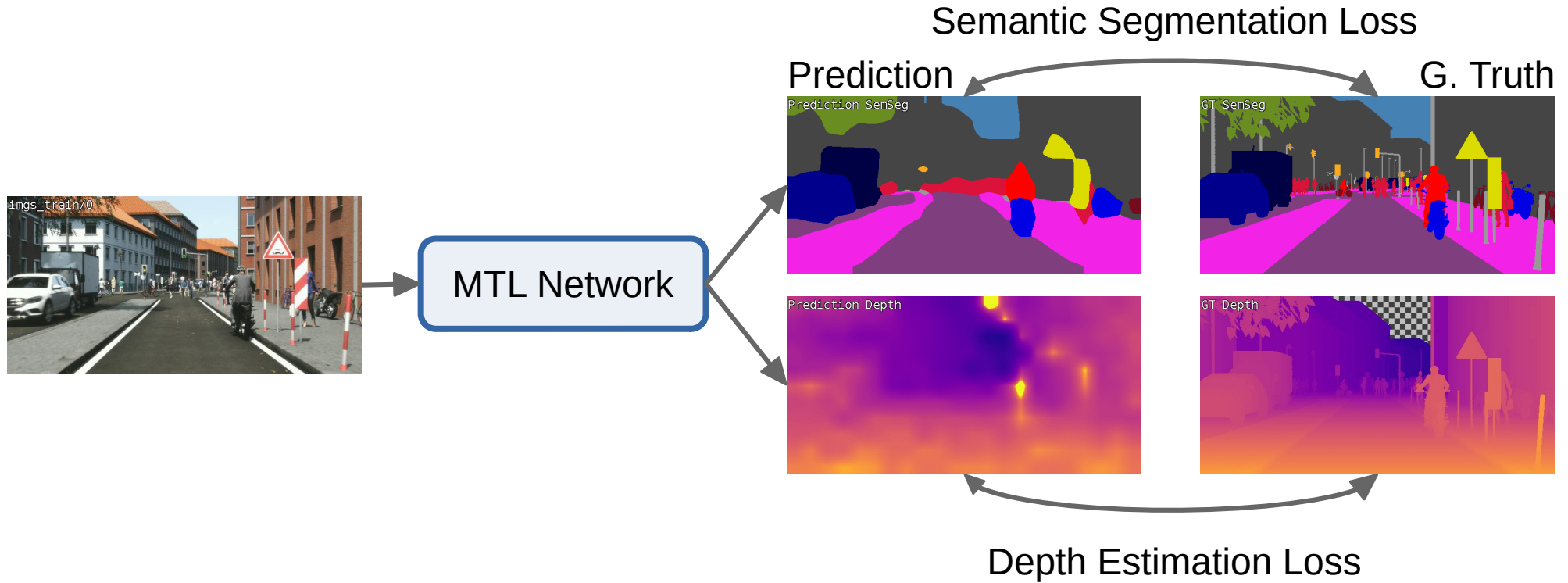


Deep Learning for Autonomous Driving

Project 2: Multi-Task Learning for Semantics and Depth

Lukas Hoyer, Qin Wang, Anton Obukhov, Dengxin Dai

Multi-Task Learning (MTL)



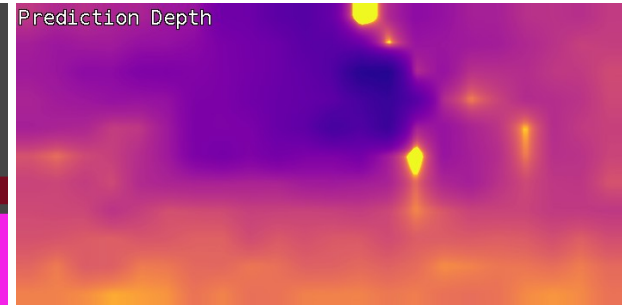
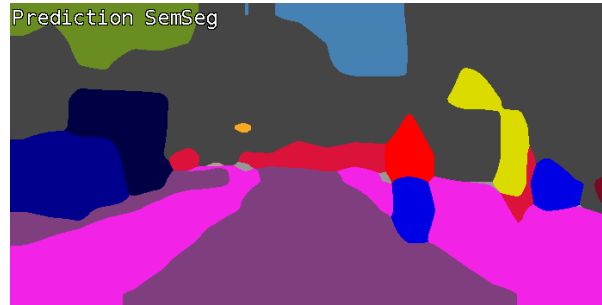
Learning Objectives

