Entropy-Based Evaluation of Decoders

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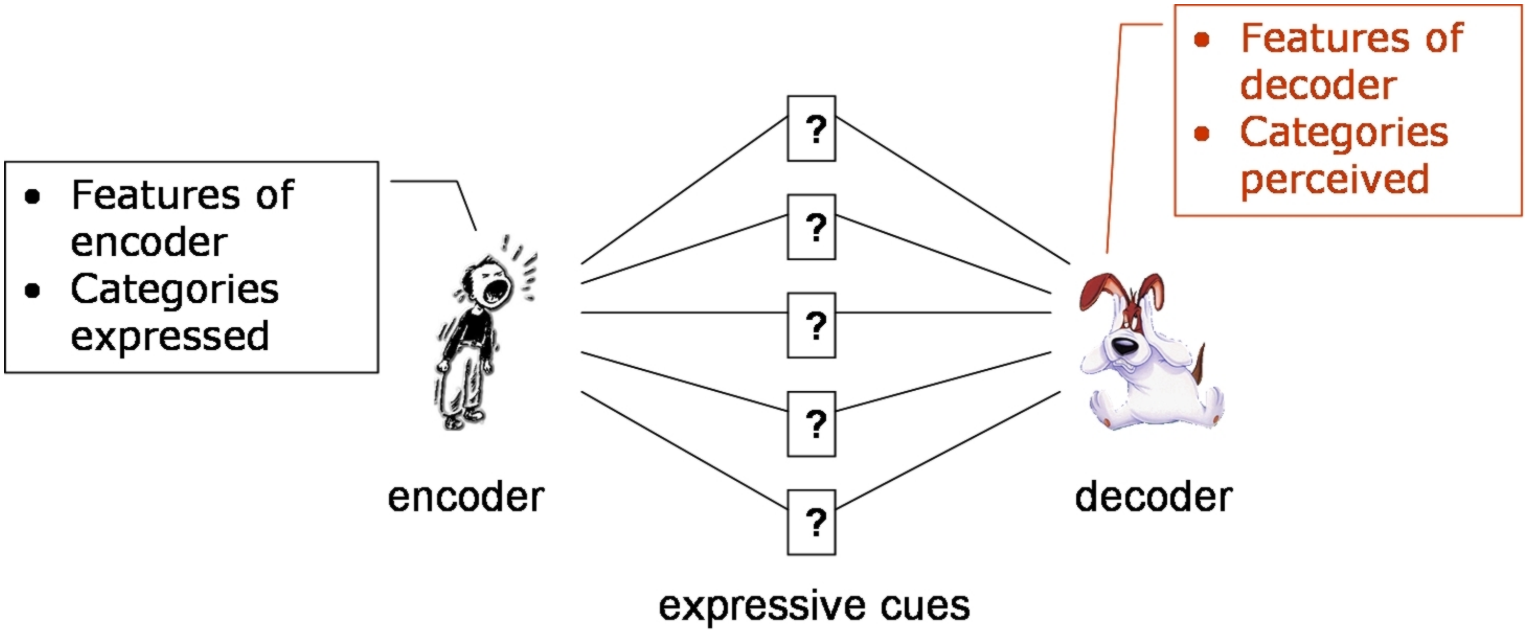
humaine

Emotional Communication Skills



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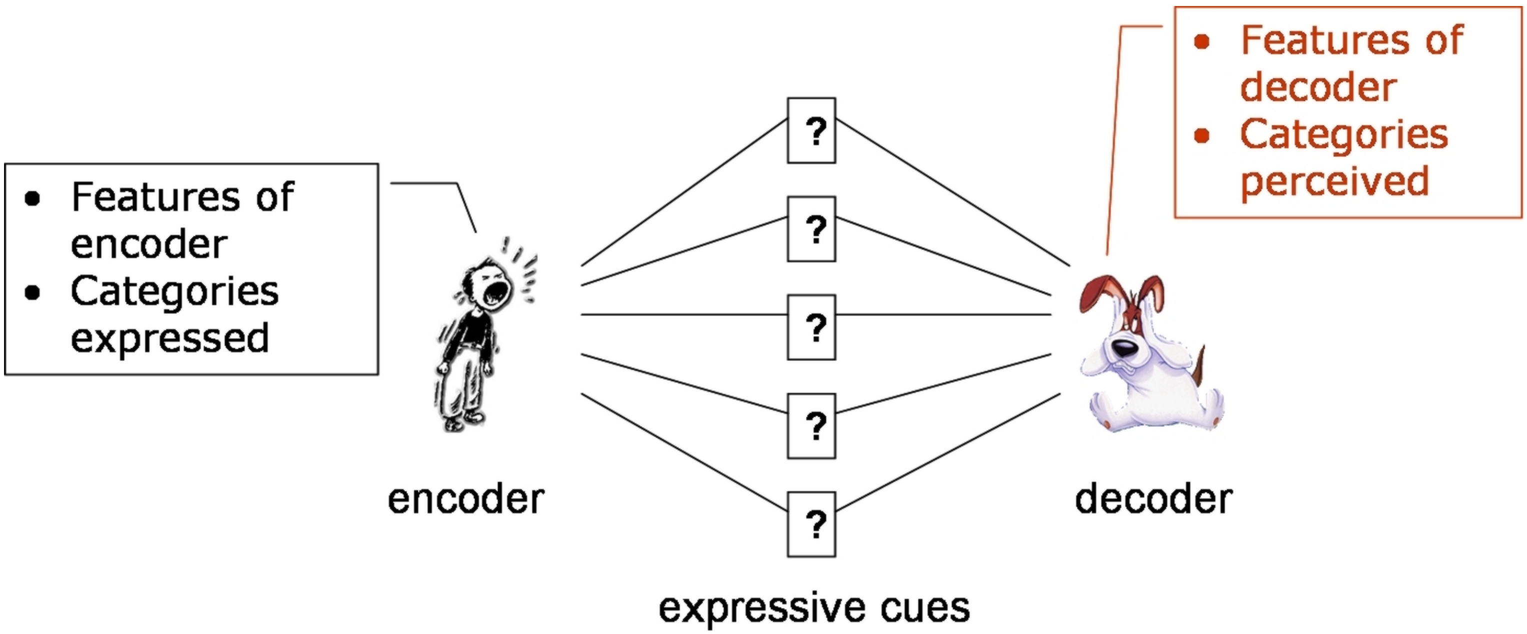
Emotional Communication Skills



