Methodology for Objective Metrics Performance Evaluation...

… and its use for large scale training

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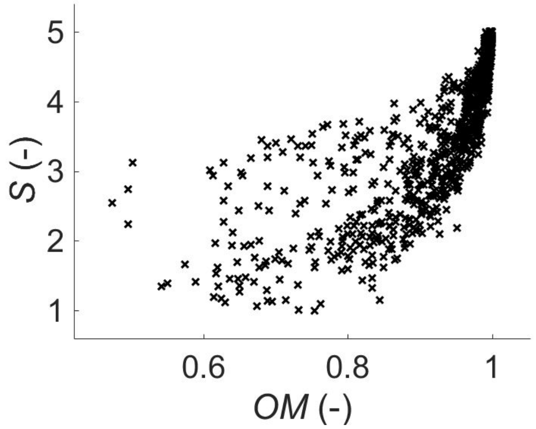
Objective Metrics Performance Evaluation

- Comparing subjective vs. automatically predicted scores (*S* vs. *OM*)



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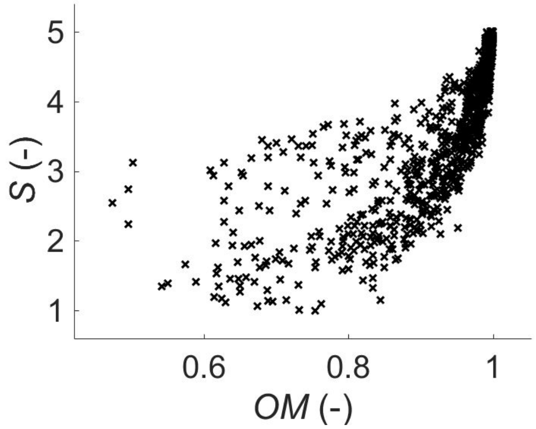
- Typical measures [ITU-T Rec. P.1401]
  - Pearson Correlation Coefficient
  - Root Mean Squared Error
  - Outlier Ratio



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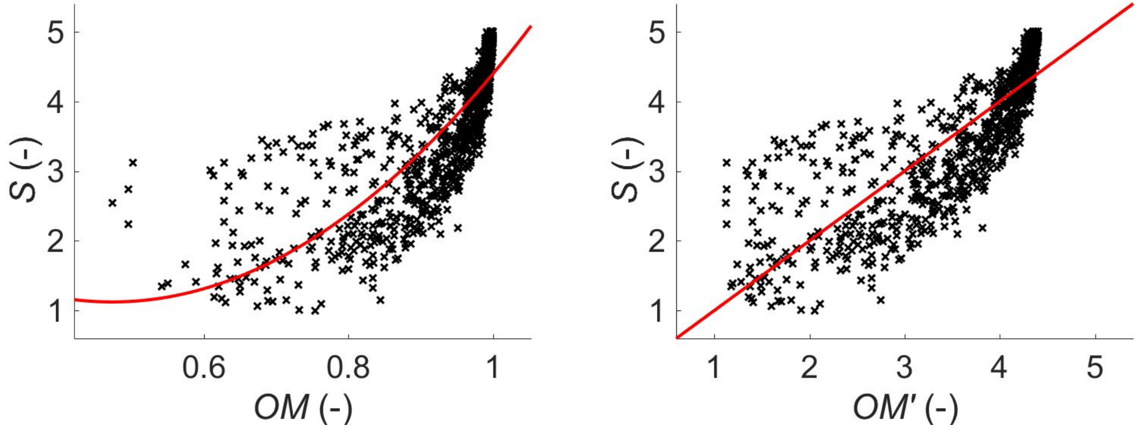
Necessity of mapping to the common scale



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    - Reproducibility is questionable
  - Mapping can bias the results

Correlation for CSIQ database after 3rd order polynomial mapping	SSIM	MS-SSIM
Fitting function coefficients optimized with PLCC (VQEG)	**0.8575**	0.8562
Fitting function coefficients optimized with RMSE (ITU-T Rec. J.149)	0.8581	**0.8859**

Rank Order Correlation

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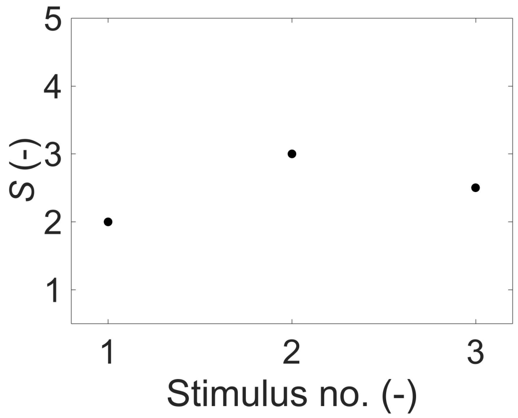

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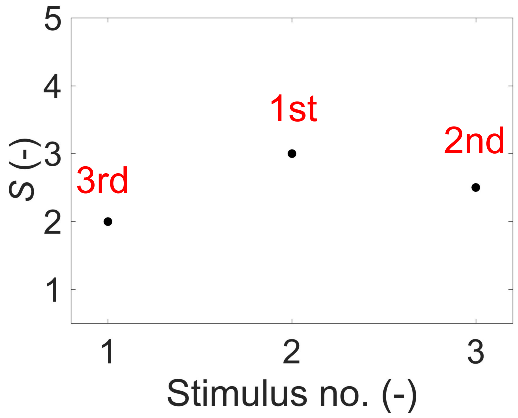

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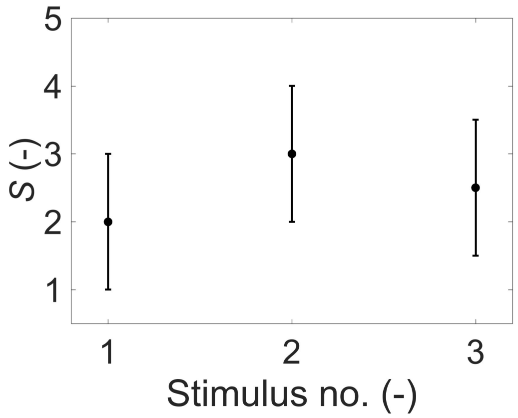

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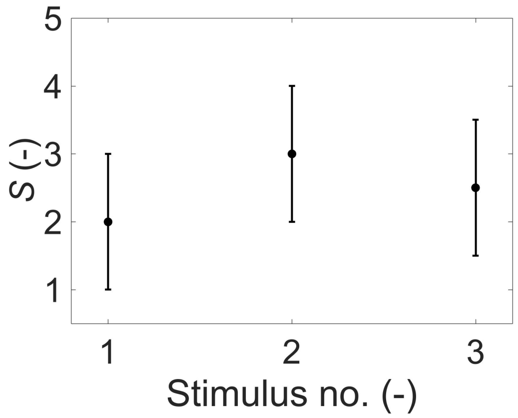

What is the correct order?

