Master in Computer Vision Barcelona

Project Module 4 Coordination

Video Surveillance for Road Traffic Monitoring

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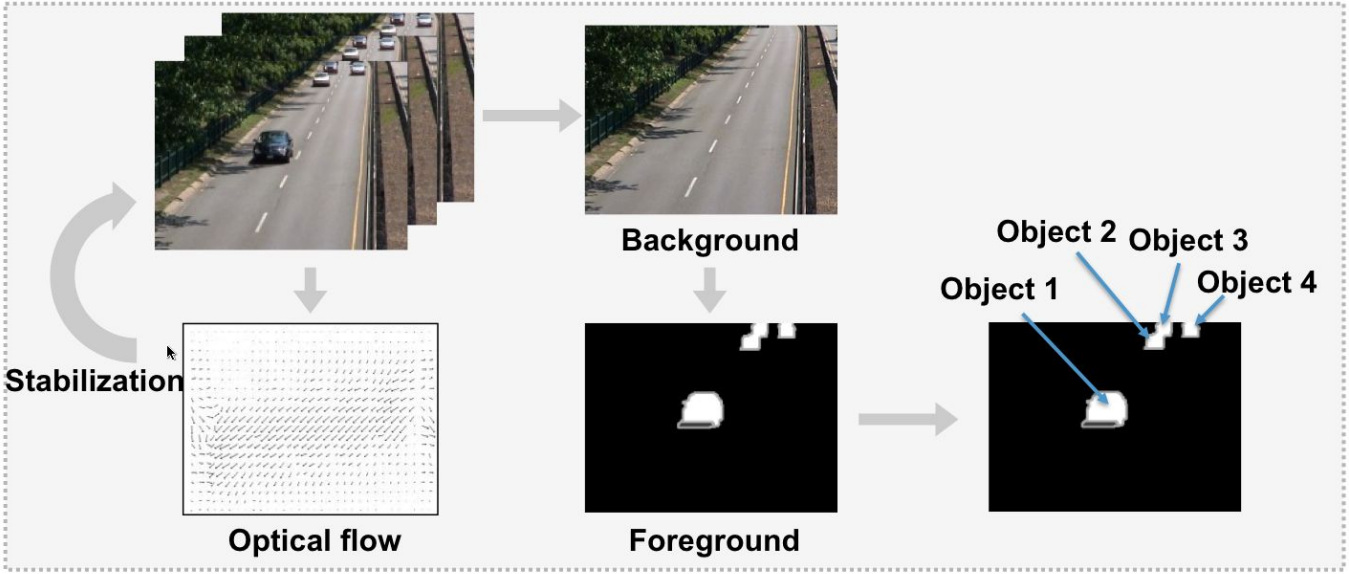
Week 1: Tasks Description

Project Schedule



Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
•Introduction •DB •Evaluation metrics	•Background estimation •Stauffer & Grimson	•Foreground segmentation •Area filter •Hole filling •Shadow removal	•Optical flow •Video stabilization	•Region tracking •Kalman filter	**•Presentation**

Master in Computer Vision Barcelona

Goals Week 1

- Understand and become familiar with the programming framework used in the project (Matlab/Python).
- Learn about the databases to be used
- Implement the evaluation metrics and graphs used during the module.
- Read / write video sequences and ground truth.

Evaluation metrics

Confusion matrices provide a by-class comparison between the results of the automatic classifications with ground truth annotations.