- Apply concepts of the lecture in practice
- Compose networks with multiple task branches
- Implement a selection of advanced network modules
- Train networks in the cloud with AWS
- Explore and tune hyperparameters
- Ablate and understand network components
- Present your results, observations, and discussion in a report

Solution Template

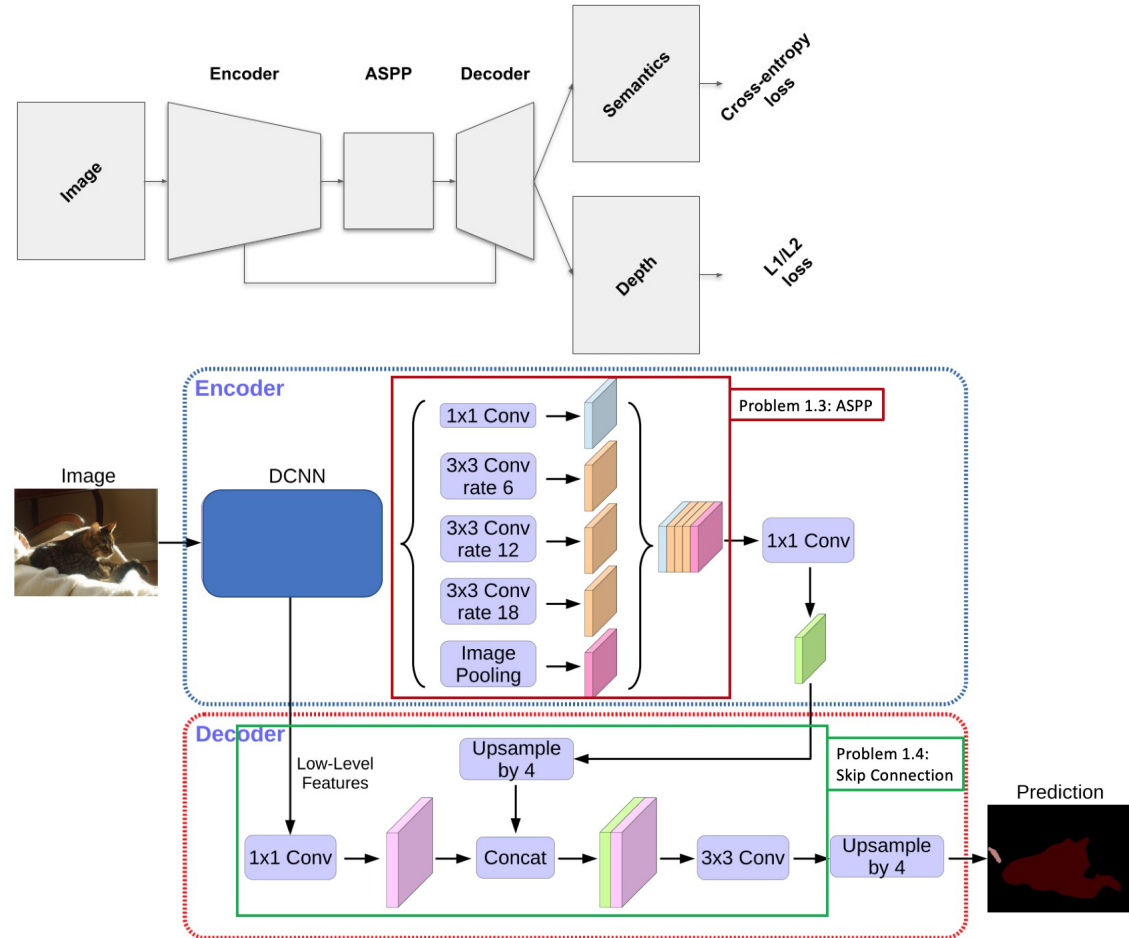
- Functional solution template:
<https://gitlab.ethz.ch/dlad21/exercise2>
- Quite poor MTL performance
- Starting point for exercise 2