Novel performance evaluation methodology

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  - No mapping during the process
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(a) Are any two stimuli statistically significantly different in quality?

$$[i,j] \in \mathrm{N} \quad \Leftrightarrow \quad \Pr\{\, S(i) \neq S(j) \,\} < 1-\alpha$$

$$[i,j] \in \mathrm{D} \quad \Leftrightarrow \quad \Pr\{\, S(i) \neq S(j) \,\} \geq 1-\alpha$$

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(b) If they are, which of them is qualitatively better?

$$[i,j] \in B \quad \Leftrightarrow \quad \Delta S(i,j) = S(i) - S(j) \geq 0, \ \forall \ [i,j] \in D$$
$$[i,j] \in W \quad \Leftrightarrow \quad \Delta S(i,j) = S(i) - S(j) \leq 0, \ \forall \ [i,j] \in D$$

Novel performance evaluation methodology:

Proposed Assumptions

- Reliable metric then

  I. Provides **close** scores for **similar** pairs and **distant** scores for **different**

$$|\Delta OM(i,j)| = |OM(i) - OM(j)| \rightarrow 0, \ \forall \ [i,j] \in N$$

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II. Provides **higher** score for qualitatively **better** stimulus

$$\mathrm{sign}\{ \Delta OM(i,j) \} = \mathrm{sign}\{ \Delta S(i,j) \}, \ \forall \ [i,j] \in D$$

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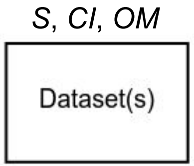

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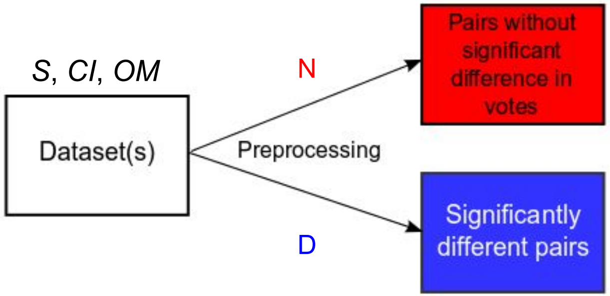

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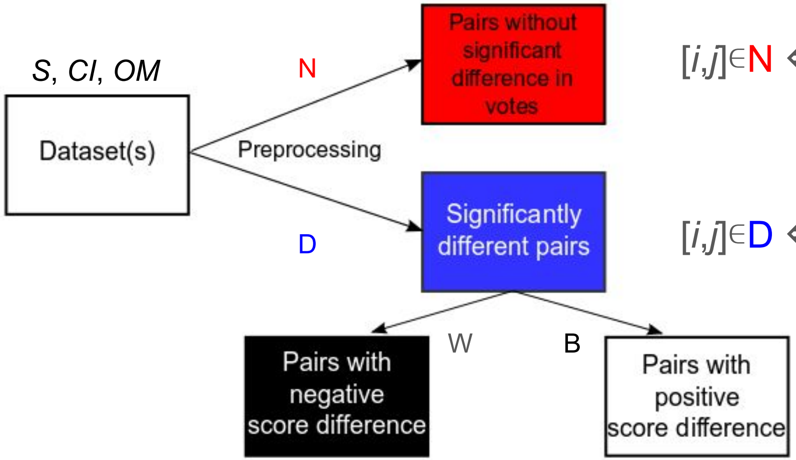

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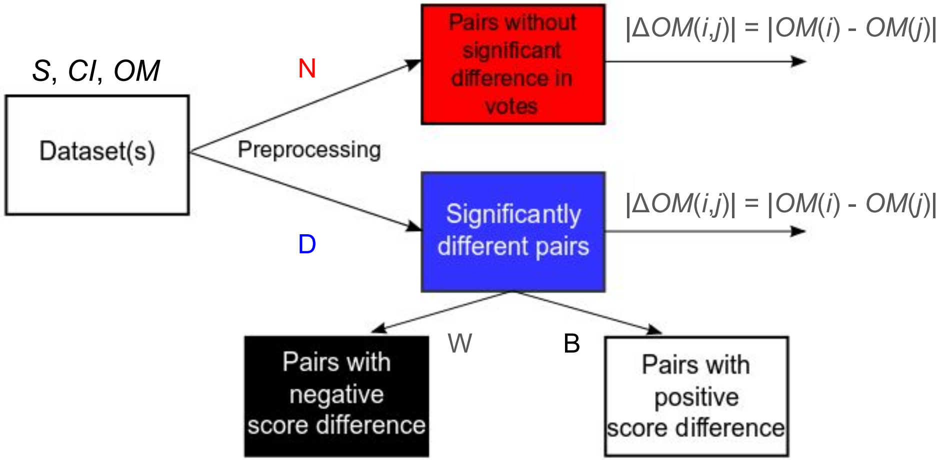

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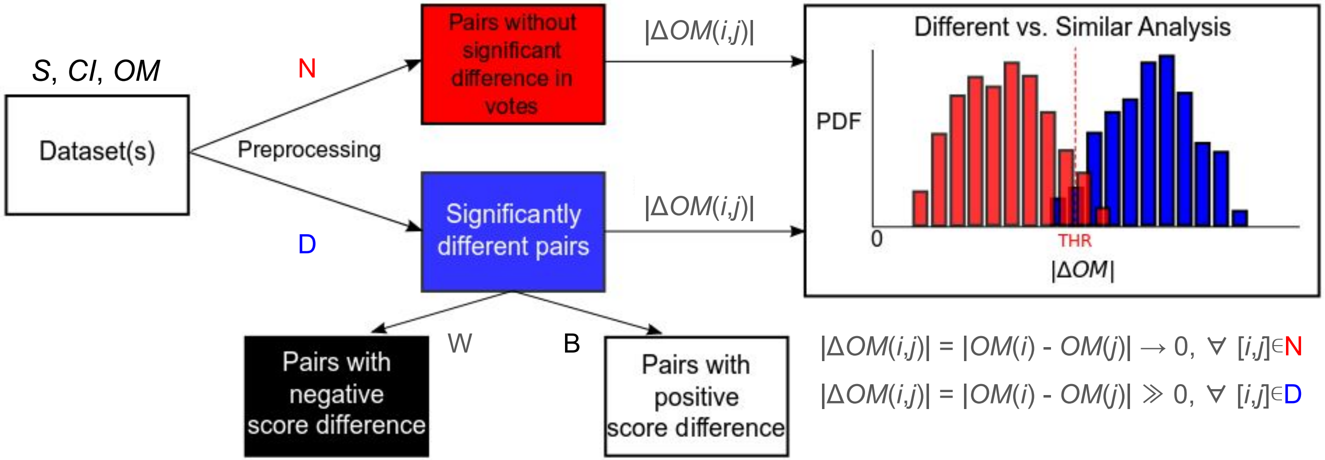