		Automatic		
		class1	class2	class3
Manual	class1	12	1	0
	class2	3	13	0
	class3	0	0	20

		Automatic		
		class1	class2	class3
Manual	class1	100%	0%	0%
	class2	0%	100%	0%
	class3	0%	0%	100%

Evaluation metrics

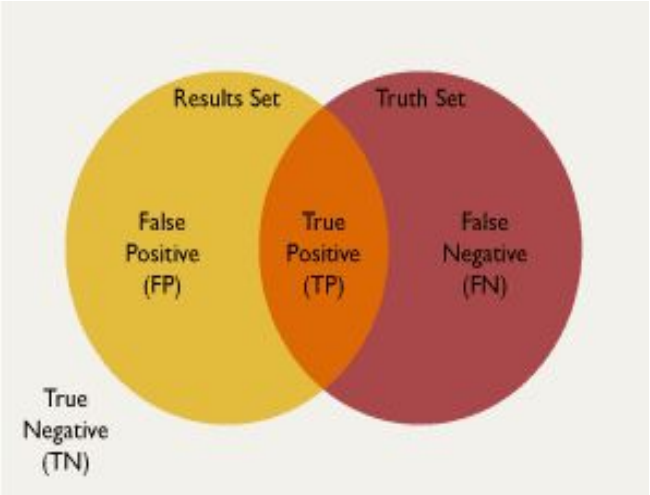
Correct classifications appear in the diagonal, while the rest of cells correspond to errors.

		Prediction		
		Class 1	Class 2	Class 3
Ground Truth	Class 1	x(1,1)	x(1,2)	x(1,3)
	Class 2	x(2,1)	x(2,2)	x(2,3)
	Class 3	x(3,1)	x(3,2)	x(3,3)

Evaluation metrics

Special case: Binary classifiers in terms of “Positive” vs “Negative”.

		Prediction	
		Positives	negative
Ground Truth	Positives	True positive (TP)	False negative (FN)
	negative	False positives (FP)	True negative (TN)



Evaluation metrics

The “accuracy” measures the proportion of correct classifications, not distinguishing between classes.

$$Accuracy = \frac{\sum_{i=1}^{3} x(i,i)}{\sum_{i=1}^{3}\sum_{j=1}^{3} x(i,j)}$$

Binary

$$Accuracy = \frac{TP+TN}{TP+TP+FP+FN}$$

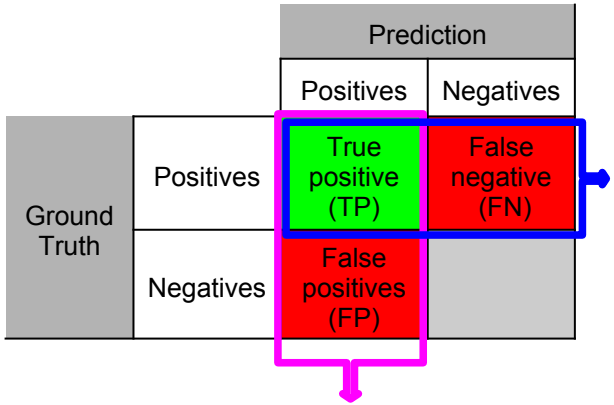
		Prediction		
		Class 1	Class 2	Class 3
Ground Truth	Class 1	x(1,1)	x(1,2)	x(1,3)
	Class 2	x(2,1)	x(2,2)	x(2,3)
	Class 3	x(3,1)	x(3,2)	x(3,3)

		Prediction	
		Positives	negative
Ground Truth	Positives	True positive (TP)	False negative (FN)
	Negative	False positives (FP)	True negative (TN)

Evaluation metrics

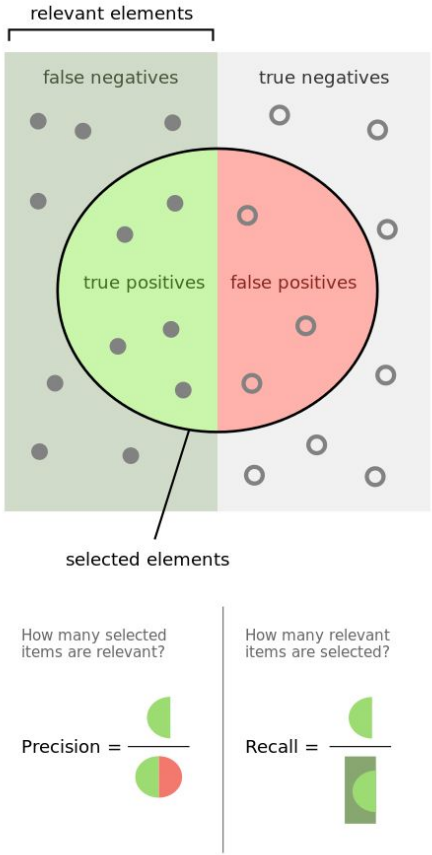
Given a reference class, its Precision (P) and Recall (R) are complementary measures of relevance.

