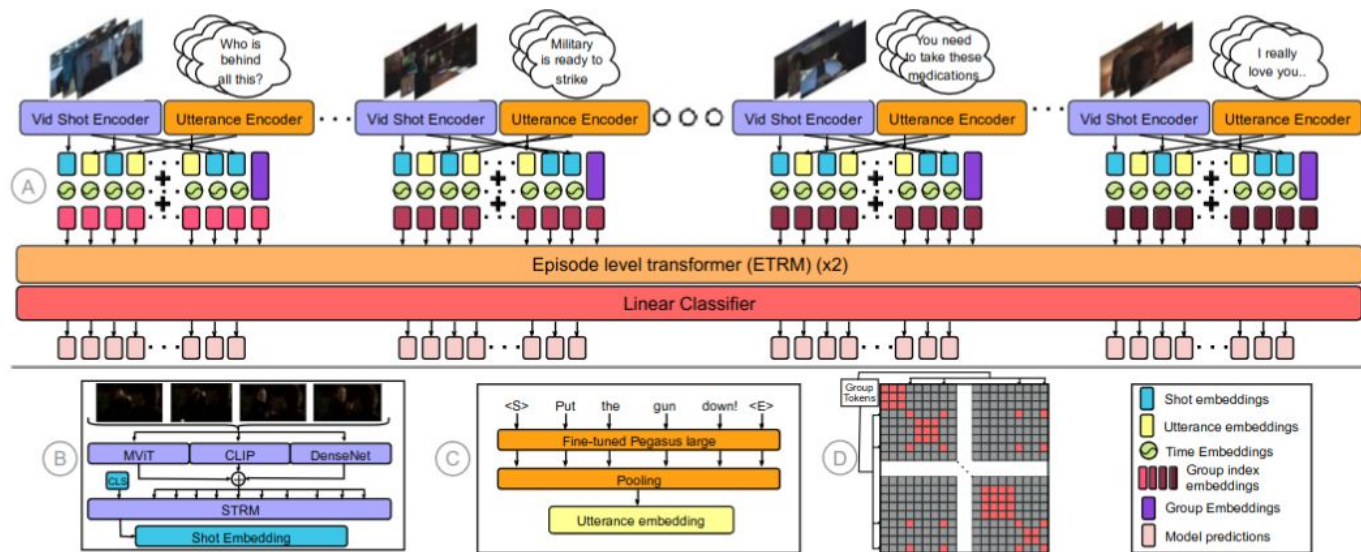
What do we mean by experiment tracking.

Projects grow and get complex over time.



What do we mean by experiment tracking.

Projects grow and get complex over time.



What do we mean by experiment tracking.

You may put a lot of efforts, those efforts should not be useless!



USEFUL



USELESS

What do we mean by experiment tracking.



How experiment runs usually look like

There is no fun in analysing this!

- {'epoch': 1, 'train_loss': 1.1452948740124702, 'eval_loss': 0.7713702845573426, 'train_ap_score': 0.6731415009678289, 'eval_ap_score': 0.8116030823185824, 'lr': 0.0001}
- {'epoch': 2, 'train_loss': 0.5890168227255345, 'eval_loss': 0.6724603283405304, 'train_ap_score': 0.8755422621356335, 'eval_ap_score': 0.8489012873912365, 'lr': 0.0001}
- {'epoch': 3, 'train_loss': 0.3640854485332966, 'eval_loss': 0.6902201867103577, 'train_ap_score': 0.9443318746126932, 'eval_ap_score': 0.8558312675174203, 'lr': 0.0001}
- {'epoch': 4, 'train_loss': 0.20835940316319465, 'eval_loss': 0.733428498506546, 'train_ap_score': 0.9796843642719427, 'eval_ap_score': 0.8559268354265821, 'lr': 0.0001}
- {'epoch': 5, 'train_loss': 0.1133101735264063, 'eval_loss': 0.8106619369983673, 'train_ap_score': 0.9937608794513503, 'eval_ap_score': 0.8549025780413813, 'lr': 0.0001}
- {'epoch': 6, 'train_loss': 0.06395852622576058, 'eval_loss': 0.872140085697174, 'train_ap_score': 0.9981744515435429, 'eval_ap_score': 0.856293925063724, 'lr': 0.0001}

What do we mean by experiment tracking.