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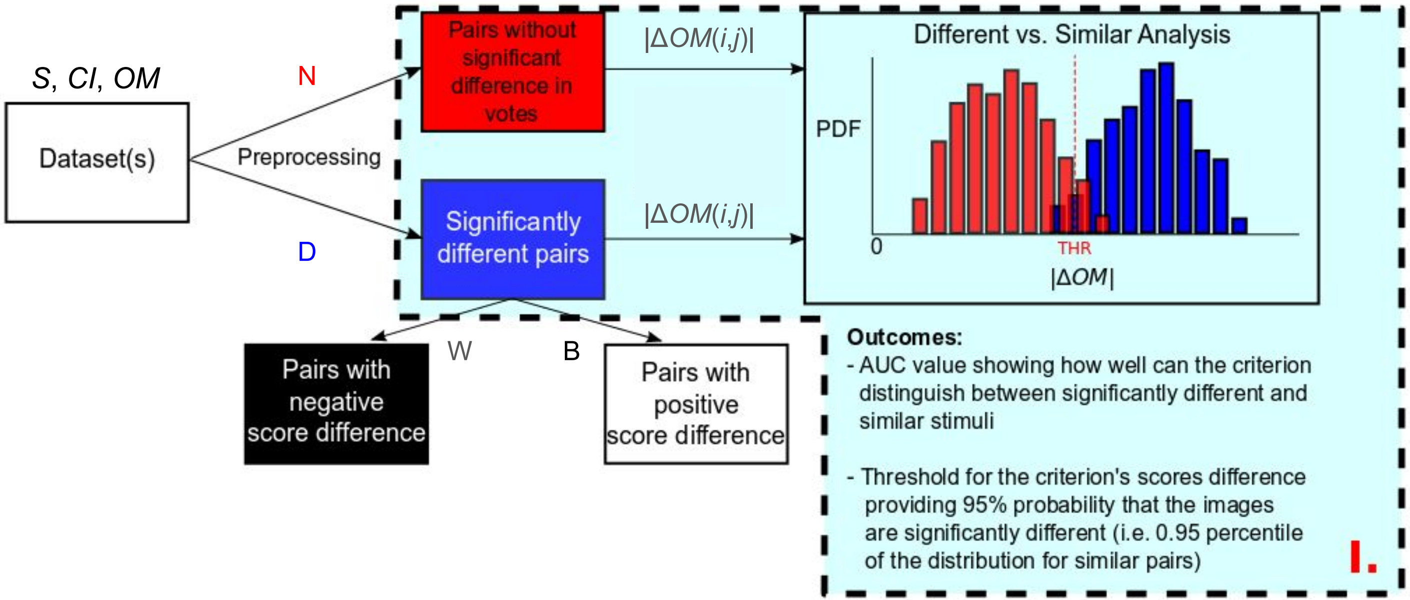

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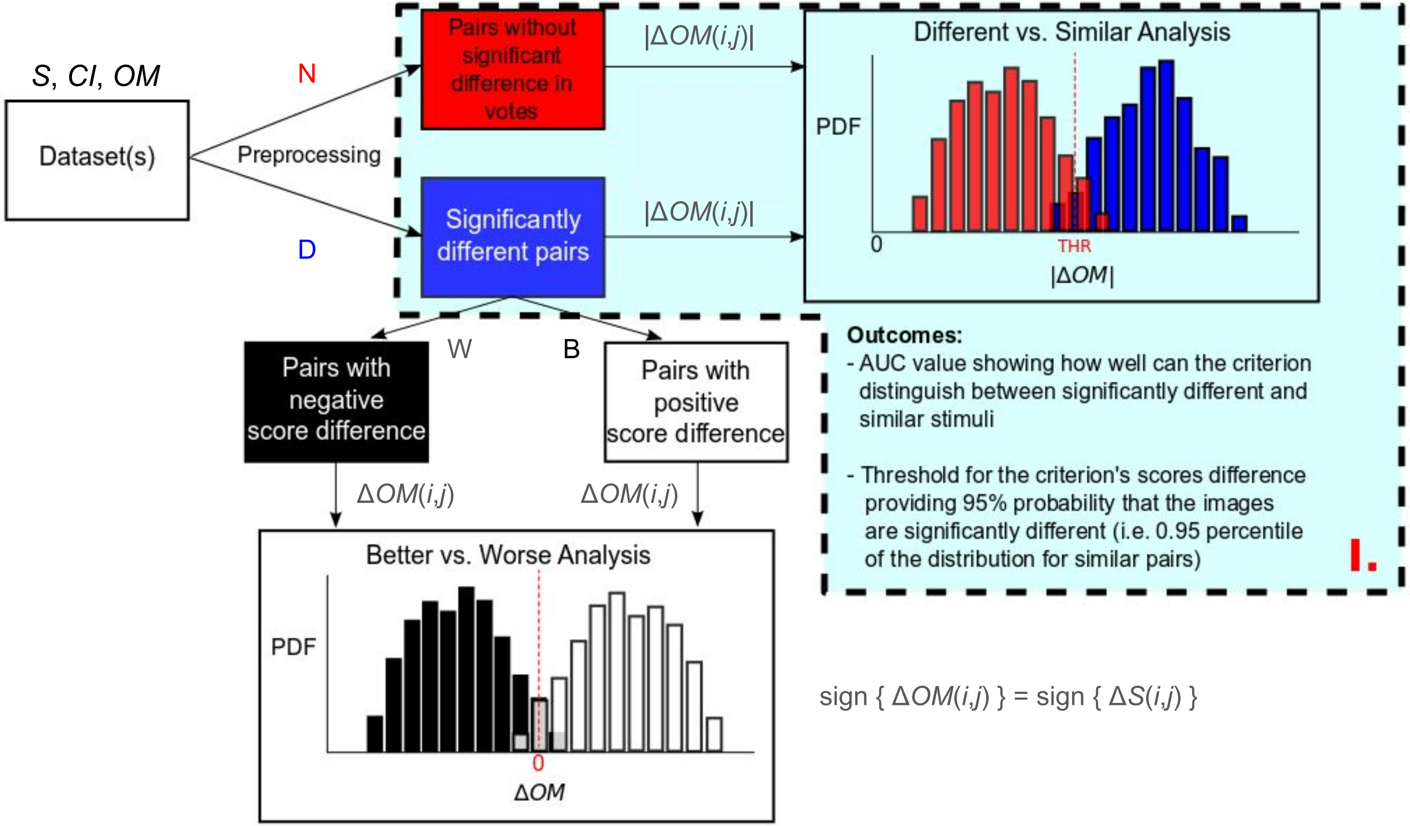