Example: Relevant class is "Positive" in a binary classifier.



$$Recall = \frac{TP}{TP + FN}$$

$$Precision = \frac{TP}{TP + FP}$$



Evaluation metrics

Given a reference class, its Precision (P) and Recall (R) are complementary measures of relevance.

Example: Relevant class *"n"*.

$$P(Class\ \ n) = \frac{x(n,n)}{\sum_{i \neq n} x(i,n)}$$

$$R(Class\ \ n) = \frac{x(n,n)}{\sum_{i \neq n} x(n,i)}$$

		Prediction		
		Class 1	Class 2	Class 3
Ground Truth	Class 1	x(1,1)	x(1,2)	x(1,3)
	Class 2	x(2,1)	x(2,2)	x(2,3)
	Class 3	x(3,1)	x(3,2)	x(3,3)

Evaluation metrics

F1 score (F-Measure) combines Precision and Recall in a single measure.

$$F_1 = 2\frac{P \cdot R}{P + R}$$

A more general formula allows assigning a higher weight to Precision (beta > 1) or Recall (beta<1).

$$F_\beta = (1 + \beta^2)\frac{P \cdot R}{(\beta^2 \cdot P) + R}$$

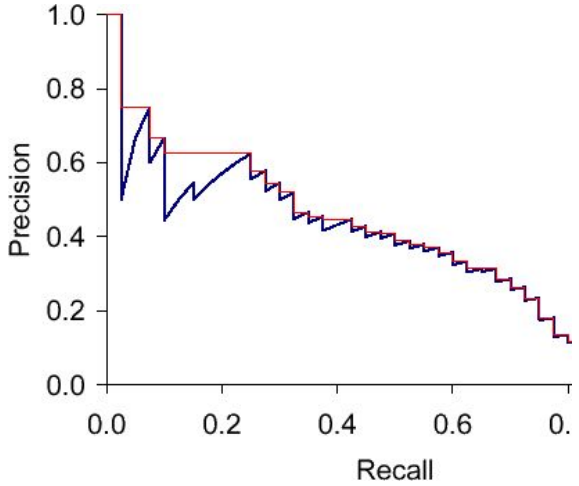
Evaluation metrics

Binary classification results often depend from a parameter (eg. decision threshold) whose value directly impacts precision and recall. For this reason, in many cases a Precision-Recall Curve (PR curve) is provided as a result.

The Area Under the Curve (AUC) provides a numerical assessement of the quality of the system.

$$Precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$



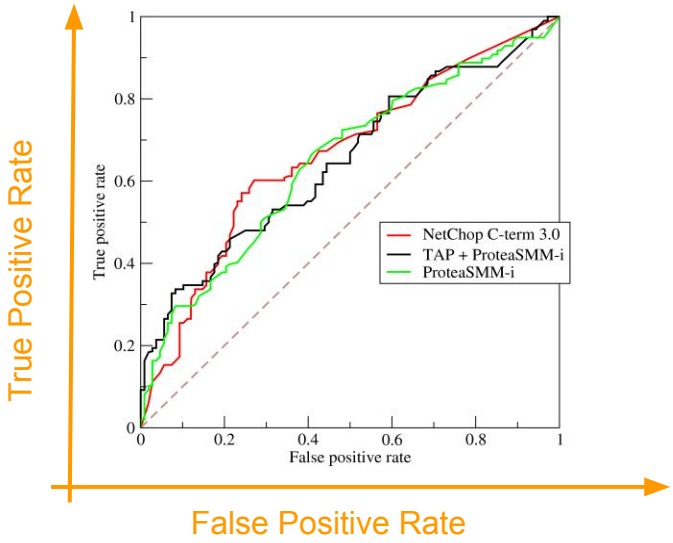
+ info on PR curve: http://nlp.stanford.edu/IR-book/html/htmledition/evaluation-of-ranked-retrieval-results-1.html
+ info on AUC: http://fastml.com/what-you-wanted-to-know-about-auc/