Solution template without modifications



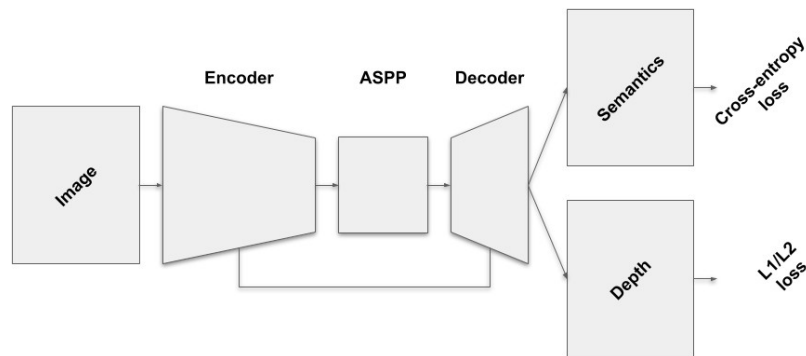
Problem 1: Joint Architecture

- Hyperparameters
- Encoder Initialization
- Dilated Convolutions
- ASPP
- Skip Connections



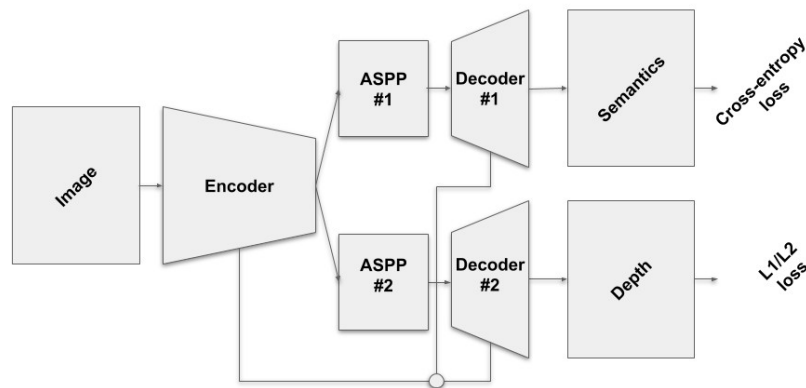
Problem 2: Branched Architecture

Joint Architecture



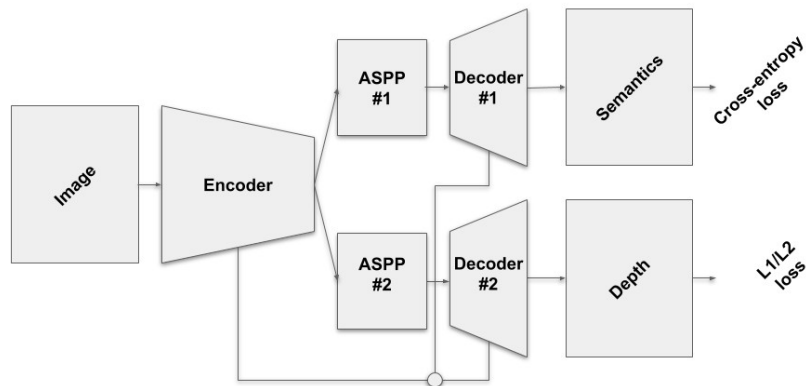
Introduce Task-Specific Decoder

Branched Architecture



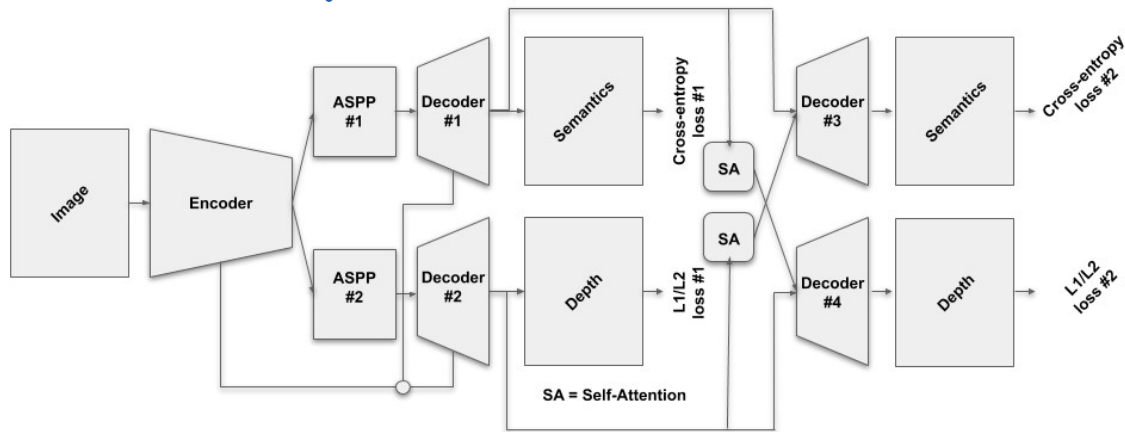
Problem 3: Task Distillation

Branched Architecture



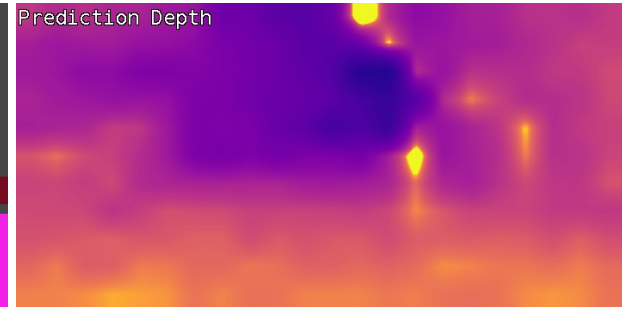
