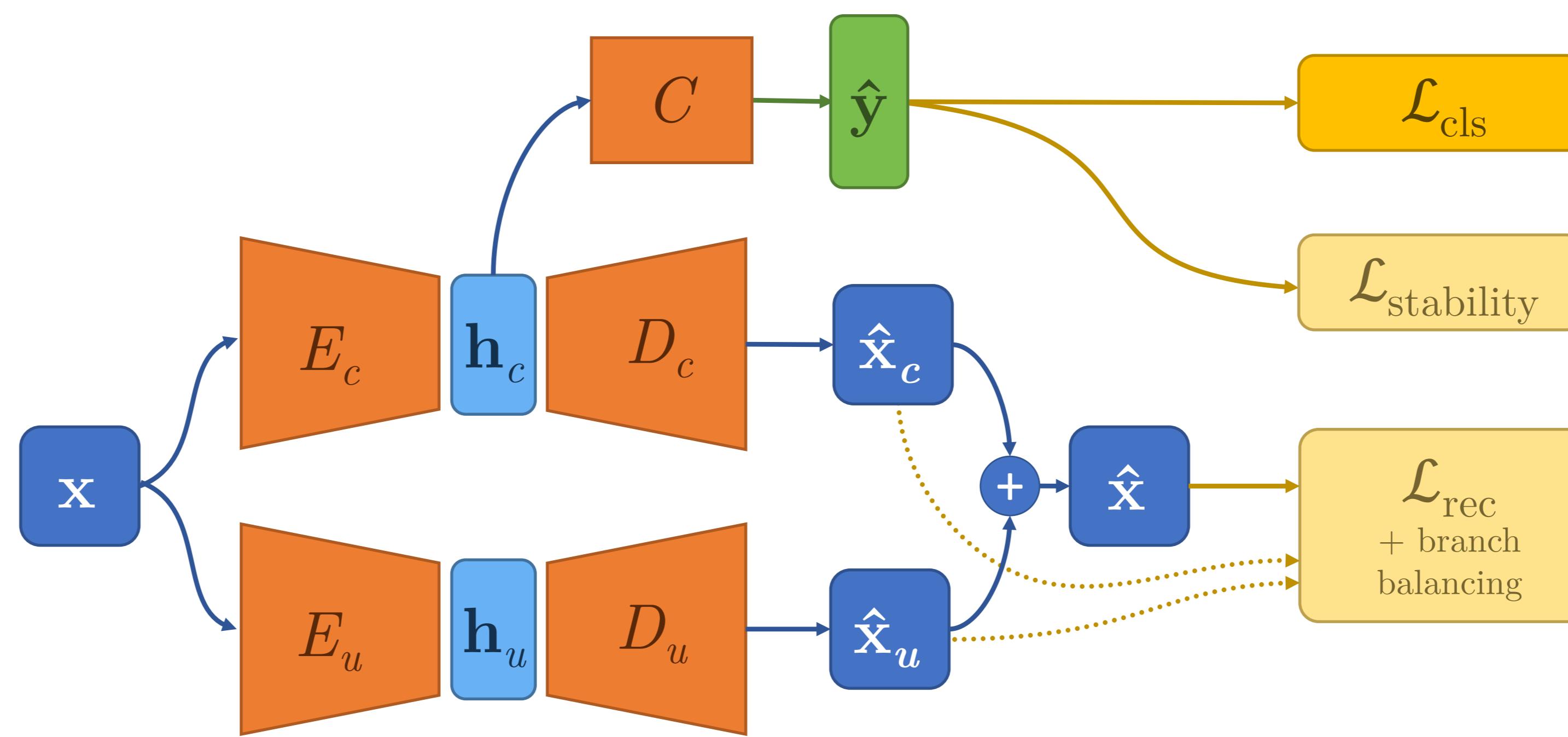


Thomas Robert¹, Nicolas Thome², Matthieu Cord¹¹Sorbonne Université (LIP6) & ²CNAM – Paris, France

1. Context

- Improving classification score on partially labeled data (< 5%)
- Auto-encoder based semi-sup. with classif. and reconstr.
- Problem: antagonists costs
 - Classification requires *information loss*
⇒ invariant features & good generalization
 - Reconstruction requires *information conservation*
⇒ correct reconstruction of the input
- Related work:
 - Auto-encoder w/ skip connections (LadderNet^[1], SWWAE^[2])
 - Classifier w/ stability based regularization (no reconstr.)^[3,4,5]