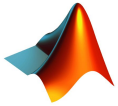
Evaluation metrics

The Receiver Operating Characteristic (ROC) is a similar curve also very popular in classification problems.

$$True\ Positive\ Rate = \frac{TP}{TP+FN} = Recall = Sensitivity$$

$$False\ Positive\ Rate = \frac{FP}{TP+FN} = 1 - specificity$$



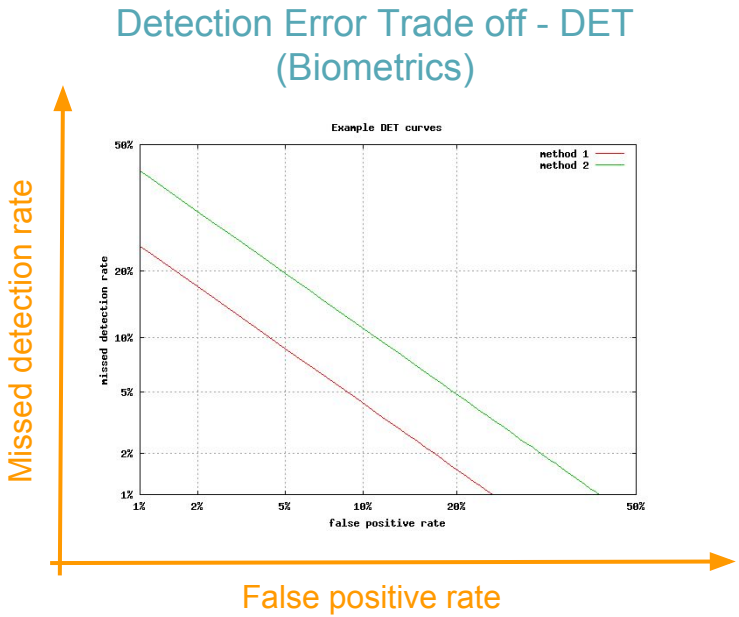


Matlab tip: *perfcurve* can computes ROC and PR curves, and their associated AUCs.

+ info on PR vs ROC curves: Davis, Jesse, and Mark Goadrich. "The relationship between Precision-Recall and ROC curves." *Proceedings of the 23rd international conference on Machine learning*. ACM, 2006.

Evaluation metrics

Similar curves to the PR and ROC ones are common in related fields to computer vision:



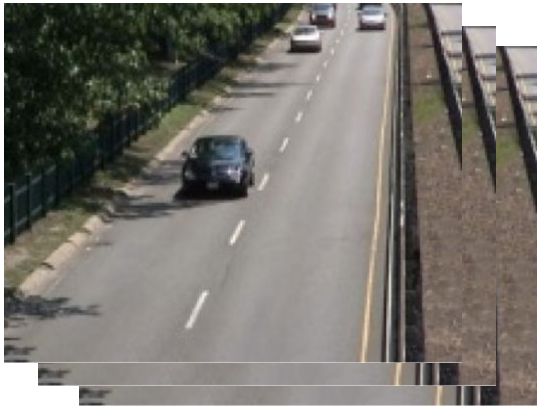
Tasks

- Mandatory
  - Task 1: segmentation metrics (total).
  - Task 2: understand precision & recall.
  - Task 3: segmentation metrics (frame by frame).
  - Task 4 & 5: optical flow evaluation metrics.
- Optional
  - Task 5: De-synchornized results.
  - Task 6: Visual representation optical flow.