Improve your machine learning workflow

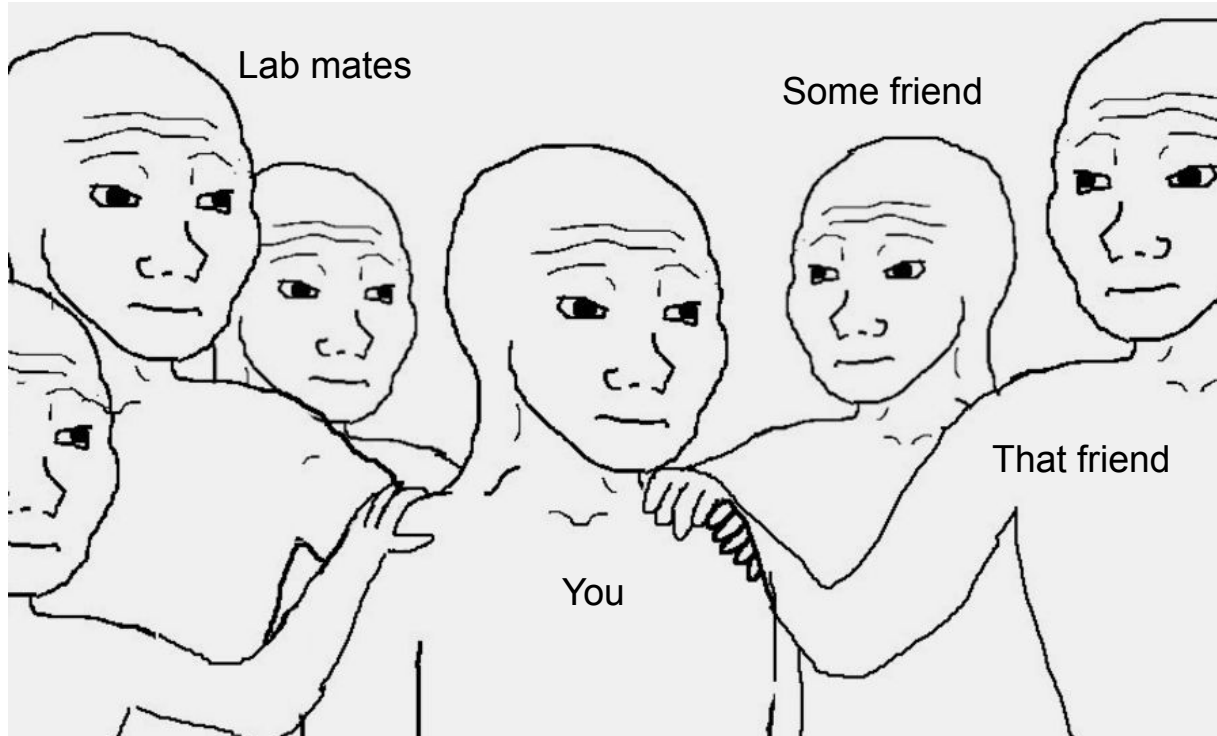


Without visualization/tracking, it is tough to answer queries like-

- How long does it take to run your experiments?
- Around what epoch does it start to overfit?
- When scheduler updated the learning rate, how much did that affect the metrics? Did it even trigger?!
- How to compare X different runs that only have change in one parameter? Which one to choose?
- Many more.....

What do we mean by experiment tracking.

Research work needs support



What do we mean by experiment tracking.

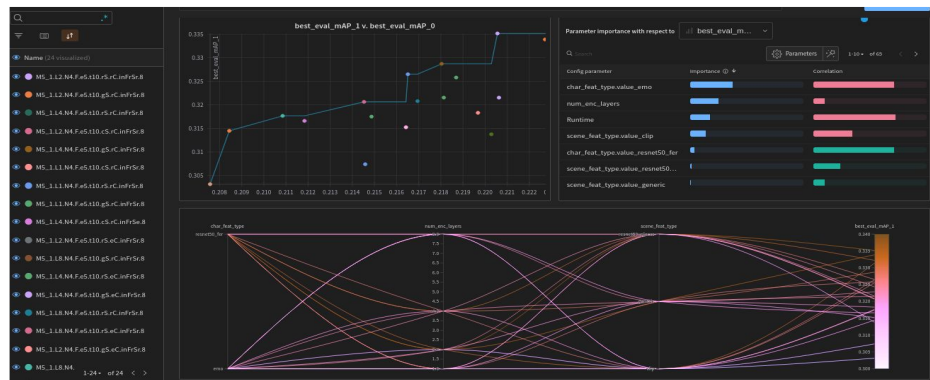
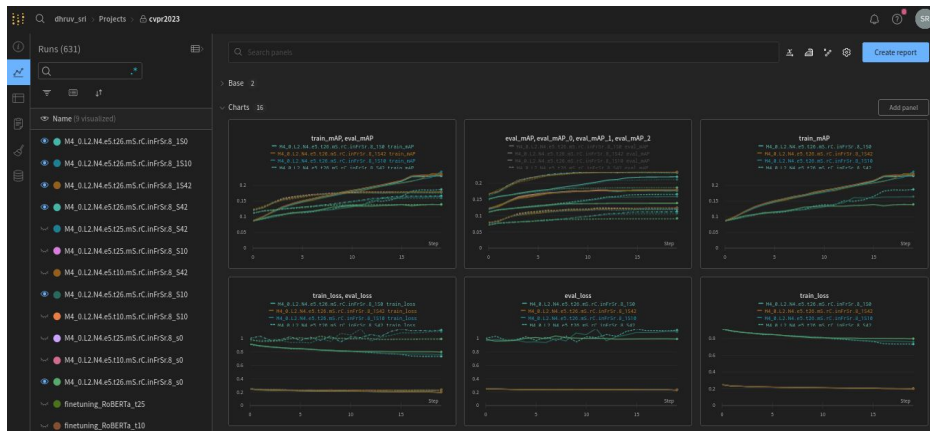
We will share one more friend with you today!



Introduction to WandB

One place for all you experiments

- WandB is a powerful experiment tracking tool that helps machine learning practitioners to keep track of their models, datasets, and experiments. WandB offers a range of features including real-time visualization, hyperparameter tuning, and experiment comparison.
- Code → github | Exp. → WandB
- Easy to configure and use!



Lets jump to code

Log some configs and experiment data to **WandB**.

