PHILIPS

Balanced sampling for an object detection problem

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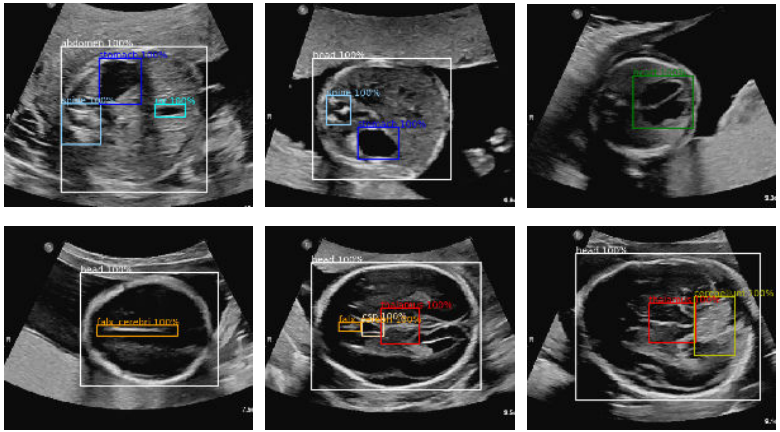
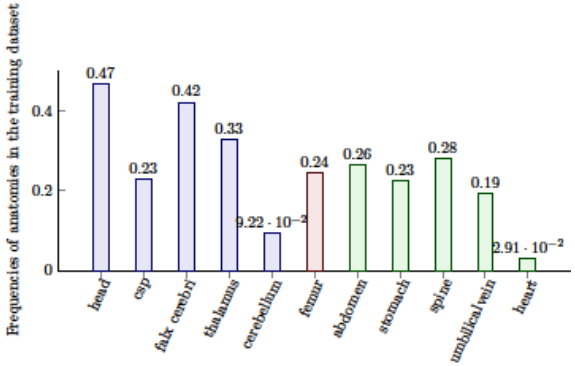
innovation you

Balanced sampling as quadratic optimization problem

- Problem description
  - Dataset with N images $(X_1, X_2, \ldots, X_N)$, and objects from C classes with high imbalance
  - Difficulty: object presences are not independent, and imbalance can not be corrected easily → Duplicating images from the minority classes will introduce unwanted bias in the dataset





Problem formulation

Find a probability vector $p \in \mathbb{R}^N$, such that sampling the images with the distribution p results in each class being equally frequent

QP optimization formulation

$$\frac{1}{2} p^T A\, p + \lambda \frac{p^T p}{2} \rightarrow \text{Minimize}$$

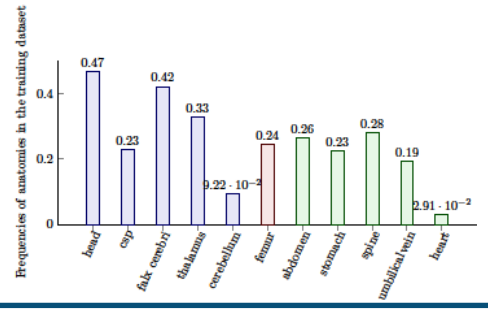
Subject to

$$p_i \geq \alpha$$

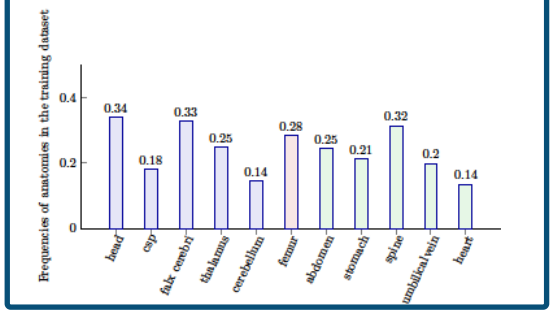
$$p_1 + p_2 + \ldots + p_N = 1$$

Results

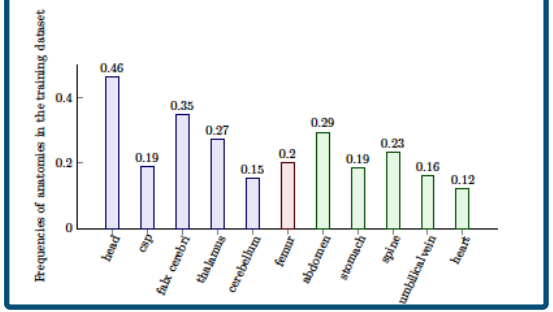
Original distribution in training dataset



Frequencies after our resampling



Frequencies after naive oversampling



	Uniform sampling			Bal. sampling (ours)			
	average	std	best	average	std	best	p-value
all anatomies							
mAP @ $\theta = 0.2$	58.97	3.96	63.4	**62.35**	1.53	**64.3**	.035
mAP @ $\theta = 0.4$	54.87	3.98	**59.6**	**57.75**	1.48	59.3	.087
Heart							
AP @ $\theta = 0.2$	1.03	3.08	7.7	**6.95**	7.34	**21.2**	.038
AP @ $\theta = 0.4$	0.5	2.31	7.7	**5.7**	5.8	**15.4**	.031
Cerebellum							
AP @ $\theta = 0.2$	4.84	12.01	33.8	**17.13**	9.91	**36.3**	.0002
AP @ $\theta = 0.4$	3.72	9.4	28.6	**14.9**	9.4	**36.3**	.0001

	oversampling			Bal. sampling (ours)			
	average	std	best	average	std	best	p-value
all anatomies							
mAP @ $\theta = 0.2$	56.8	3.5	62.3	**62.35**	1.53	**64.3**	.002
mAP @ $\theta = 0.4$	51.9	3.5	57.2	**57.75**	1.48	**59.3**	.004
Heart							
AP @ $\theta = 0.2$	3.4	4.5	15.3	**6.95**	7.34	**21.2**	.86
AP @ $\theta = 0.4$	0.0	0.0	0.0	**5.7**	5.8	**15.4**	.04
Cerebellum							
AP @ $\theta = 0.2$	**19.1**	12.0	**44.1**	17.13	9.91	36.3	.89
AP @ $\theta = 0.4$	14.6	10.7	**37.2**	**14.9**	9.4	36.3	.85

- Boosts performance on under-represented structures, while not deteriorating overall performance
- Outperforms both baselines
- Reduced std. → more reproducible and stable training