Task 1

- Sequences

#1201-1400 HIGHWAY
(200 frames)



Background substraction (parameters A)

Background substraction (parameters B)

TEST A

TEST B

http://changedetection.net/
(Datasets > 2014 Dataset > Baseline > Highway.zip)

https://cv2008.uab.cat/
M4 Video Analysis > Project Materials > test_results_foreground

Task 1

- Implement and compute the specified measures for sequences A and B.
- Consider the entire sequence for the measures (do not compute the mean of precision for each frame)

	Test A	Test B
True Positive		
True Negative		
False Positive		
False Negative		
Precision		
Recall		
F1 Score		

Task 2

- Explain the numerical results obtained in Task 1 from a visual exploration of the obtained binary masks.
- Provide an interpretation of the different values obtained for Test A and Test B.

Task 3

- Temporal analysis of the results
  - Graph 1: F1 Score vs # frame

  - Graph 2: True Positive & Total Foreground pixels vs #frame

Task 4

- Optical flow estimations using the Lucas-Kanade algorithm.
- Sequences 45 and 157 (image_0) from the KITTI dataset.
- Only 1 estimation / sequence (2 frames!)
- Check the KITTI website for code to read results (dense motion vectors)

GROUND TRUTH

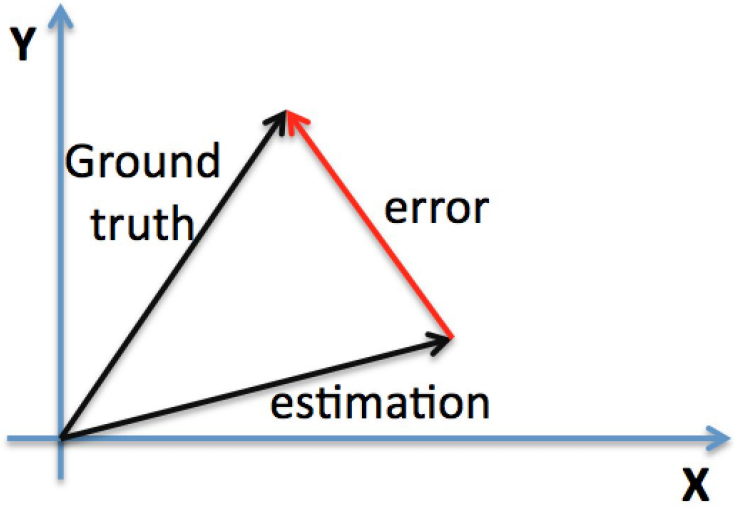
http://www.cvlibs.net/datasets/kitti/
(Flow 2012 > Stereo / Optical flow dataset)

TEST

https://cv2008.uab.cat/
M4 Video Analysis > Project Materials > test_results_motion

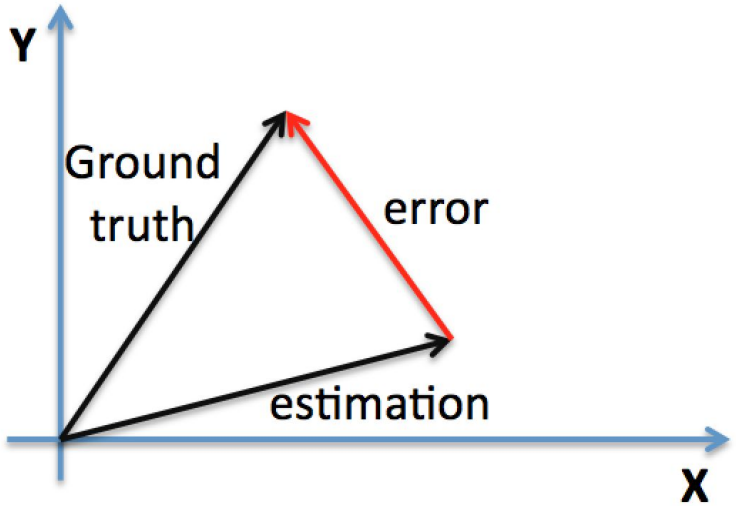
Task 4

- Metric: MSEN
  - Mean Square Error in Non-occluded areas
  - *flow_noc* in the dataset



Task 5

- Metric: PEPN
  - Percentage of Erroneous Pixels in Non-occluded areas (PEPN)
  - Consider erroneous pixels those whose motion vector error is greater than 3.