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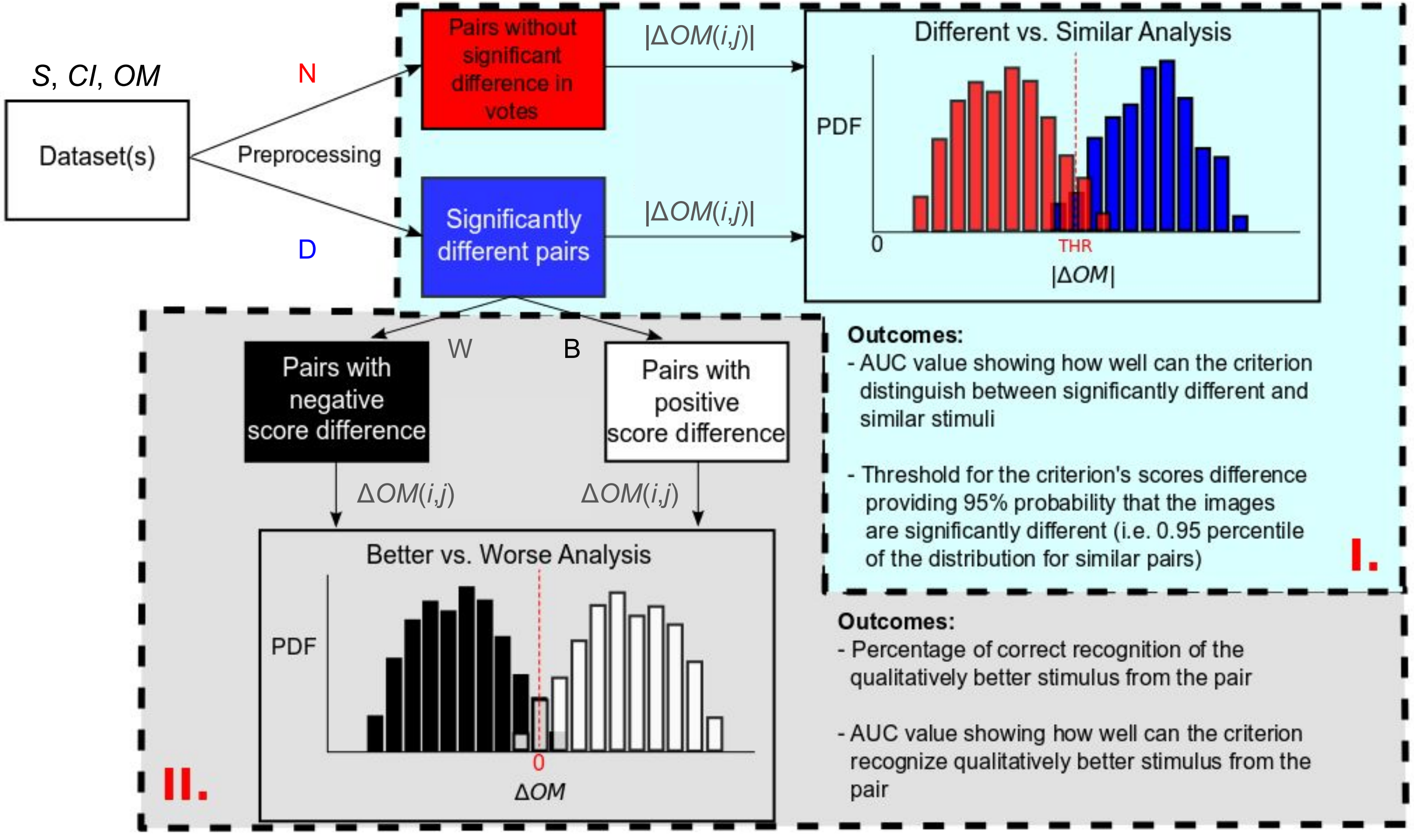

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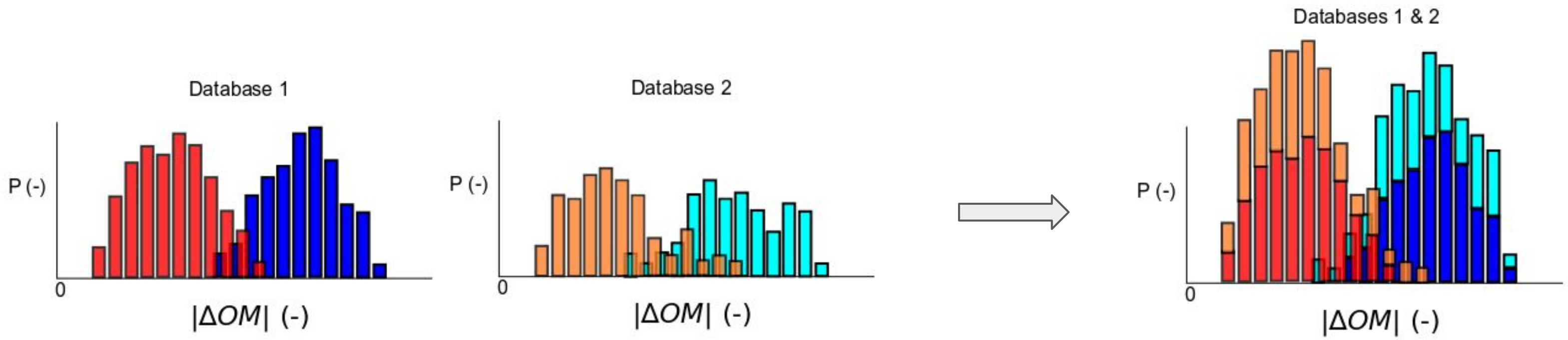