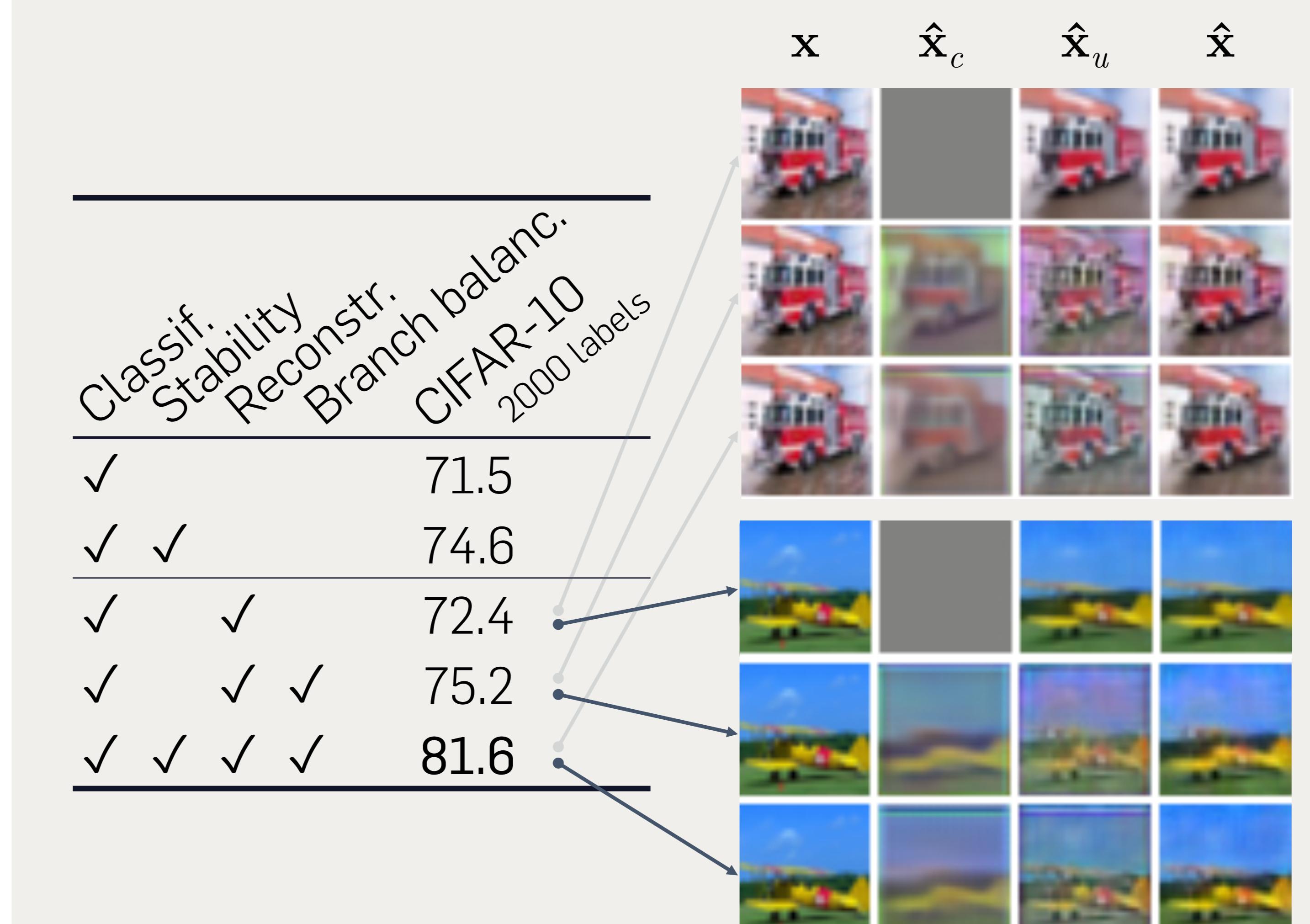


3. Controlling information separation

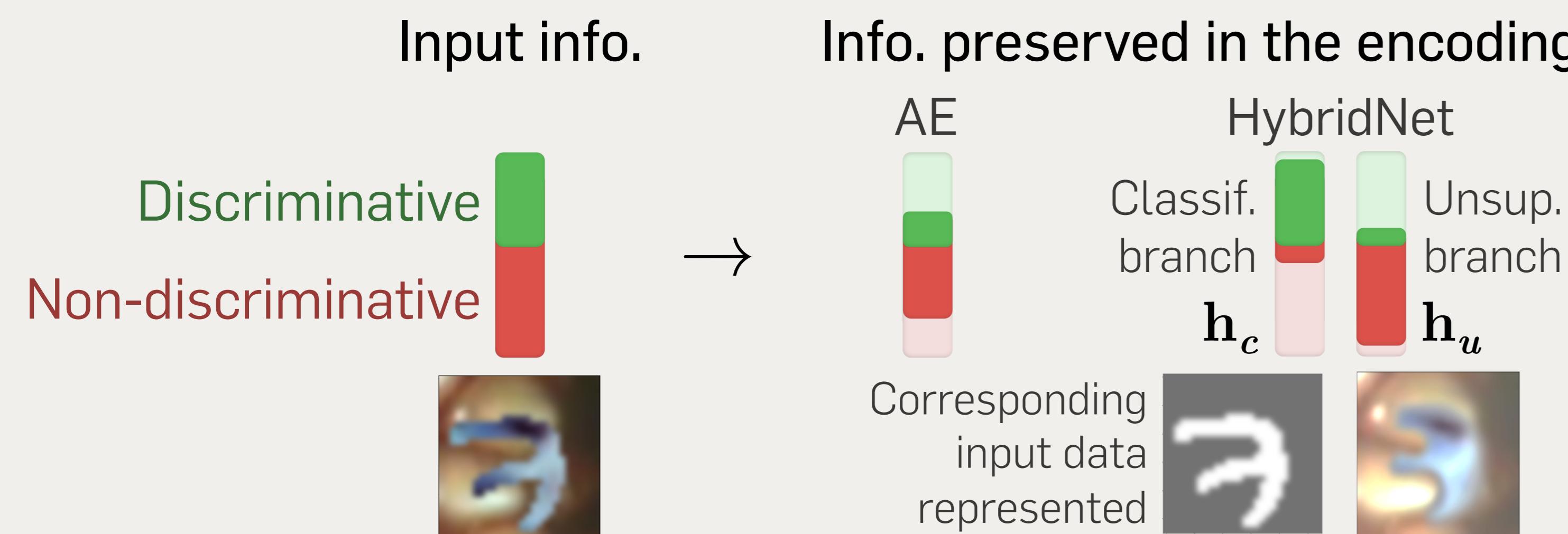
$$\mathcal{L} = \mathcal{L}_{cls} + \lambda_s \mathcal{L}_{stability} + \lambda_r \mathcal{L}_{rec}$$

- Controls the behavior of information separation
- Encourage discriminative / invariant features in E_c
 - Classification loss $\mathcal{L}_{cls} = \text{CrossEntropy}(y, \hat{y})$
 - Stability loss^[3-5] $\mathcal{L}_{stability} = \|\hat{y}^{(k)} - \tilde{z}^{(k)}\|$
 $\tilde{z}^{(k)} = \text{EMA}(\hat{y}^{(k)})$
- Extract additional info. & balance branches
 - Reconstruction loss $\mathcal{L}_{rec} = \|\hat{x} - x\|$
 - Branch balancing backpropagate \mathcal{L}_{rec} only in the branch making the largest error btwn $\|\hat{x}_c - x\|$ and $\|\hat{x}_u - x\|$