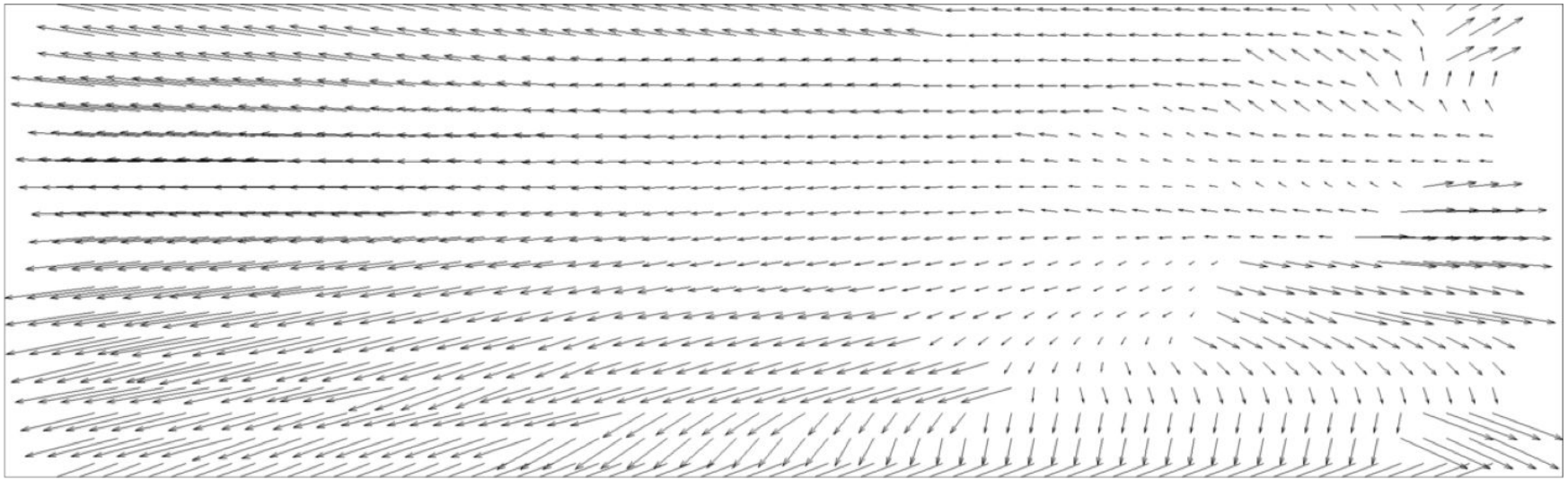


Task 6 (optional)

- Forward de-synchronized results for background substraction (HIGHWAY sequence)

Task 7 (optional)

- Plot the optical flow
  - *Quiver* function in Matlab
  - Dense representation -> too many motion vectors
    - Propose a simplification method for a clean visualization.