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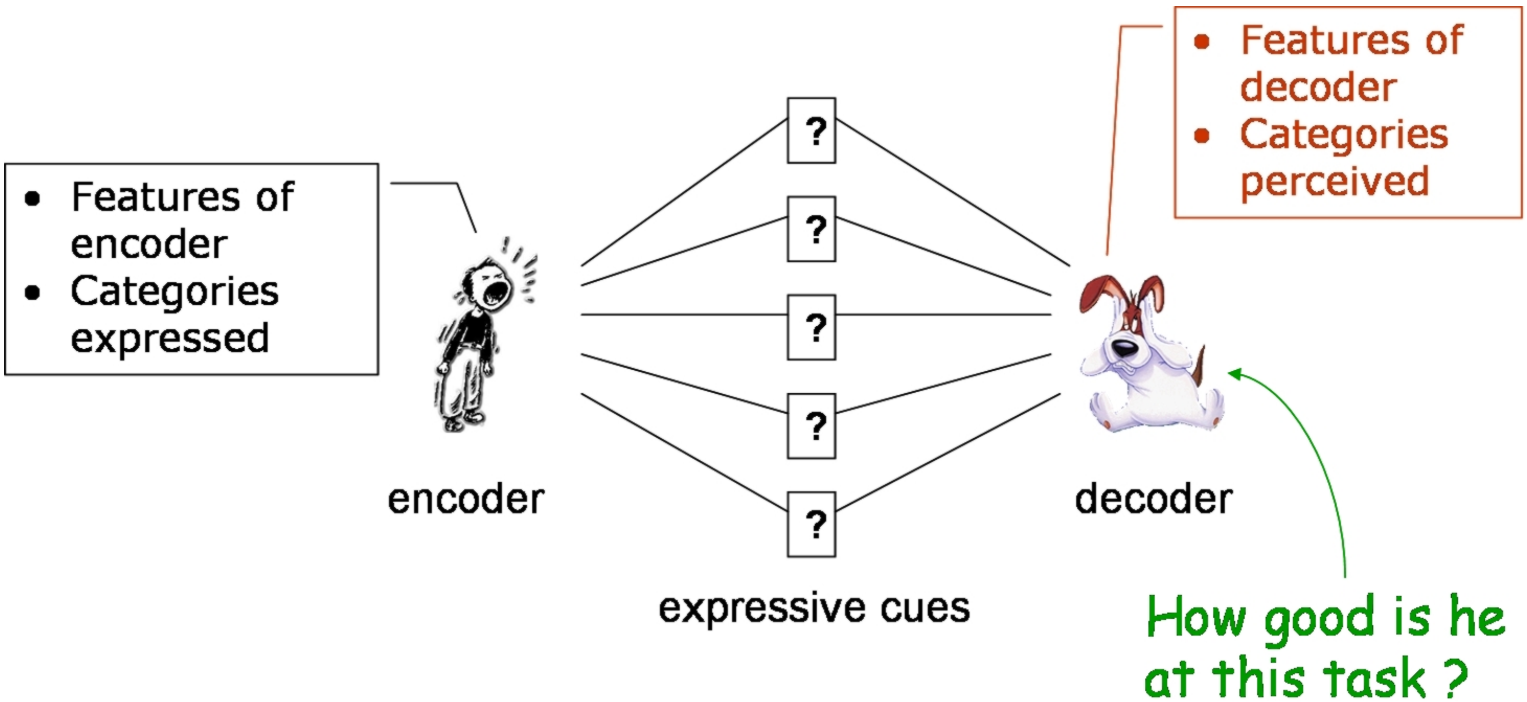
- Psychologists: sensitivity of individuals to emotional expressions
- Computer scientists: performance of machine classifiers