Introduce Cross-Task Distillation

Task Distillation

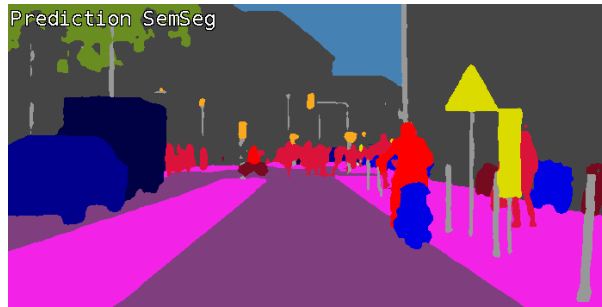


What you will achieve

Solution template without modifications



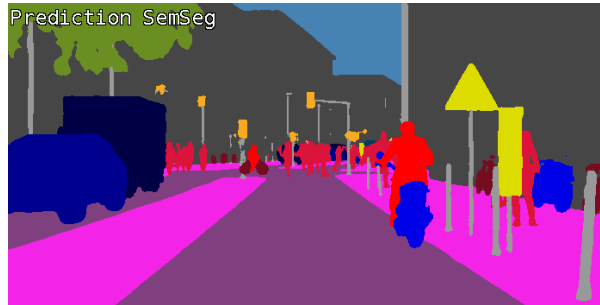
After completing problem 3 (results can vary)



Problem 4: Open Challenge

- Explore your own ideas to improve MTL!
- Inspirations are provided in the handout
- Grading
 - MTL performance
 - Implementation effort
 - In-depth analysis (ablations, parameter study, discussion, ...)
 - Discussion of related works