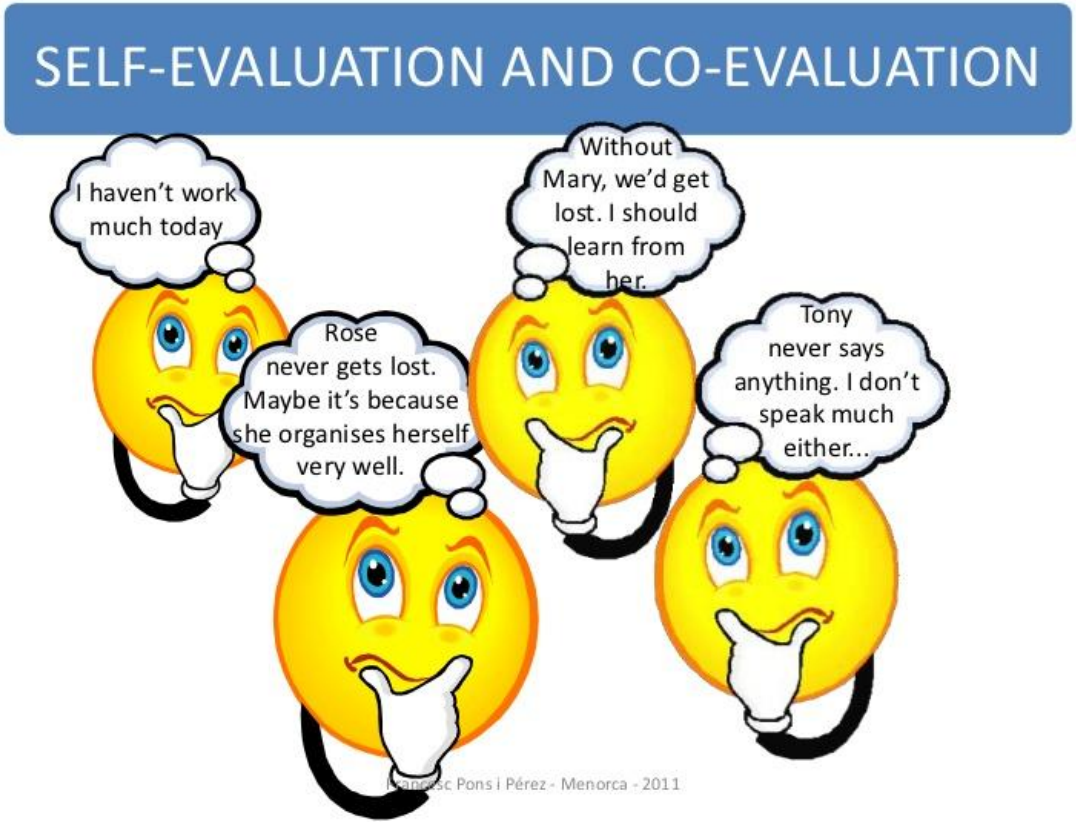


Scoring Rubric

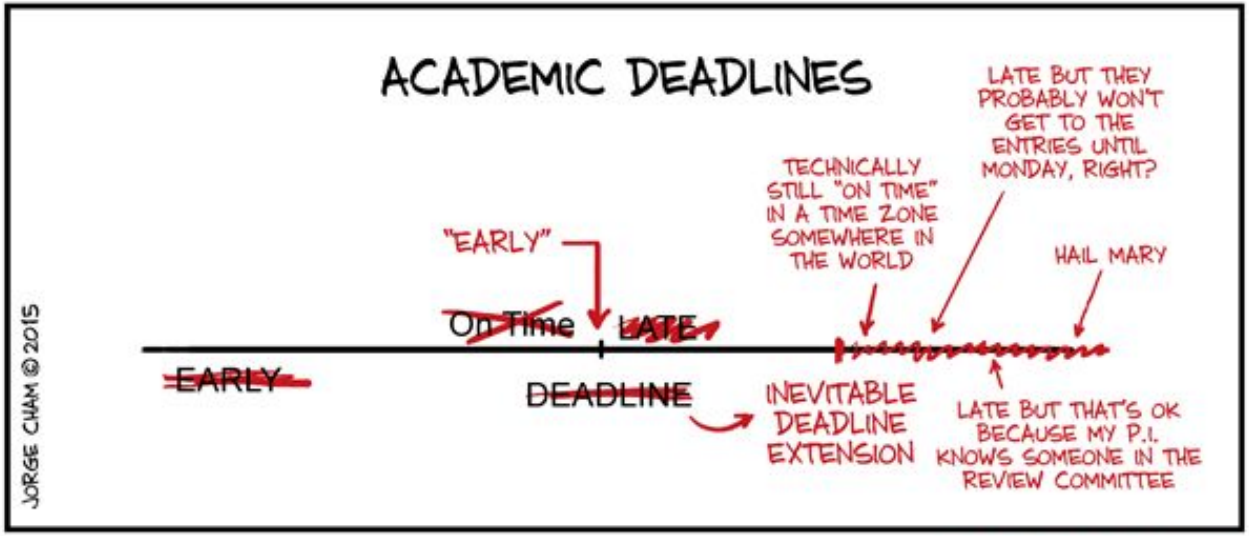
Grade is assigned based on the satisfactory accomplishment of...