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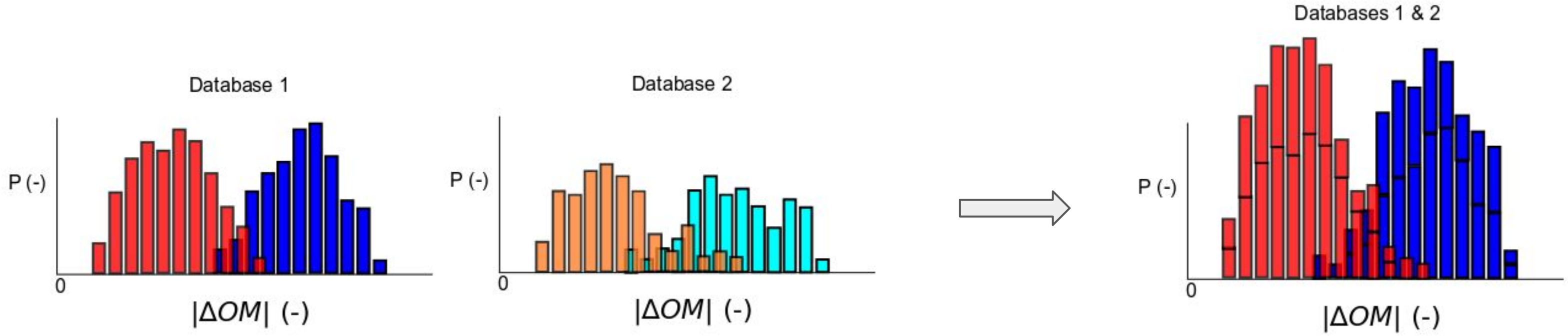

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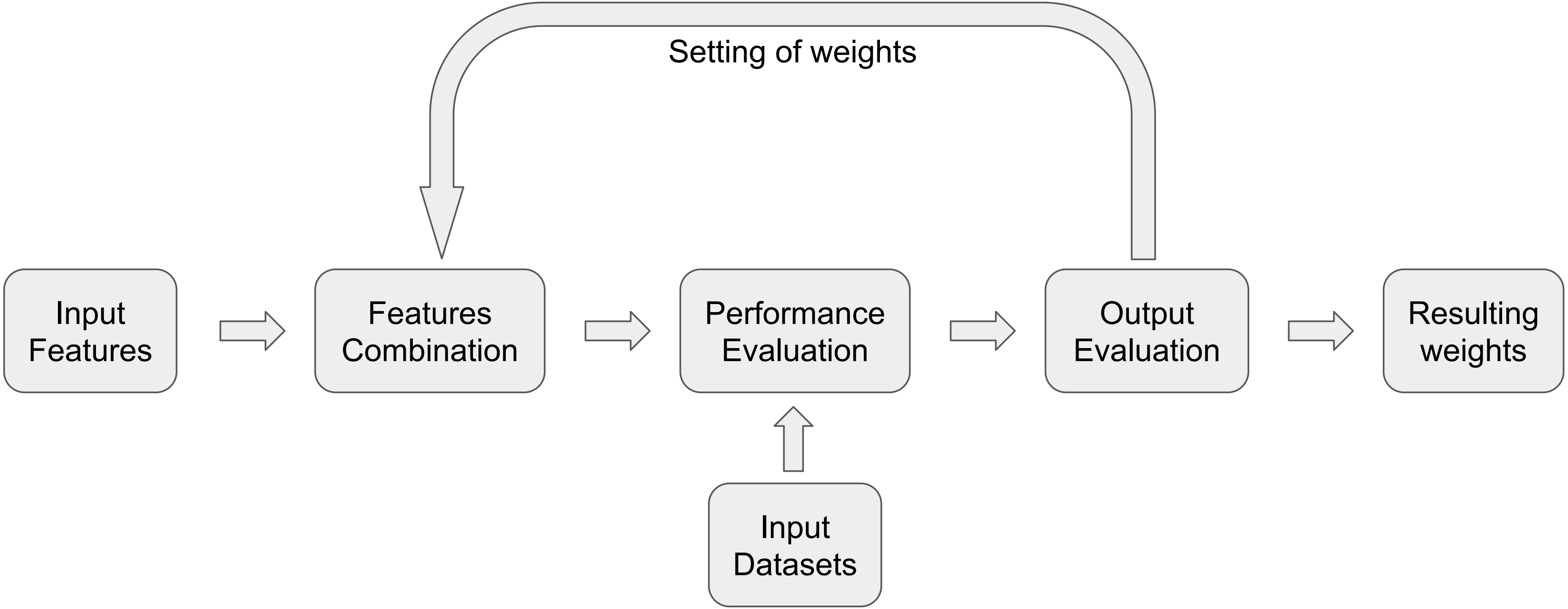
  - High statistical power (due to the pair-wise approach)
  - **Enables simple and meaningful combination of the data coming from multiple datasets**
    - No inter-experiment mapping necessary
    - Overall performance can be easily determined
    - Increase of number of training/testing points in orders of magnitude - deep learning etc.

Using the framework for objective metrics training



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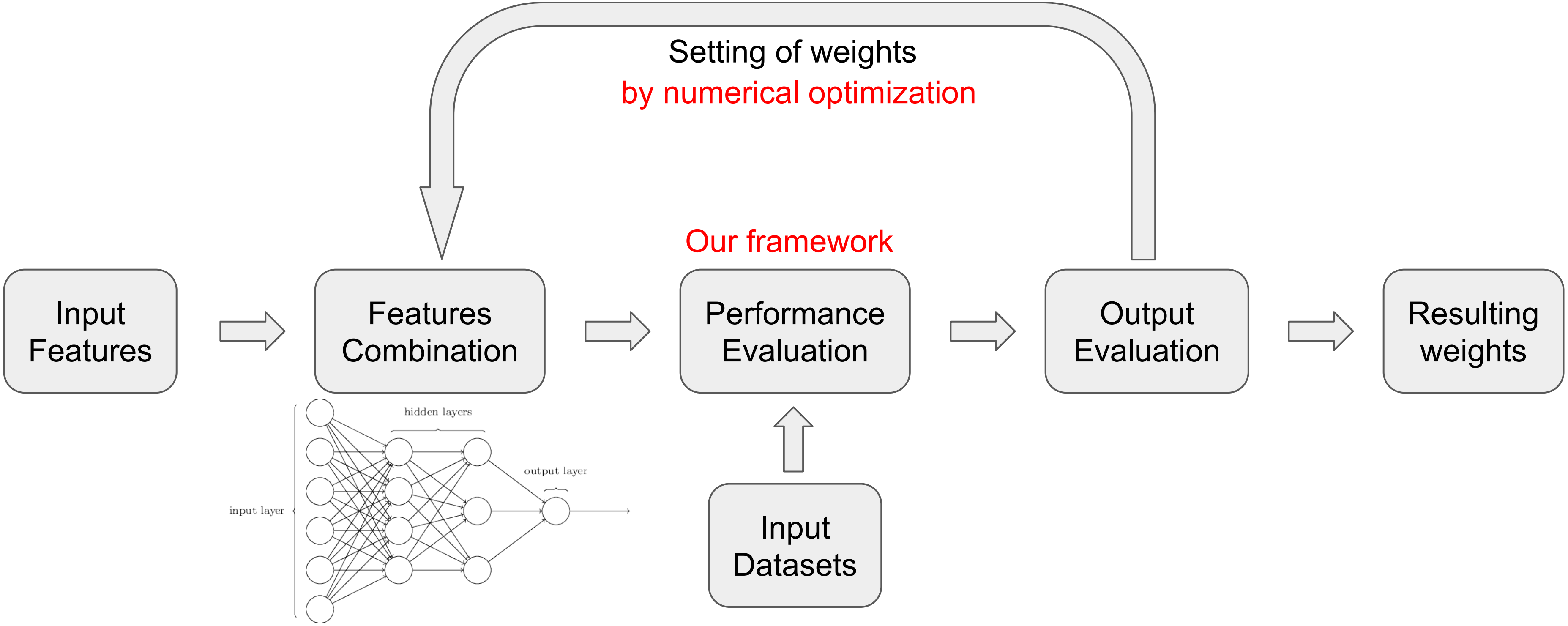