Emotional Communication Skills



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Evaluation of the Decoder

Traditional:

- (Classwise averaged) recognition rates

Problems:

- (Hard) reference needed
- Dependent on the number and the similarity of the classes
- Confusions of similar emotions are as wrong as confusions of totally different emotions
- Independent of the "quality" of the reference

The Aibo-Emotion-Corpus

- Words labelled by 5 labellers as we do not know which emotion the child expressed
- 4 cover classes: **A**nger, **M**otherese, **E**mphatic, **N**eutral
- Majority voting as reference (3 or more labellers)

emotion	frequency	
anger	1645	3,3 %
5 of 5	191	11,6 %
4 of 5	473	28,7 %
3 of 5	981	59,5 %
emphatic	2528	5,2 %
5 of 5	67	2,6 %
4 of 5	550	21,7 %
3 of 5	1911	75,5 %

emotion	frequency	
motherese	1261	2,6 %
5 of 5	16	1,2 %
4 of 5	510	40,4 %
3 of 5	735	58,2 %
neutral	39182	80,9 %
5 of 5	12654	32,2 %
4 of 5	16112	41,1 %
3 of 5	10416	26,5 %

Entropy-Based Evaluation of the Decoder

- Proposed in our ICASSP 2005 paper
- Creation of soft reference labels $\boldsymbol{l}_{\mathrm{ref}}$

L1	L2	L3	L4
A	A	E	N

$\longrightarrow$

A	M	E	N
0,50	0,00	0,25	0,25

- Calculate the entropy

$$
\begin{aligned}
0 \leq H(\boldsymbol{l}_{\mathrm{ref}}) &= -\sum l_i \cdot \mathrm{ld}\, l_i \\
&= -\left(\frac{1}{2} \cdot \mathrm{ld}\frac{1}{2} + \frac{1}{4} \cdot \mathrm{ld}\frac{1}{4} + \frac{1}{4} \cdot \mathrm{ld}\frac{1}{4}\right) = 1.5 \leq \mathrm{ld}(4) = 2
\end{aligned}
$$

The entropy is a measure for the agreement of the labellers.

Entropy-Based Evaluation of the Decoder

- Decision of the decoder $\boldsymbol{l}_{\mathrm{dec}}$

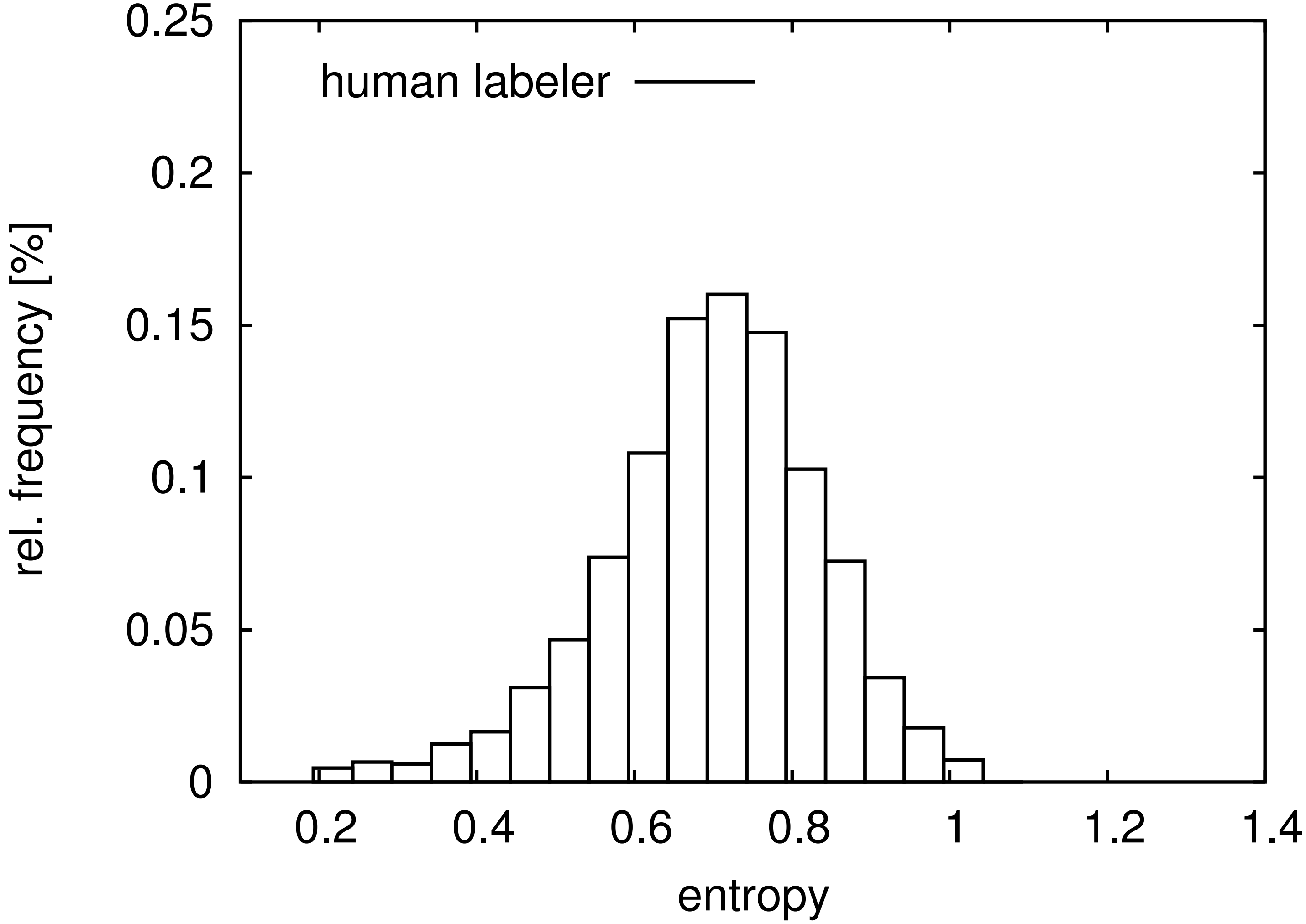
$$\boxed{\begin{array}{c} \text{D} \\ \text{A} \end{array}} \longrightarrow \boxed{\begin{array}{cccc} \text{A} & \text{M} & \text{E} & \text{N} \\ 1{,}00 & 0{,}00 & 0{,}00 & 0{,}00 \end{array}}$$