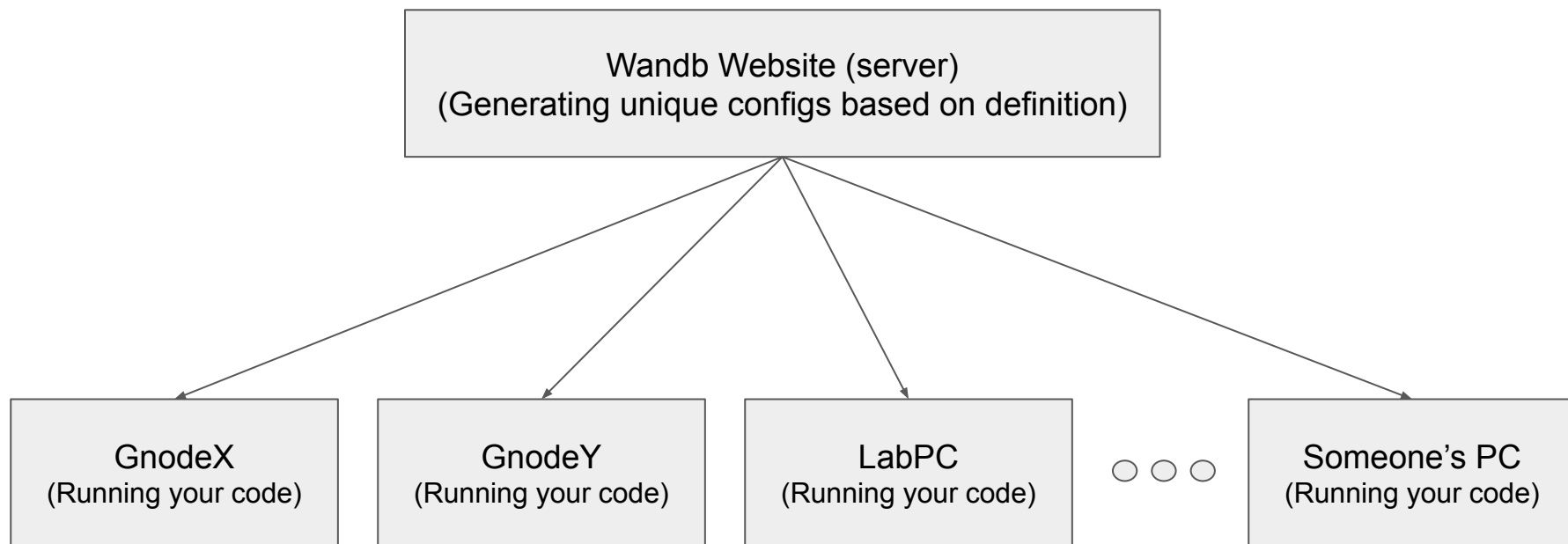
Head over to

<https://tinyurl.com/KathaAiWandB>

https://wandb.ai/dhruv_sri/wandb_demo/

WandB sweeps

Overview





Break

Visualization is worth a
thousand words 🙌:

UI/UX of WandB

WandB Functionality



UI elements from **COARSE** to **FINE** and how to effectively use them

WandB Home - the GLOBAL view of all your experiments...

The screenshot displays the WandB Home interface. On the left is a sidebar with navigation options: Home, My projects (with a search bar and a list of projects), and Applications (with links to Model registry and Launch). The main content area is titled 'Home' and features a 'Runs' section. This section contains a table of runs with columns for Name, Project, State, and Created. All runs in the table are marked as 'Finished' and were created '2 days ago'. Below the runs table is a 'Reports' section with a message: 'You haven't created any reports yet.'

Home

Runs

Name	Project	State	Created
B[C.ST.IMC]Avg-1.PL[ET.SA.WG.Split6	vidsum-abl	Finished	2 days ago
B[C.ST.IMC]Avg-1.PL[ET.SA.WG.Split5	vidsum-abl	Finished	2 days ago
B[C.ST.IMC]Avg-1.PL[ET.SA.WG.Split4	vidsum-abl	Finished	2 days ago
PGLSUM.C.IMC.TRM.Split6	vidsum-abl	Finished	2 days ago
B[C.ST.IMC]Avg-1.PL[ET.SA.WG.Split3	vidsum-abl	Finished	2 days ago
PGLSUM.C.IMC.TRM.Split5	vidsum-abl	Finished	2 days ago
B[C.ST.IMC]Avg-1.PL[ET.SA.WG.Split2	vidsum-abl	Finished	2 days ago
PGLSUM.C.IMC.TRM.Split4	vidsum-abl	Finished	2 days ago
PGLSUM.C.IMC.TRM.Split3	vidsum-abl	Finished	2 days ago
B[C.ST.IMC]Avg-1.PL[ET.SA.WG.Split1	vidsum-abl	Finished	2 days ago

Reports

You haven't created any reports yet.

WandB Functionality

UI elements from **COARSE** to **FINE**



Sections

- Charts
- Sweep (If sweeping is done)
- System
- Hidden Panels
(Smoothing, Outlier-handling, Layout Thingy)

> Charts 10

> Sweep 3

> System 20

> Hidden Panels 0

Add section












WandB Functionality

UI elements from **COARSE** to **FINE**



Adding a custom panel:

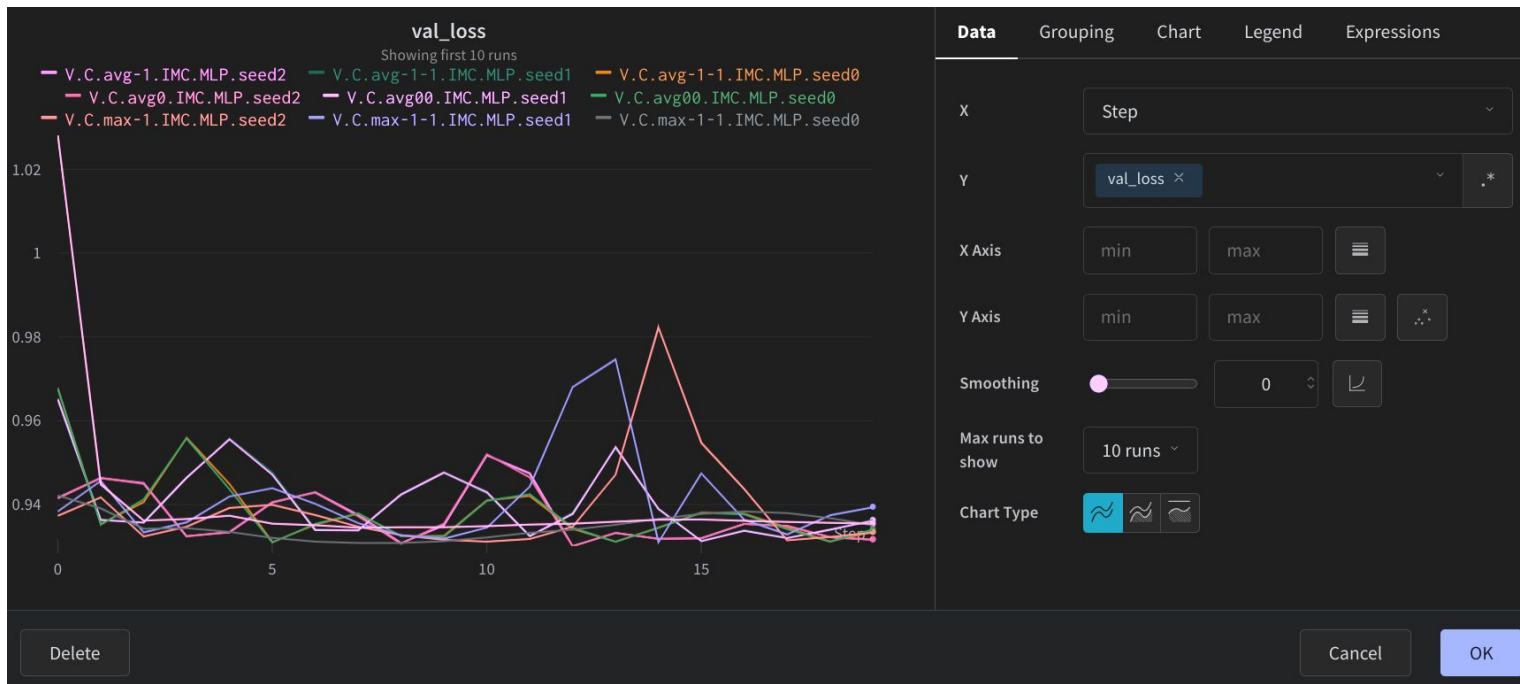
- Line/Bar/Scatter/Parallel Plots
- Run Comparer
- Parameter Importance
- Code
- Markdown
- Custom chart
- Weave (to check/verify project essentials)

-  Line plot
-  Bar chart
-  Scatter plot
-  Parallel coordinates
-  Scalar chart
-  Run comparer
-  Parameter importance
-  Code
-  Markdown
-  Custom chart
-  Weave

WandB RUNs - Chart View



- Edit panel (Data, Grouping, Chart, Legend, Expression)
- Chart, Legend, Expression)
- Miscellaneous (Export, Duplicate, Download)



WandB RUNs - Table View



- Search / Filter / Group
- Sort
- Tag
- Move / Delete
- Magic wand (feature selection)
- Columns

Sweep: V.C.Max/Avg.0/-1.seed.MLP/ET



Filter



Group



Sort



Tag



Move



Create Sweep



Columns



Name (24 selected)