Preliminary results

- Publicly available VMAF (Video Multi-Method Assessment Fusion) package
  - VMAF features (VIF on 4 scales, Detail Loss, Motion)
- 18 datasets (9 used for training, 9 for testing)
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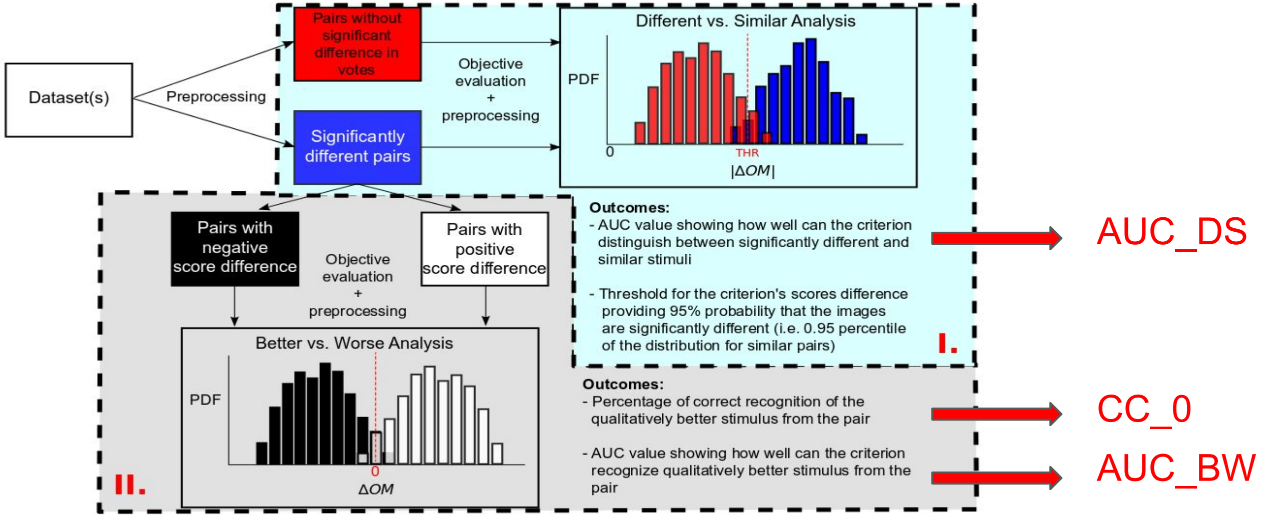

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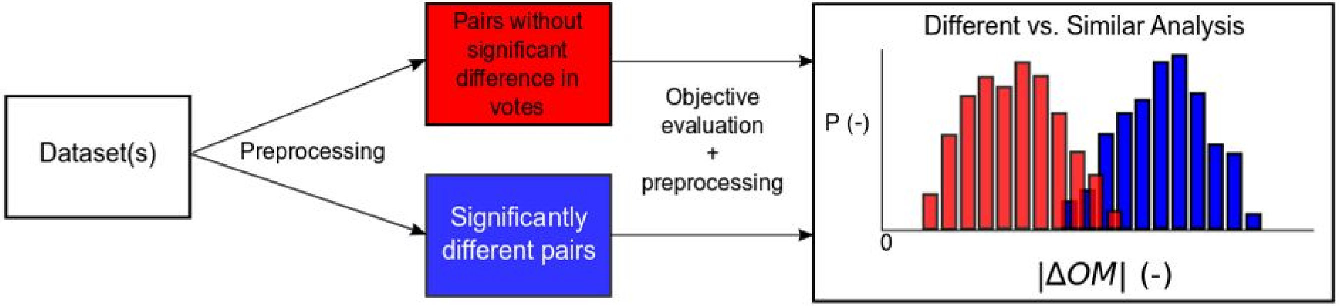
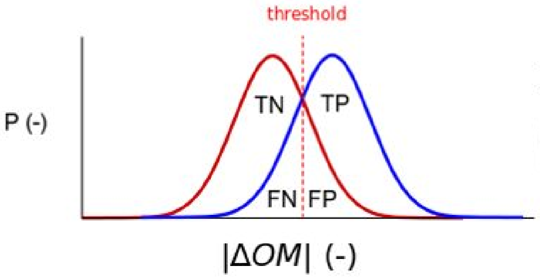
	Custom Neural Network:	VMAF (trained on one of the datasets):
Test set	AUC_DS = **0.7869**	AUC_DS = 0.7586
	AUC_BW = **0.9550**	AUC_BW = 0.9490
	CC_0 = **0.8963**	CC_0 = 0.8951
Test + Train sets	AUC_DS = **0.7646**	AUC_DS = 0.7230
	AUC_BW = **0.9551**	AUC_BW = 0.9469
	CC_0 = **0.8957**	CC_0 = 0.8954

Thank you for your attention!