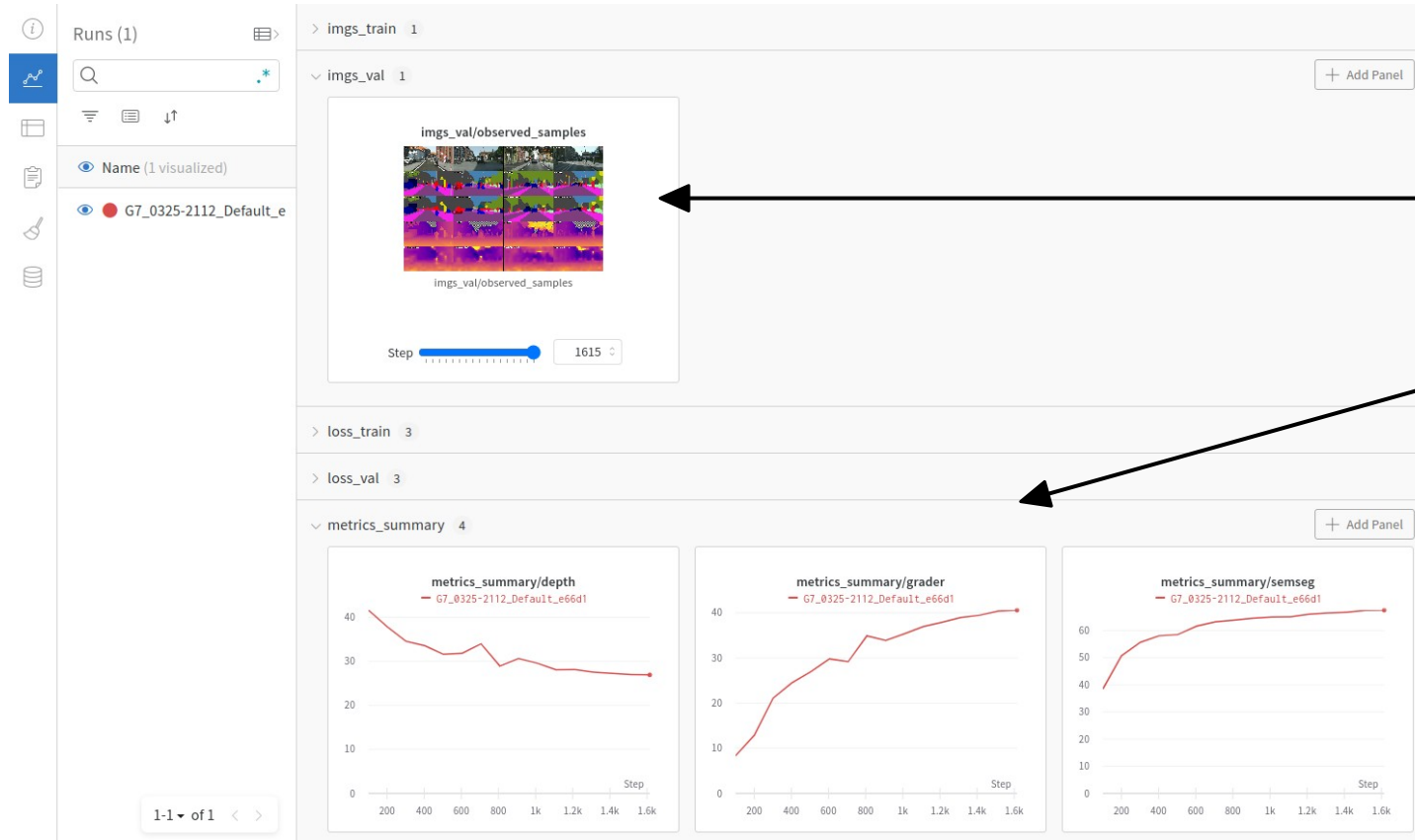
My personal best results. Can you beat it?



Training on AWS

- Setup AWS: <https://gitlab.ethz.ch/dlad21/aws-tools>
- Launch training from exercise 2 folder:
`python aws_start_instance.py`
 - Prompts team information
 - Creates AWS bucket
 - Start AWS instance
 - Syncs local source code to instance
 - Starts training (with Weights & Biases monitoring)
 - Provides ssh access information
- Monitor AWS instances:
<https://us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#Instances>
- Further details: <https://gitlab.ethz.ch/dlad21/exercise2/>

Weights & Biases (wandb)



Weights & Biases (wandb)

Runs (1)

Filter Group Sort Tag Move Create Sweep

Name (1 visualized)	Runtime	Notes	EC2_Rsync	EC2_SSH_Tmux	S3_Link	optimizer	optimizer_l	batch_size	metrics_sur	metrics_sur	metrics_sur	metrics_tas	metrics_ta
G7_0325-2112_Default	4h 28m 25	Add notes	rsync -av -	ssh -q -o StrictHos	https://s3	sgd	0.01	4	40.61	67.531	26.921	47.432	86.196