A	Excellent	All mandatory and two optional tasks
B	Very good	All mandatory and one optional task
C	Average	All mandatory tasks
D	Dificulties	All mandatory tasks but one
F	Fail	All mandatory tasks but two or more

Co-evaluation



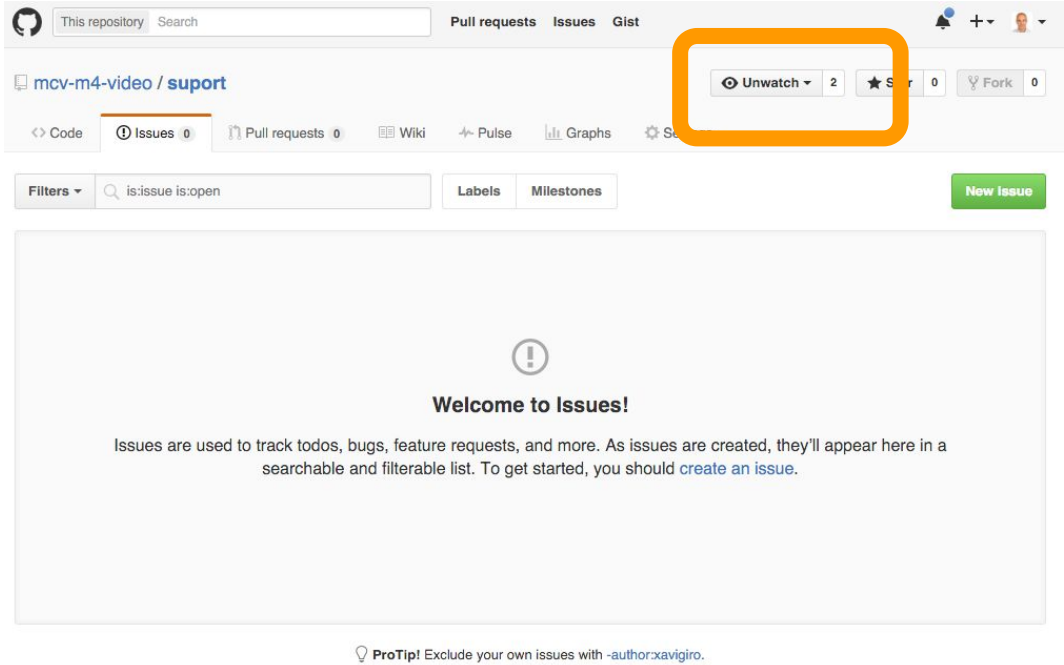
Deadline



- Wednesday 16th December 2015
  - Share a link to slides in the “issues” section of the “deliverables” repository on GitHub.
  - Fill the intra-group evaluation from a link to be published in the “issues” section of the “deliverables” repository on GitHub.

Support

- Use the “issues” tool from the GitHub “support” repository.
- Recommended: “Watch” to these issues to be aware of all the activity.



Before you leave...

- Set up a team repository in the course page on GitHub.
  - Get your team ID by writing down the team members (4-5) in this spreadsheet.
  - Join the GitHub page with a personal account.
  - Create a team with the ID assigned on the spreadsheet.
  - Create a repository with your ID to store your code.
  - (optional) Set a recent photo in your public profile.
  - (optional, in the future) Make your repository private.

https://github.com/orgs/mcv-m4-video/