ROC Analysis





TN - true negative
TP - true positive
FN - false negative
FP - false positive

True positive rate
TPR = TP / (TP+FN)

False positive rate
FPR = FP / (FP+TN)

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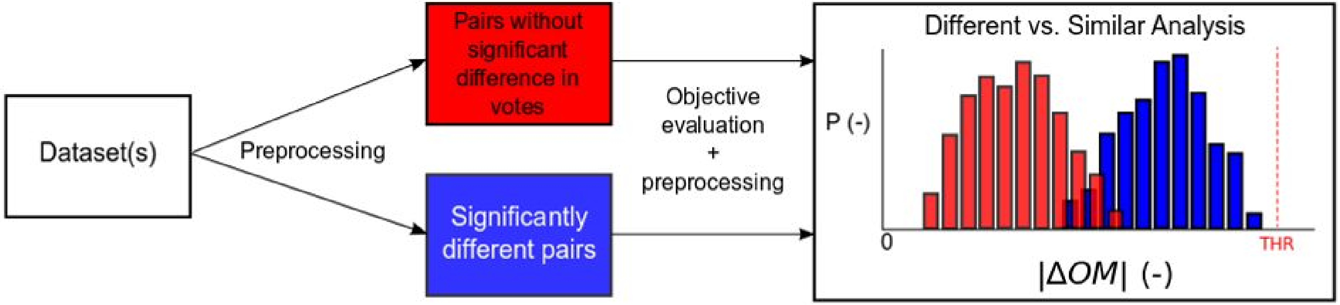

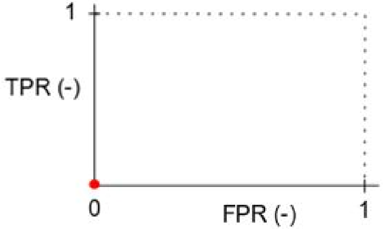

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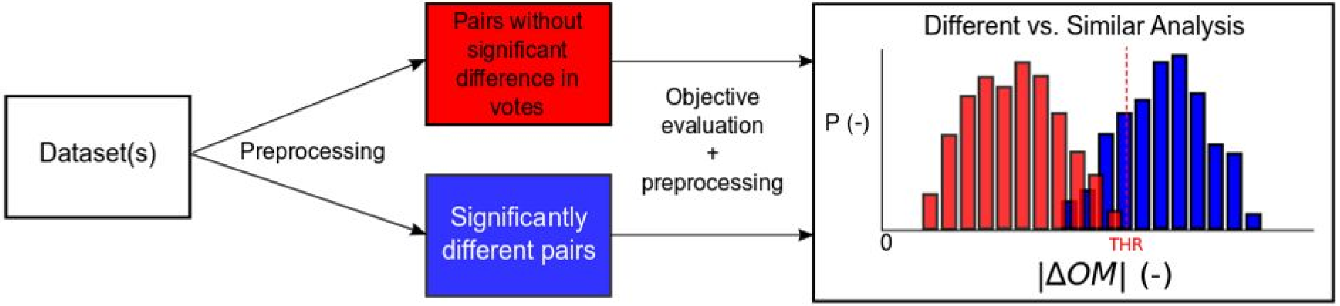

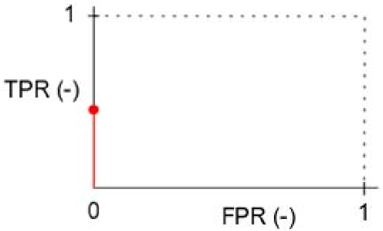

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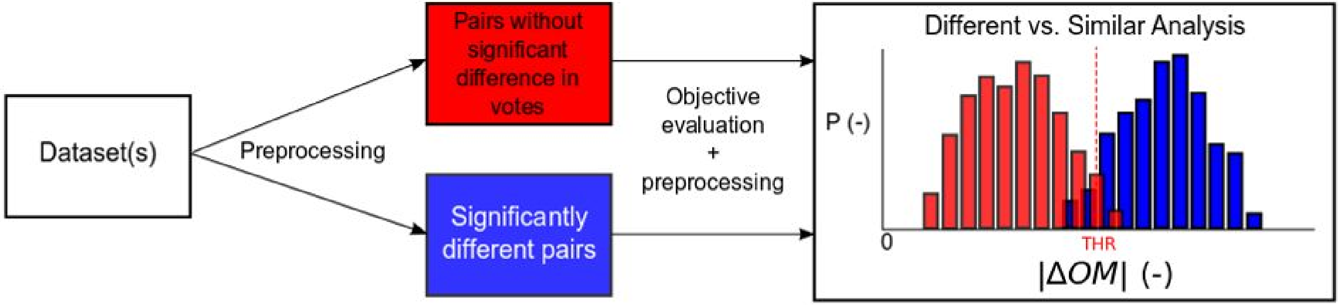

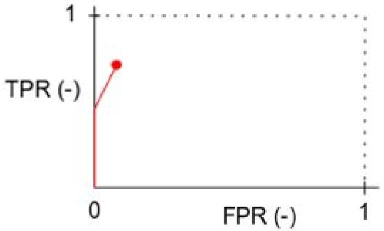

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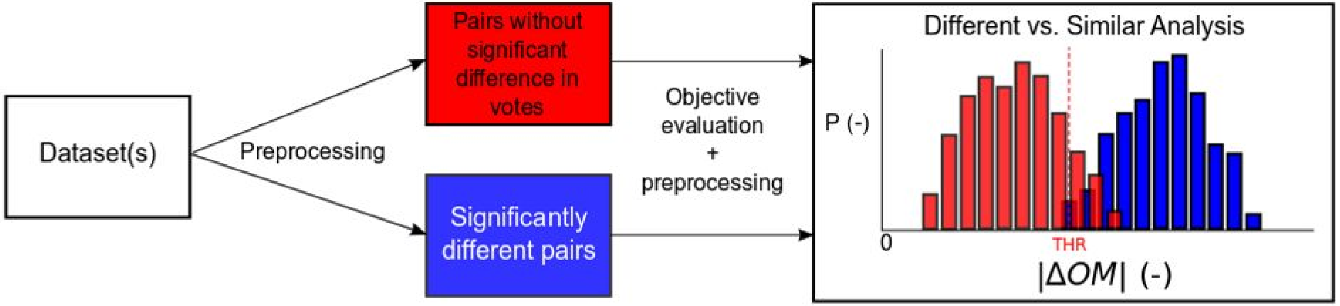