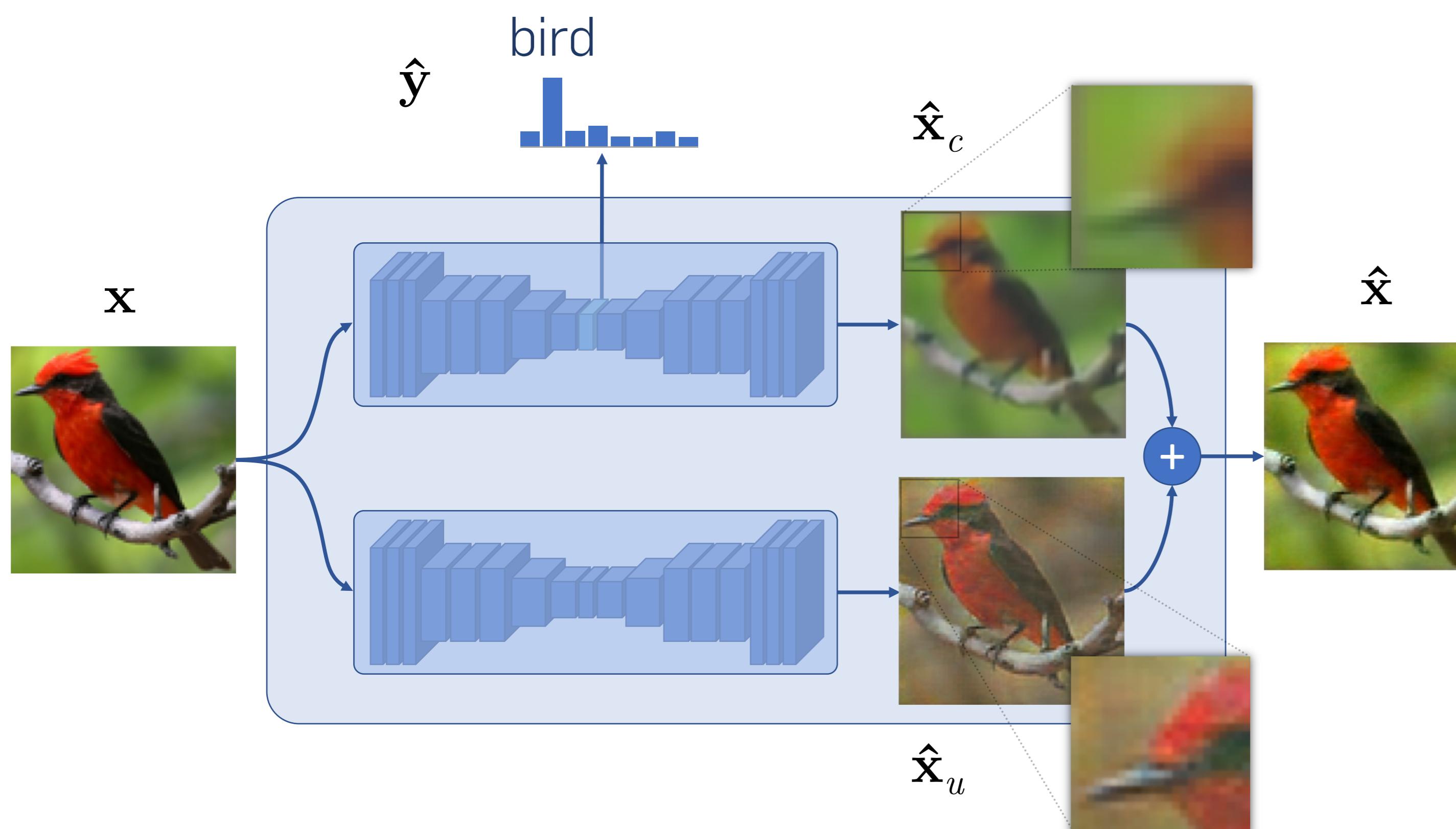
Ablation study of the different loss terms



2. Intuition & HybridNet architecture



- Explicitly separates discriminative and complementary information into two branches
- Classification branch:** discriminative info. / partial reconstr.
- Unsupervised branch:** complementary info. / complem. rec.



4. Results

Visualization of information separation

Shows loss of information in E_c and correction by E_u 

Semi-sup. state-of-the-art results

Dataset	CIFAR-10	STL-10	SVHN
Nb. of labeled images	1000	4000	1000
Nb. of unlabeled images	~50k	~100k	~600k
AE-based (Ladder ^[1])	20.40		
AE-based (SWWAE ^[2])		25.7	23.6
Stability only (MT ^[5])	10.10	6.23	16.8
Classif. baseline	45.22	15.45	18.0
HybridNet	8.81	6.09	15.9
			2.5

- ResNet-based model. N labeled samples, $N/10$ per class, rest of the dataset unlabeled
- Surpasses comparable stability & AE-based baselines on standard benchmarks

5. Future & References

Conditional generative version through latent space manipulation with information disentanglement

- [1] Rasmus *et al.* NIPS 15. SSL with ladder networks
- [2] Zhao *et al.* ICLR Whp 16. Stacked What-Where Auto-encoders
- [3] Sajjadi *et al.* NIPS 16. Regularization With Stochastic Transfo.
- [4] Laine *et al.* ICLR 17. Temporal Ensembling for SSL
- [5] Tarvainen *et al.* NIPS 17. Mean teachers are better role models