val_AP

Agent

State

Notes

User

Tags

Created ▾

Runtime

Sweep

ES.early_st

ES.patience ES



V.C.avg-1.IMC.MLP.seed2

0.4183

tdyfxi5m

Finished

Add notes

rodosir

3mo ago

26m 58s

V.C.Max/Avg

true

40

tru



V.C.avg-1-1.IMC.MLP.seed1

0.4175

cwk44gm

Finished

Add notes

rodosir

3mo ago

26m 24s

V.C.Max/Avg

true

40

tru

Application of Sweeps

Generating configs automatically

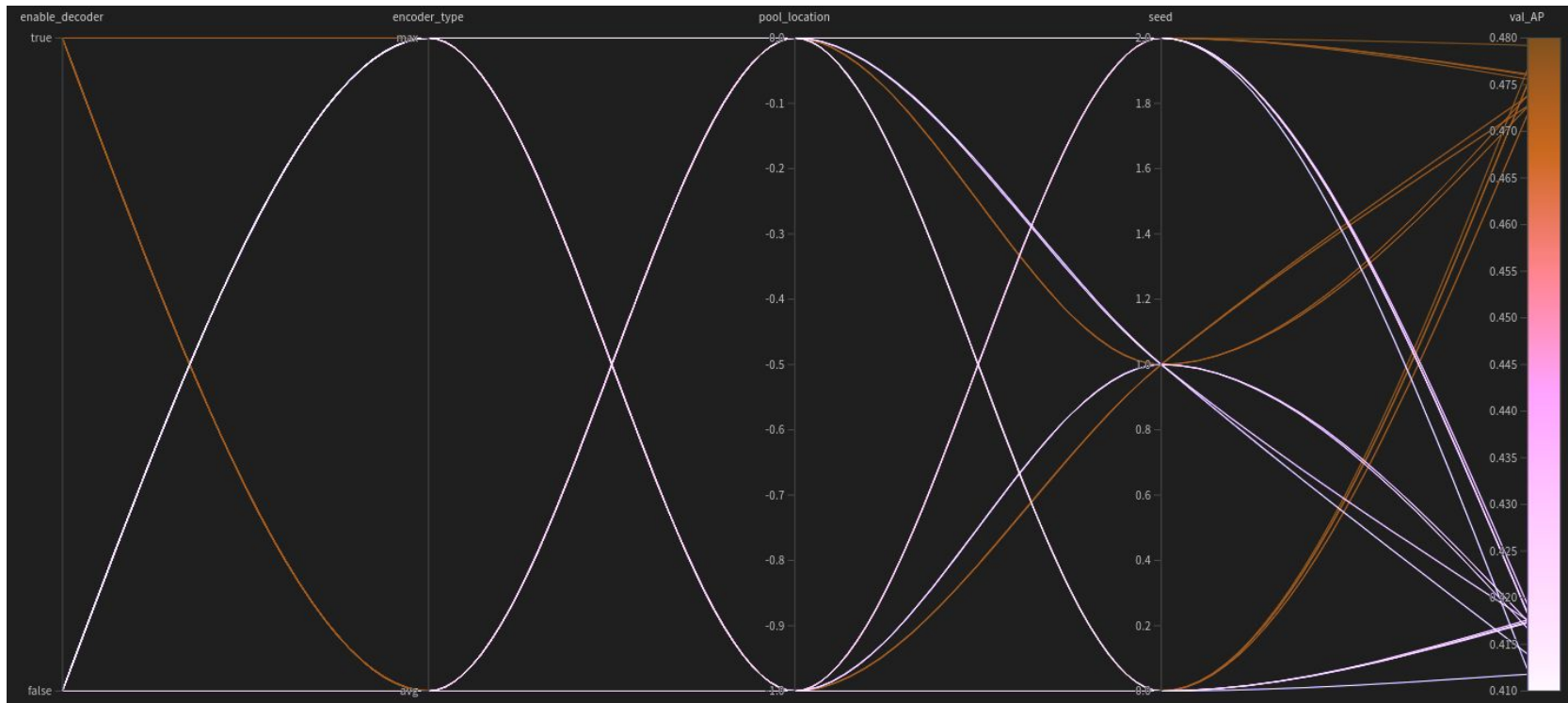


- Efficient ablation management
- Grid Search
- Visualizing and Comparing multiple runs (of our choice) through parallel coordinates plot.
- We can engage as many **gnodes** (agents/workers) we want just by mentioning **sweep-id**.

WandB Parallel Plots - A step towards HyperOpt




Parallel plots - OUR SAVIOR



Application of Sweeps (Revisited)



- Efficient ablation management: Hassle free auto execution of every combination of varying parameters.
- Grid Search: Can estimate feature importance (can be selected manually) based on metric objective.
- Visualizing and Comparing multiple runs (of our choice) through parallel coordinates plot.
- We can engage as many **gnodes** (agents/workers) we want just by mentioning **sweep-id** while submitting batch job for each **gnode**. This parallelly completes all the runs expected in that **sweep**. No need to submit usual batch job (with all pre-requirements of data and code satisfied for that gnode).
- So it does have a lot of perks, Agree? 

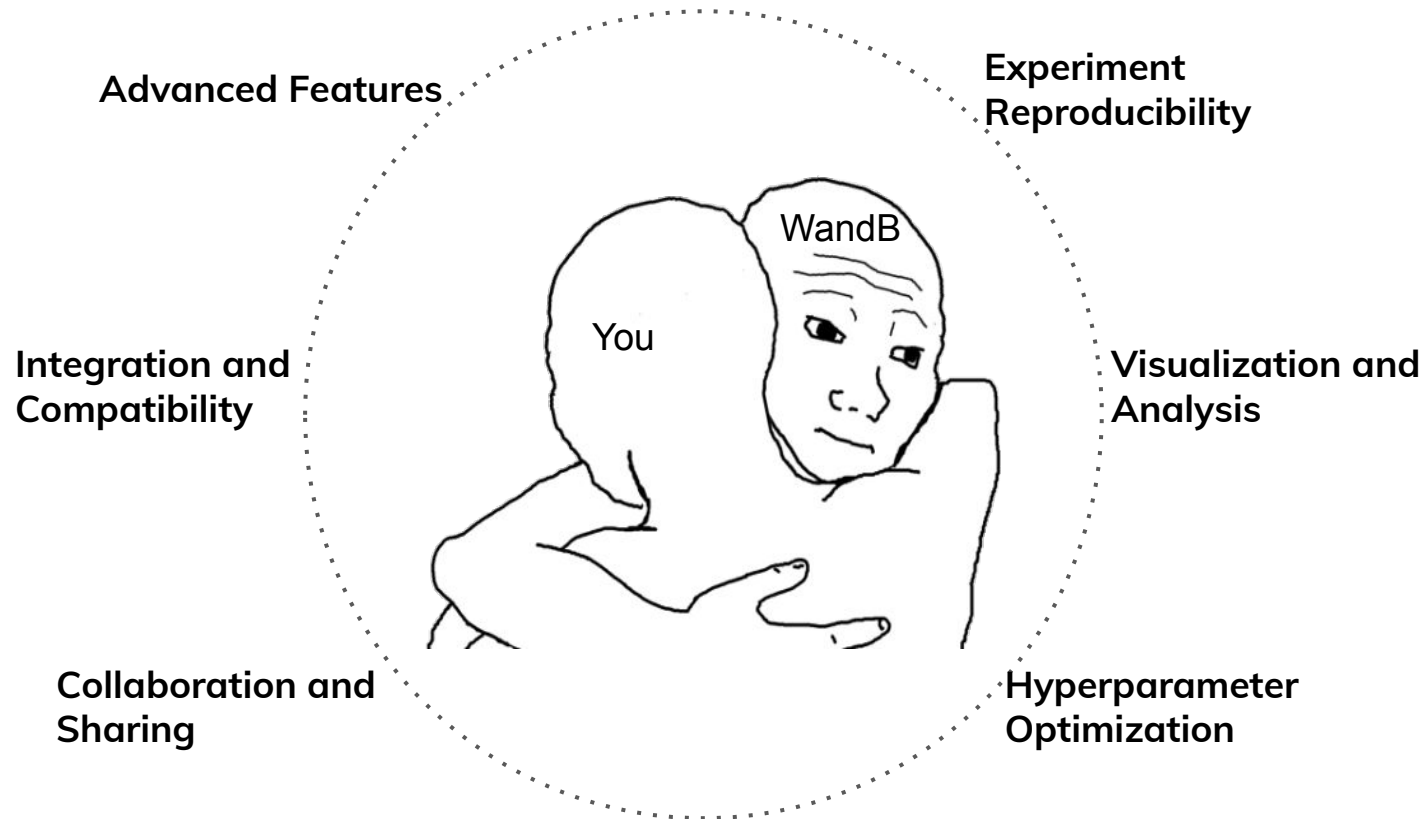
WandB Reports - [Better way to share your findings]



References:

1. [Link1](#)
2. [Link2](#)
3. [Link3](#)

ACHIEVE - 6 Perks of WandB





Research Experiences



Good Research practices

- Find the problem not the solution.
- Thorough literature review
- Designing experiments
- Analysing the outcomes
- Writing a paper
- Submitting to a conference
- Releasing the code and dataset
- Publicize your work on social media!