- 1:1 weighting

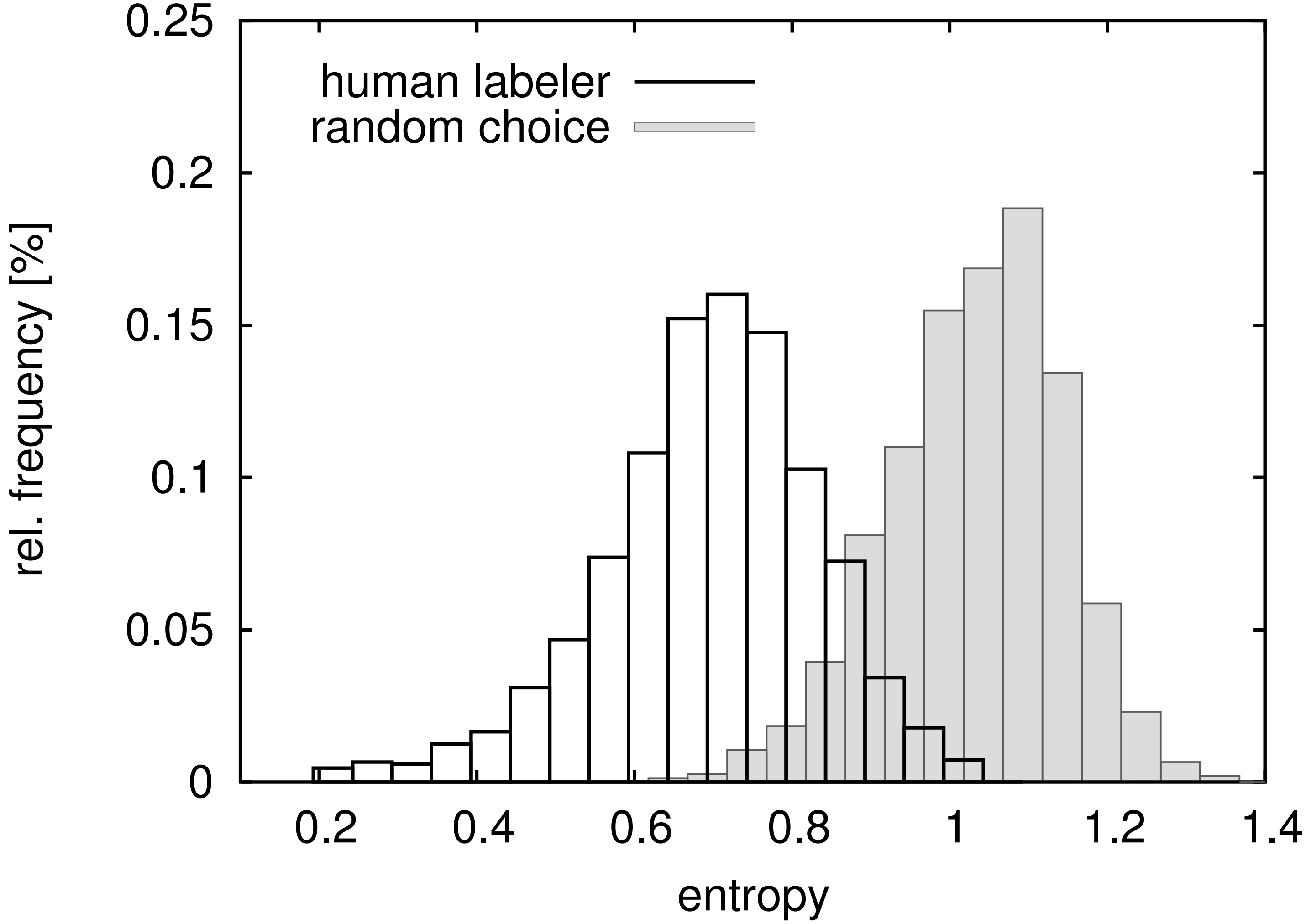
$$\boldsymbol{l} = \frac{1}{2} \cdot \boldsymbol{l}_{\mathrm{ref}} + \frac{1}{2} \cdot \boldsymbol{l}_{\mathrm{dec}}$$