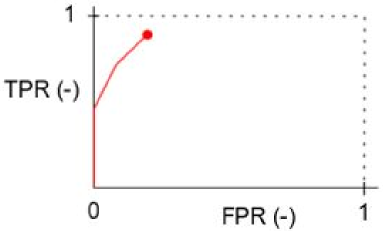

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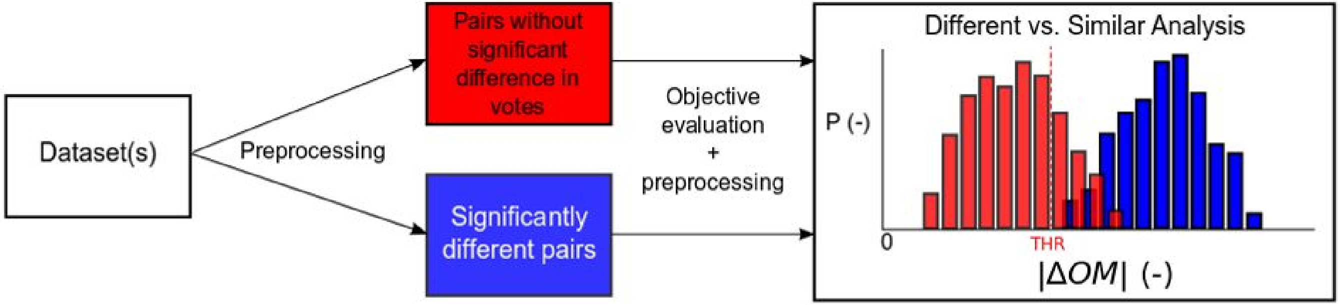

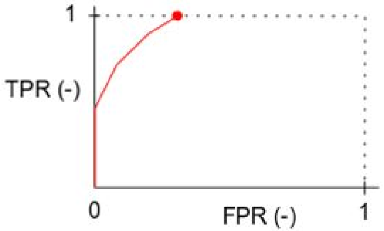

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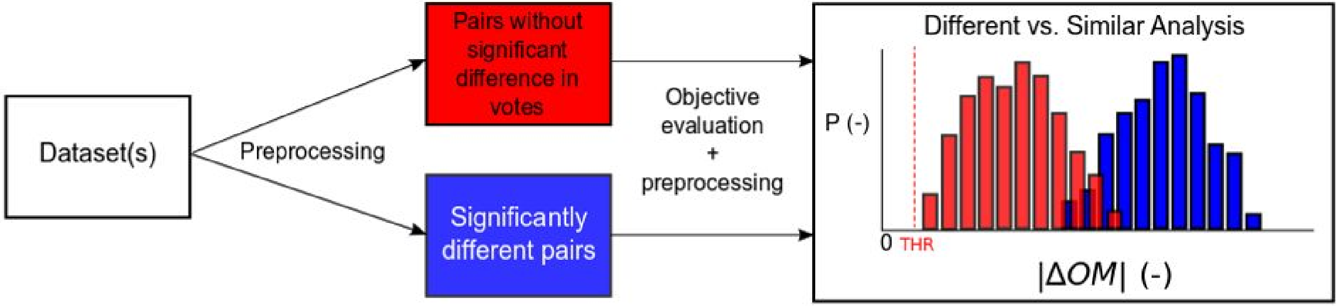

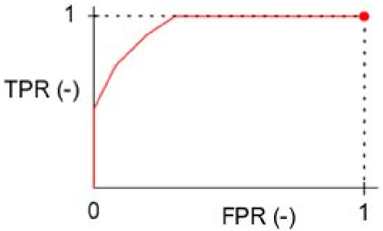

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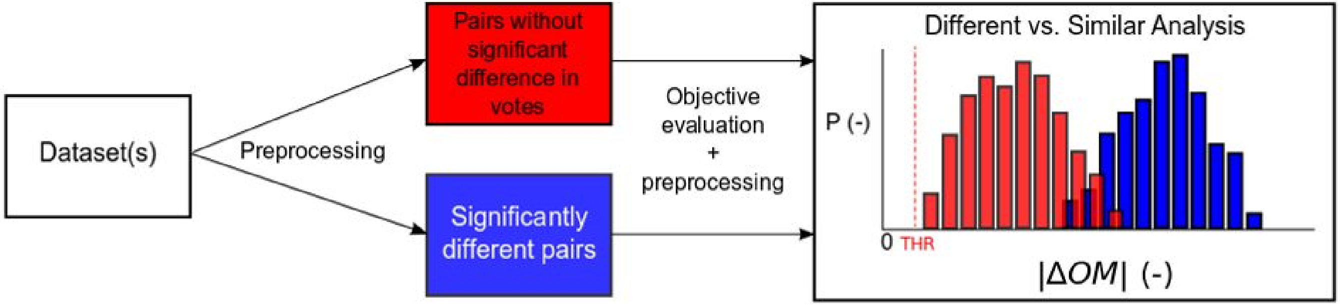

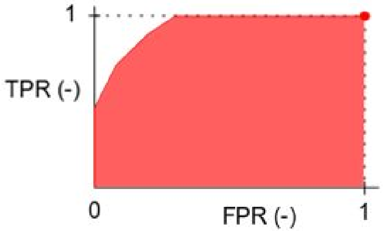

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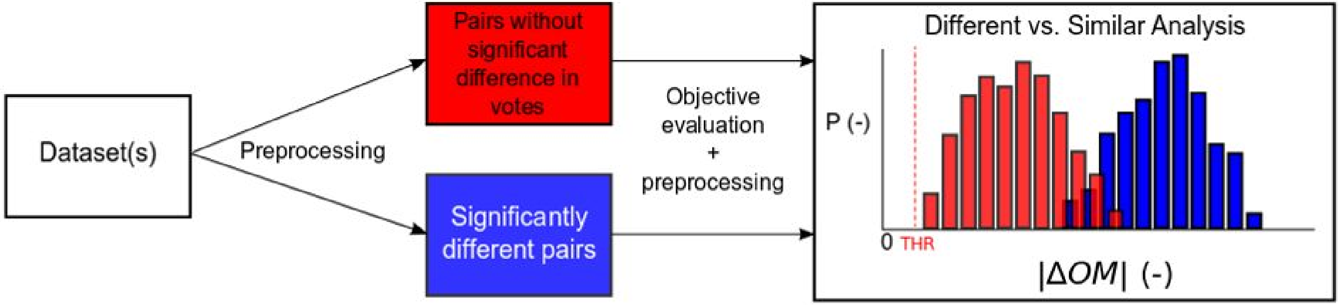
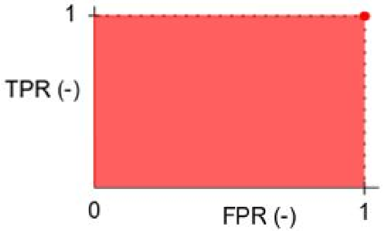
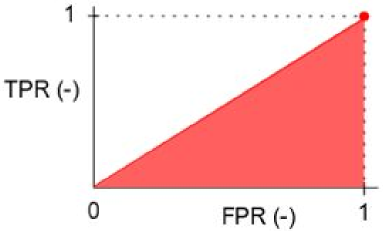


AUC = 1



AUC = 0.5



AUC = 0.85