Multiprocessing



Single Processing :(

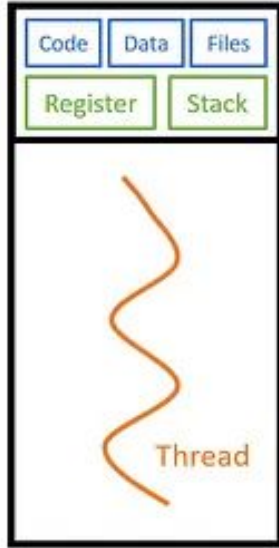


Concurrency

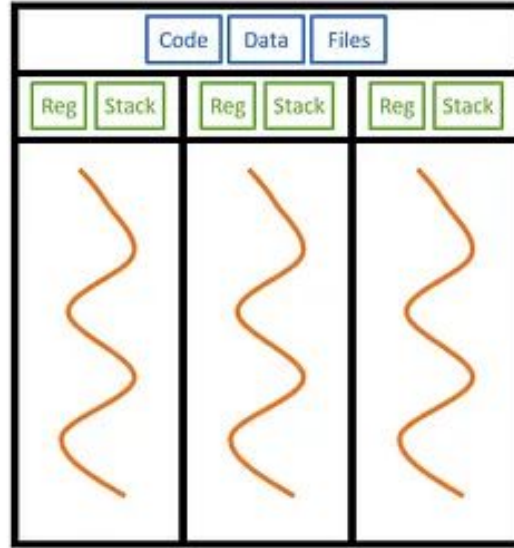


Multiprocessing

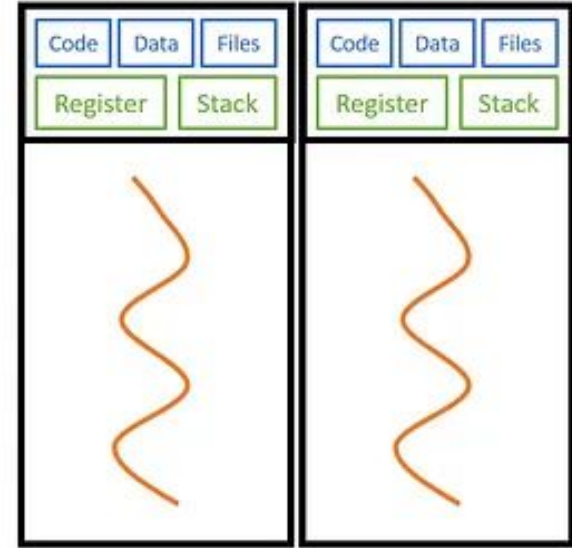
Multithreading vs Multiprocessing



Single Processor Single Thread



Single Processor Multithread



Multiprocessing

Multimodality



Credits: <https://www.dreamstime.com/royalty-free-stock-photos-juggling-color-balls-acrobat-performer-image17323338>

What are Vision Language models (VLMs)?



- VLMs are a type of neural network models that combines computer vision and natural language processing techniques to perform a variety of different multimodal tasks such as image captioning, visual question answering, and image retrieval.
- VLMs (like CLIP, Flamingo, BLIP, etc.) have been highly successful in recent years, with state-of-the-art results on various benchmark datasets for the above mentioned tasks.

What tasks can VLMs perform?



- Image Captioning
- Visual Question Answering (VQA)
- Visual Grounding
- Image-Text Matching
- Text to Image Retrieval
- Visual Scene Understanding

Image Captioning



A politician receives a gift from politician.



A collage of different colored ties on a white background.