- Calculate the entropy $H(\boldsymbol{l})$
- Calculate the mean entropy of the whole data set or for a certain number of successive samples to plot histograms
- Compare the mean entropy or the histograms for different decoders

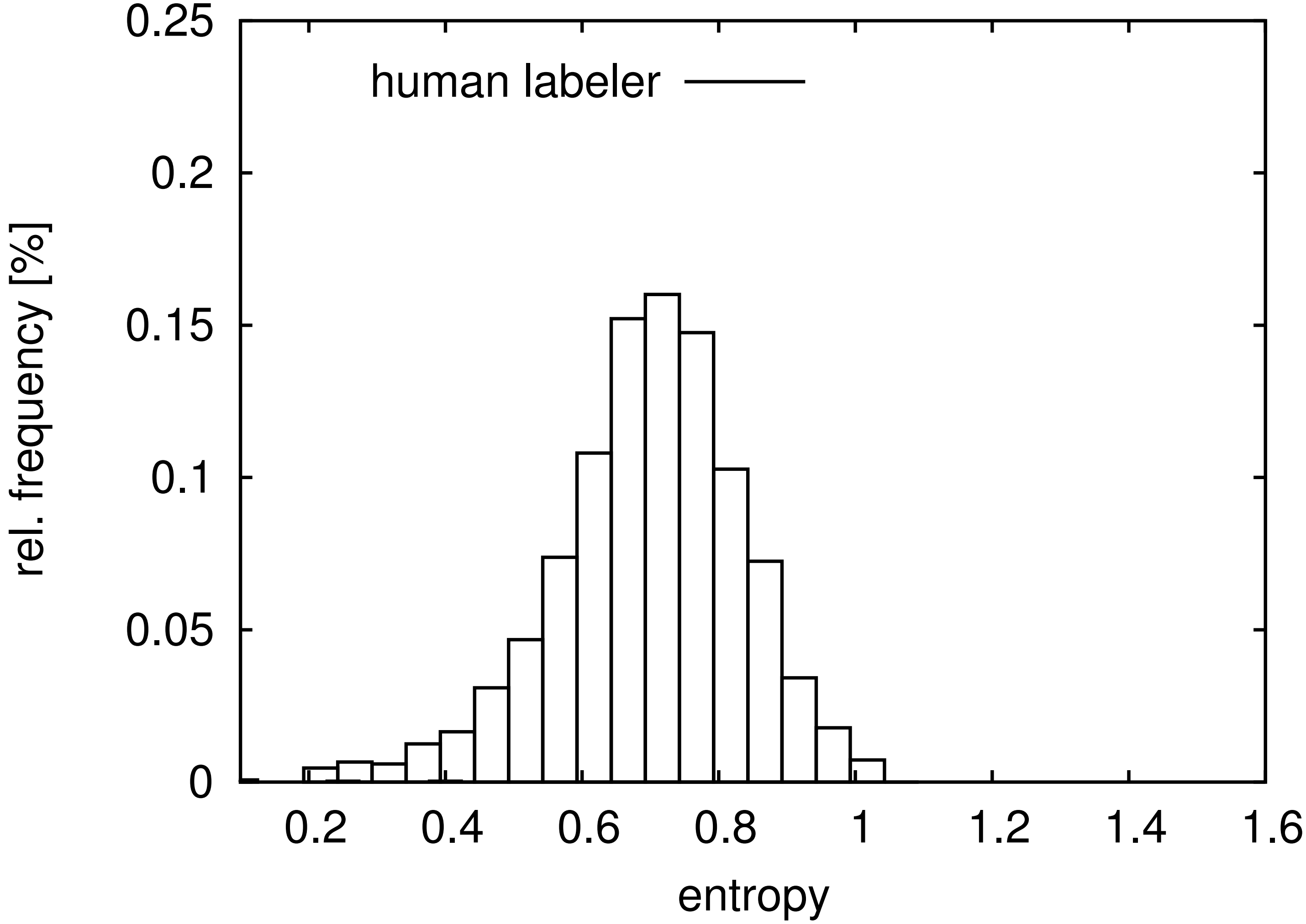
Entropy Histograms



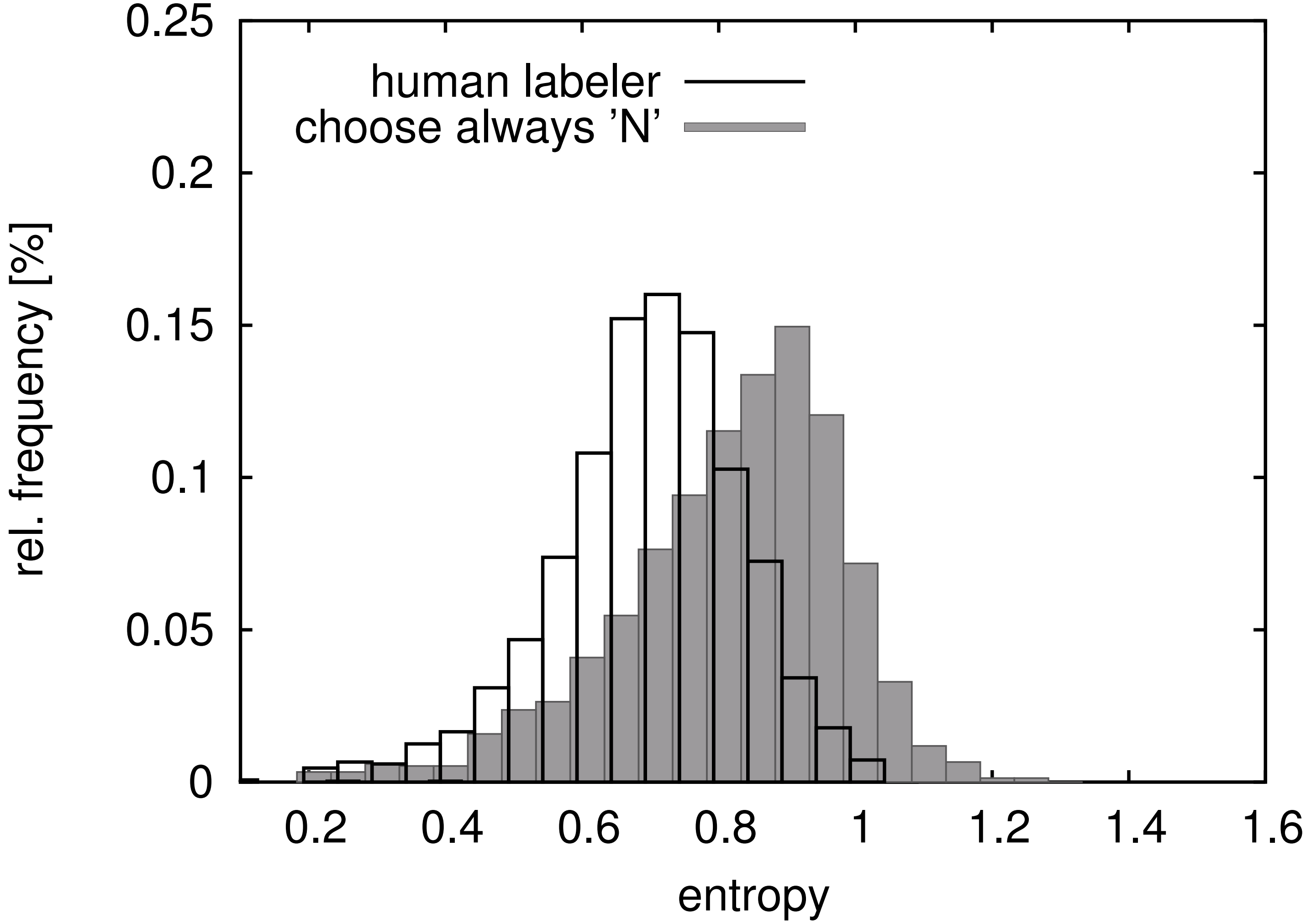
Entropy Histograms