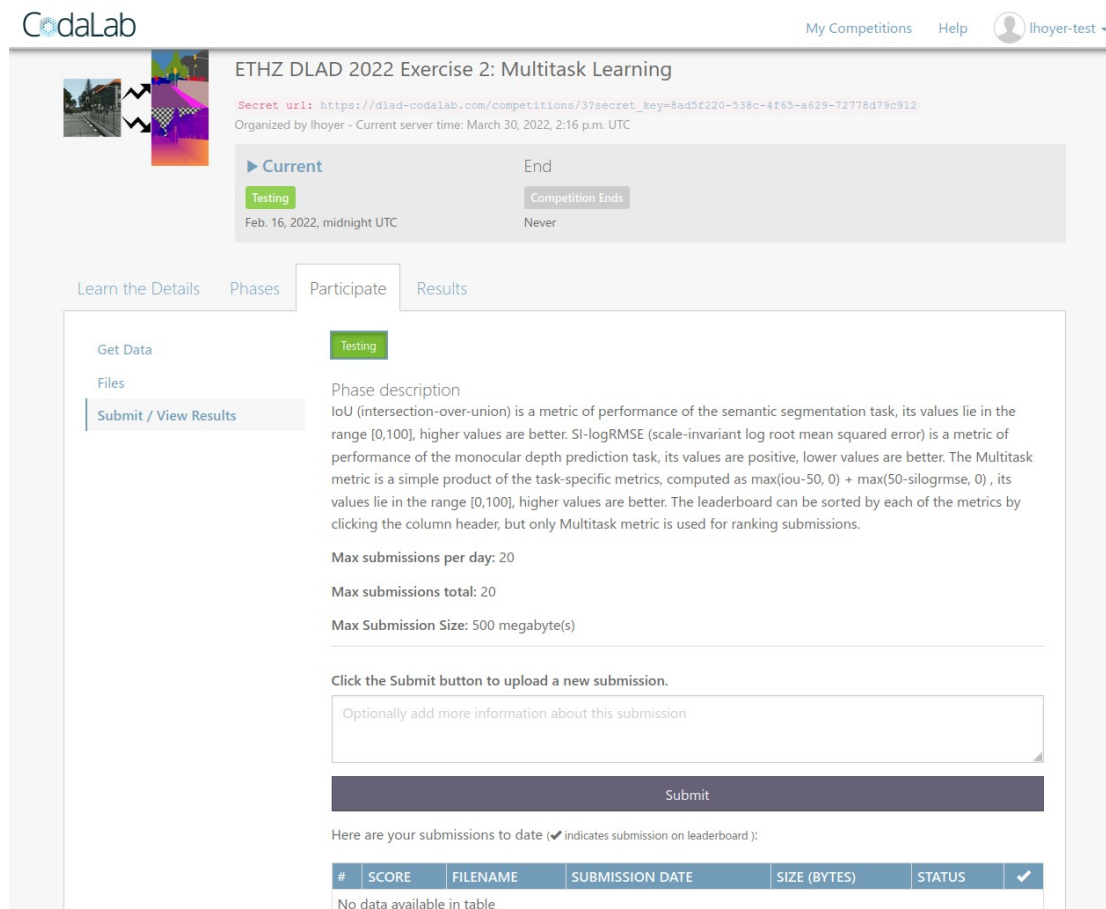
Export for W&B sheet
(part of project submission)

Select visible columns

Overview of Training Runs

- Commands & Links for AWS
- Hyperparameters
- Metrics

Codalab Grader



The screenshot shows the CodaLab Grader interface for the "ETHZ DLAD 2022 Exercise 2: Multitask Learning" competition. The header includes the CodaLab logo, navigation links for "My Competitions" and "Help", and a user profile for "lhoyer-test". The competition details section shows the "Current" phase is "Testing" (Feb. 16, 2022, midnight UTC) and the "Competition Ends" at "Never". The "Participate" tab is active, displaying a "Testing" status and a "Phase description" for the Multitask metric. The description explains that the Multitask metric is a simple product of task-specific metrics (IoU and SI-logRMSE) and can be sorted by clicking the column header. Submission limits are listed: 20 submissions per day, 20 total, and a maximum size of 500 megabyte(s). A "Submit" button is present, along with a text area for optional submission information. Below the submission area, a table shows the user's submissions to date, with columns for #, SCORE, FILENAME, SUBMISSION DATE, SIZE (BYTES), STATUS, and a checkmark for leaderboard status. The table currently shows "No data available in table".