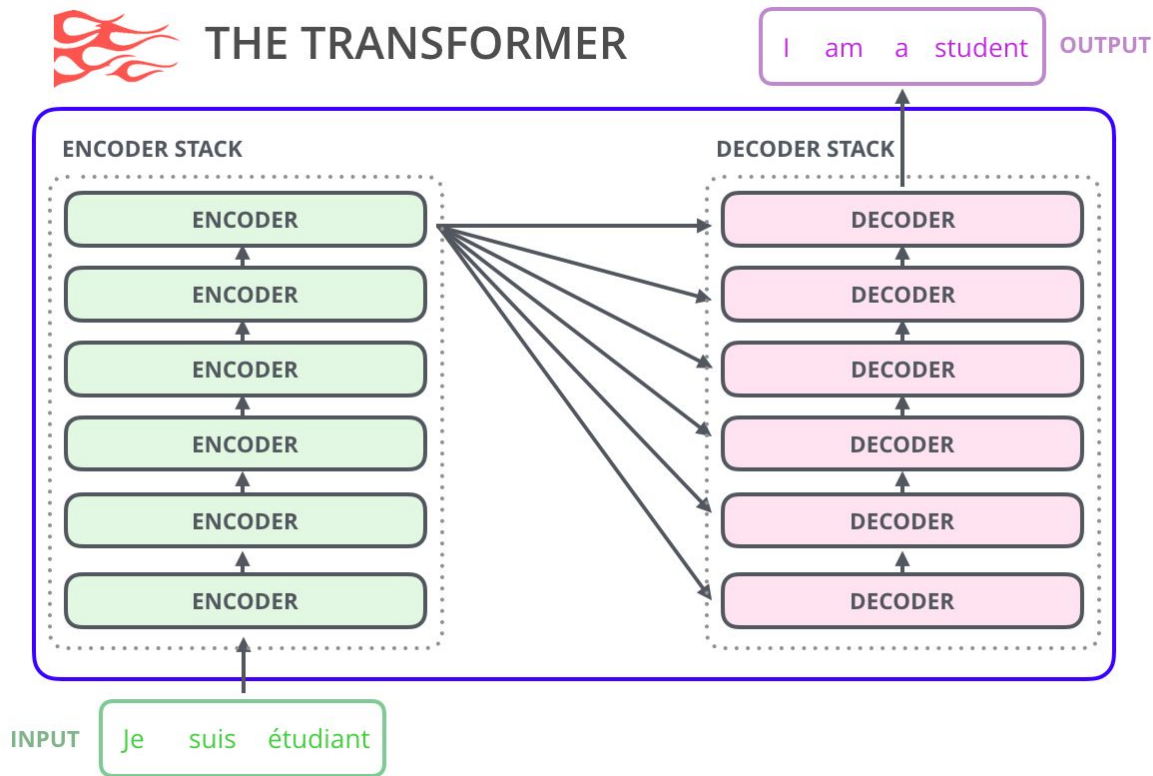


Silhouette of a woman practicing yoga on the beach at sunset.



Aerial view of a road in autumn.

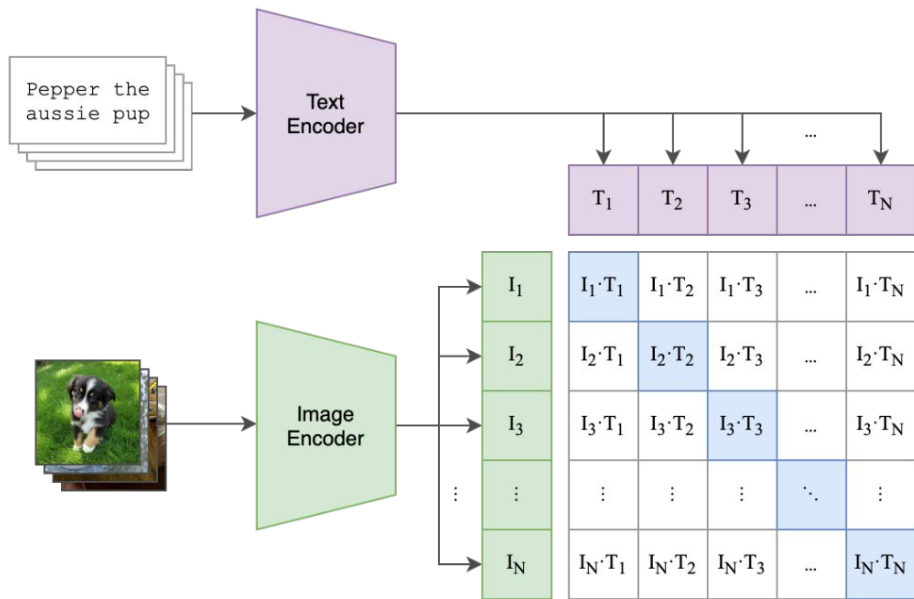
Transformer



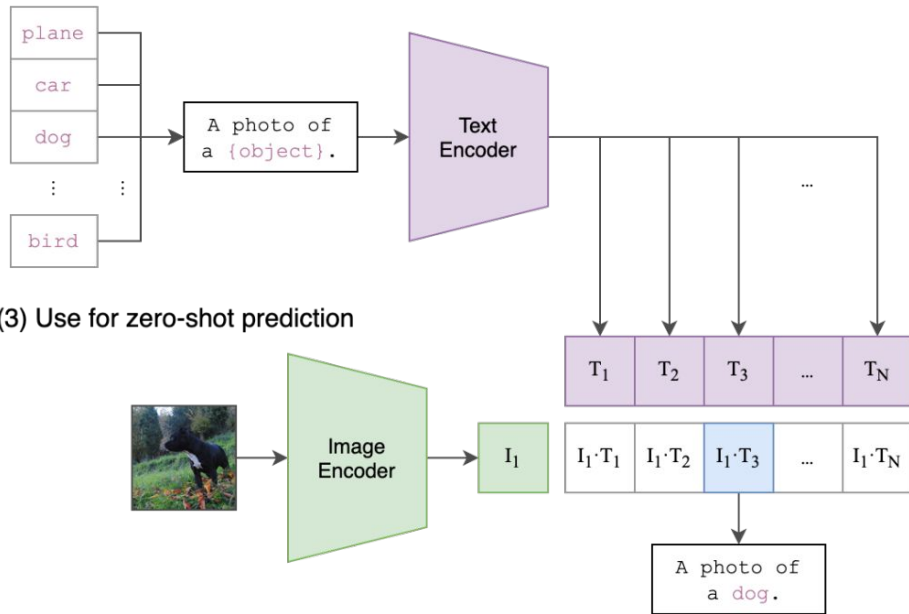
CLIP (Contrastive Language–Image Pre-training)