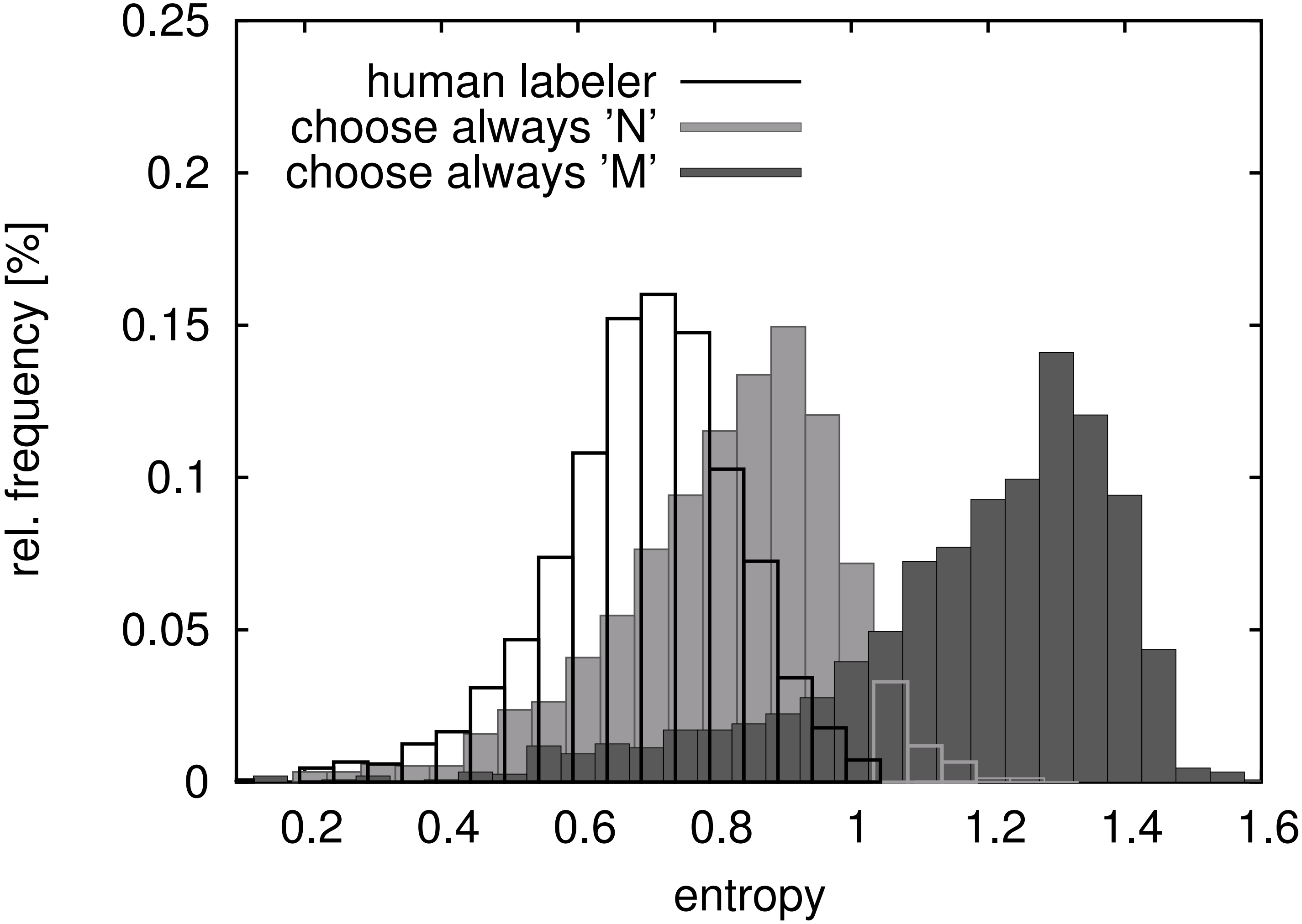
Entropy Histograms



Entropy Histograms



Entropy Histograms



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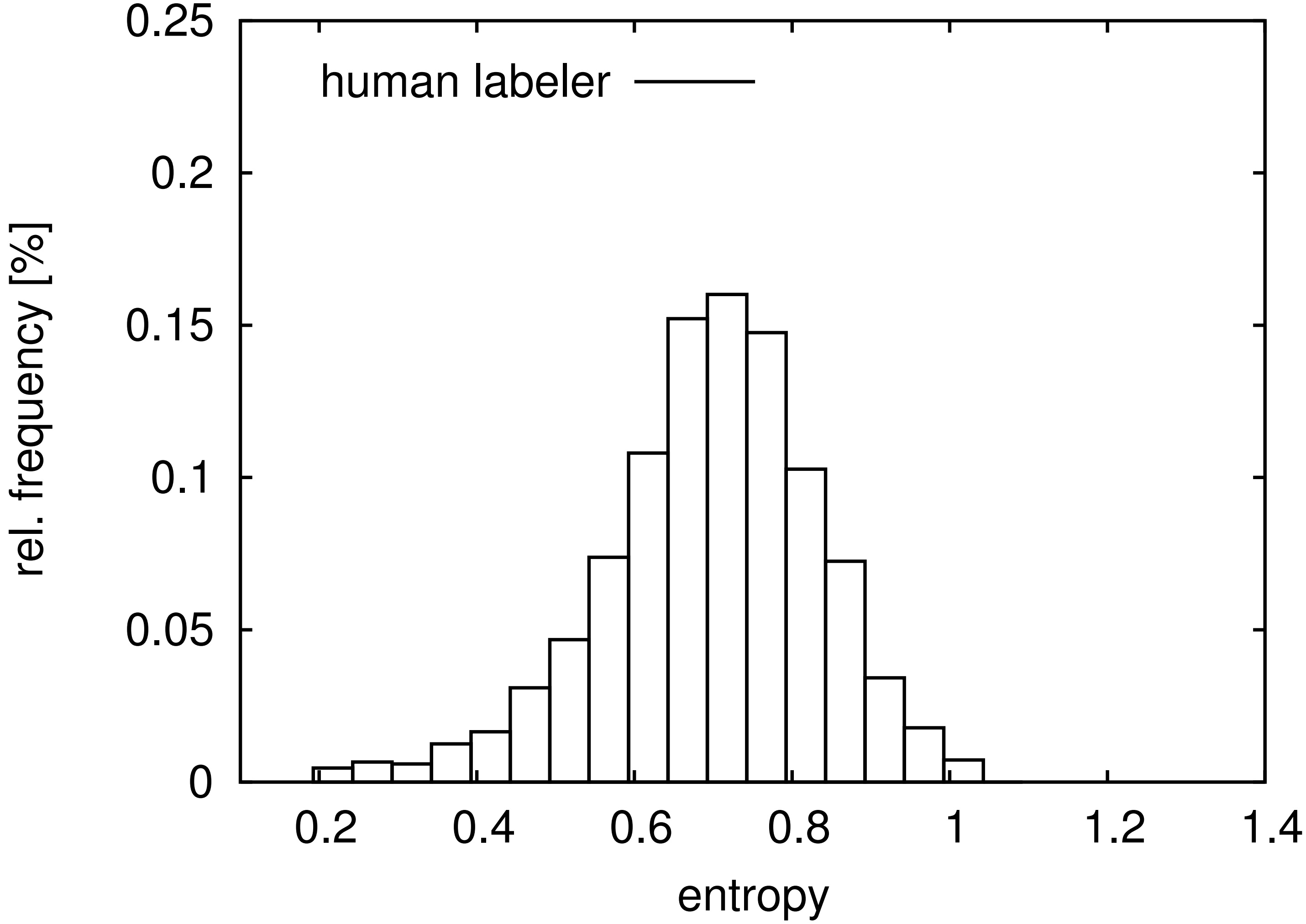