ETHZ DLAD 2022 Exercise 2: Multitask Learning

Secret url: https://dlad-codalab.com/competitions/3?secret_key=8ad5f220-538c-4f65-a629-72778d79c912

Organized by lhoyer - Current server time: March 30, 2022, 2:16 p.m. UTC

Current: Feb. 16, 2022, midnight UTC

End: Never

Competition Ends

Learn the Details Phases Participate Results

Get Data Files Submit / View Results

Testing

Phase description

IoU (intersection-over-union) is a metric of performance of the semantic segmentation task, its values lie in the range [0,100], higher values are better. SI-logRMSE (scale-invariant log root mean squared error) is a metric of performance of the monocular depth prediction task, its values are positive, lower values are better. The Multitask metric is a simple product of the task-specific metrics, computed as $\max(\text{iou}-50, 0) + \max(50-\text{si-logrmse}, 0)$, its values lie in the range [0,100], higher values are better. The leaderboard can be sorted by each of the metrics by clicking the column header, but only Multitask metric is used for ranking submissions.

Max submissions per day: 20

Max submissions total: 20

Max Submission Size: 500 megabyte(s)

Click the Submit button to upload a new submission.

Optionally add more information about this submission

Submit

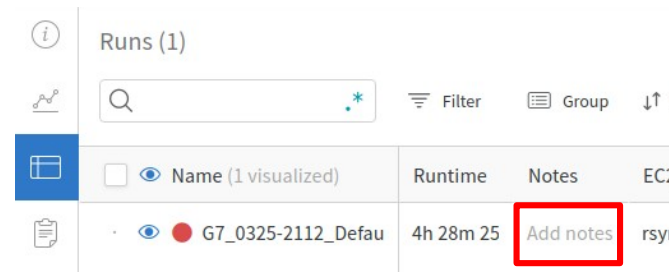
Here are your submissions to date (✓ indicates submission on leaderboard):

#	SCORE	FILENAME	SUBMISSION DATE	SIZE (BYTES)	STATUS	✓
No data available in table						

- Evaluate your model on the (private) test set
- Scores for project submission
- Public leaderboard

Final Submission

- Deadline: 13-05-2022
- 25% of course grade
- Project Report
 - Describe solution and provide source code snippets
 - Answer questions based on experiments
 - Present experimental results clearly and concisely (tables, example predictions, diagrams)
 - Describe observations and discuss possible reasons
- W&B Score Sheet
 - Annotate and export data (show all columns)
 - Do not delete AWS S3 data of runs used in report
- Grader Score Sheet (exercise2/doc/dlad22_teamXX_ex2_scores.csv)
 - Enter CodaLab grader scores of best run for each task
- Detailed instructions & grading criteria in handout



The screenshot shows the CodaLab 'Runs' interface. At the top, there's a search bar and filters. Below, a table lists runs. The first run is 'G7_0325-2112_Defau' with a runtime of '4h 28m 25'. The 'Notes' column for this run contains a red box with the text 'Add notes'.

Name (1 visualized)	Runtime	Notes	EC
G7_0325-2112_Defau	4h 28m 25	Add notes	rsy

Hints

- **Start training early!**
 - A training run can take up to 24 hours (or even more for open challenge)
 - Your training might be interrupted when AWS is crowded (e.g. before a conference deadline)
 - You might discover a bug that requires retraining previous experiments
- You are allowed to use two p2.xlarge spot instances
- Read the handout carefully, consider the evaluation criteria, and answer all questions

Resources

- Exercise Handout (with detailed instructions and grading information):
<https://gitlab.ethz.ch/dlad21/exercise2/-/blob/master/doc/handout.pdf>
- AWS Tutorial:
<https://gitlab.ethz.ch/dlad21/aws-tools>
- Solution Template (with technical instructions in README.md):
<https://gitlab.ethz.ch/dlad21/exercise2>
- CodaLab Grader:
http://dlad-codalab.com/competitions/3?secret_key=8ad5f220-538c-4f65-a629-72778d79c912