(1) Contrastive pre-training



(2) Create dataset classifier from label text

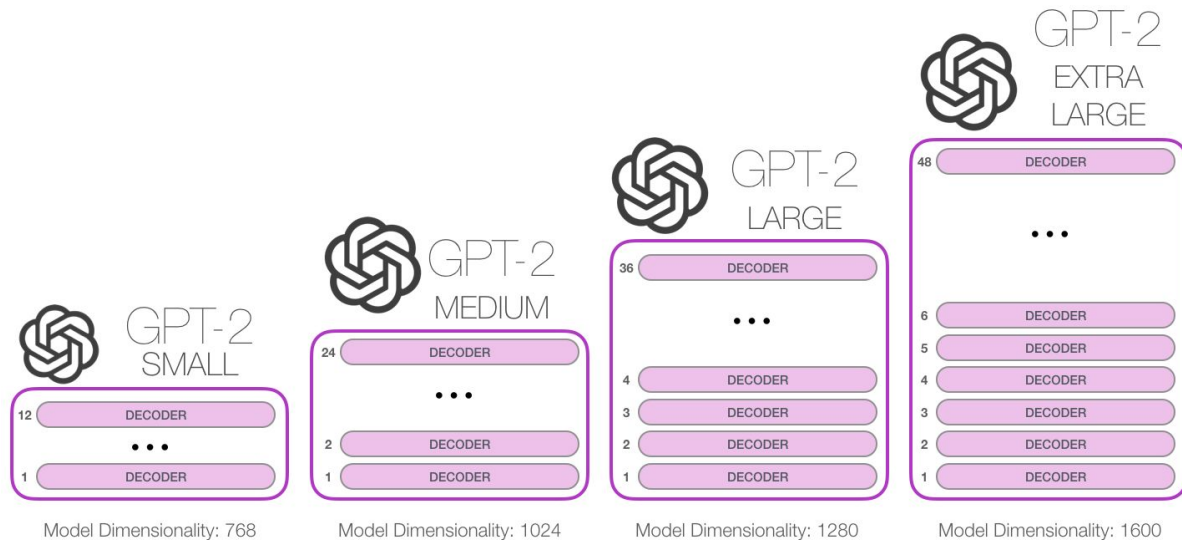


GPT: The Linguistic Genie

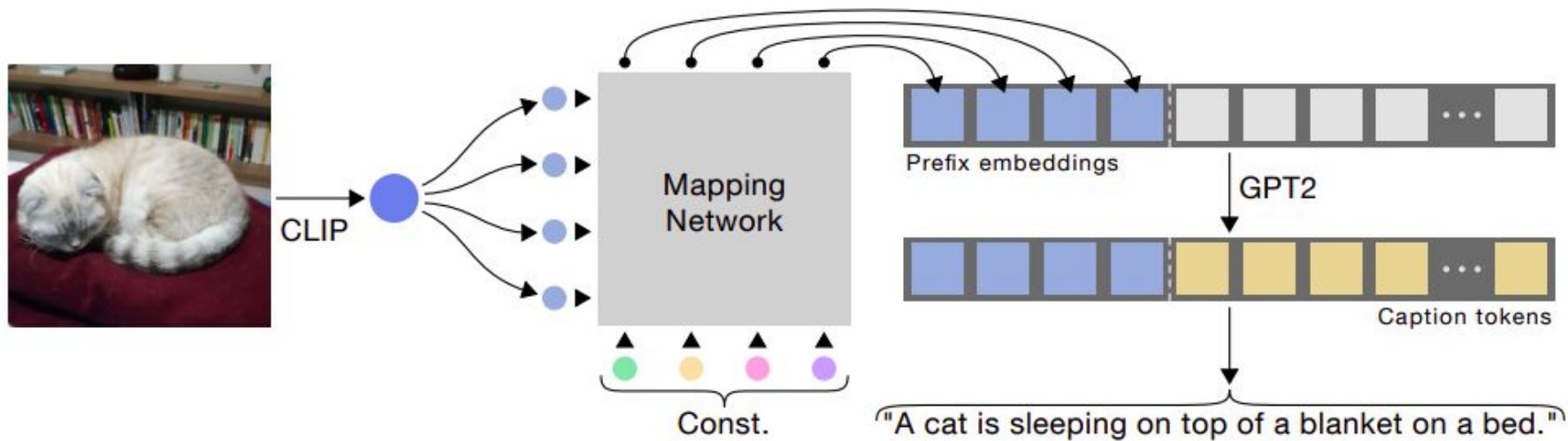


Credits: <https://www.disneyclips.com/images/images/genie-lamp2.png>

GPT-2



ClipCap: CLIP Prefix for Image Captioning¹



[1] <https://arxiv.org/abs/2111.09734>

ClipCap: Objective Function¹



Dataset: images and captions $\{x^i, c^i\}_{i=1}^N$

$$c^i = c_1^i, \dots, c_\ell^i$$

$$p_1^i, \dots, p_k^i = F(\text{CLIP}(x^i))$$

$$\mathcal{L}_X = - \sum_{i=1}^N \sum_{j=1}^{\ell} \log p_{\theta}(c_j^i | p_1^i, \dots, p_k^i, c_1^i, \dots, c_{j-1}^i)$$

[1] <https://arxiv.org/abs/2111.09734>

How and where to train the models?



**ME: LET'S RUN MACHINE
LEARNING MODELS IN HERE!**

MY 2GB RAM LAPTOP:



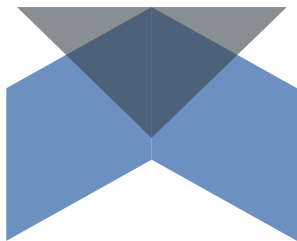
ClipCap¹



Colab Notebook: [tinyurl.com/mu8u4z9y](https://colab.research.google.com/drive/1ligZ0ZUABgcFWHKPmTgK6Sa_SVXB7hu3?usp=sharing)

(https://colab.research.google.com/drive/1ligZ0ZUABgcFWHKPmTgK6Sa_SVXB7hu3?usp=sharing)

[1] <https://arxiv.org/abs/2111.09734>



Thank You