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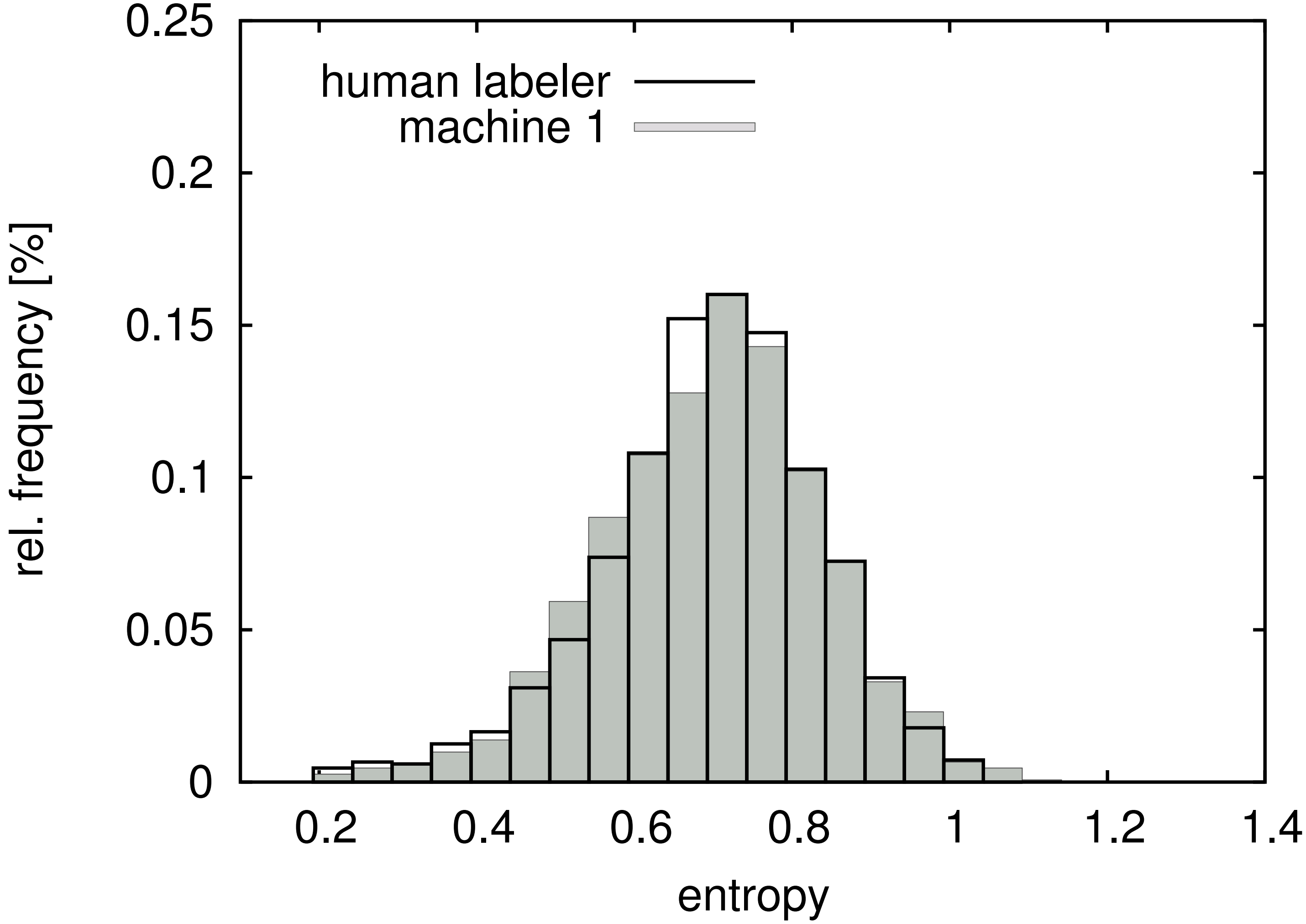

Mean Entropy

decoder	entropy
human labeller	0,721
machine classifier	0,722
all 'neutral'	0,843
all 'emphatic'	1,049
random choice	1,050
all 'anger'	1,127
all 'motherese'	1,196

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Is the recognition problem solved?

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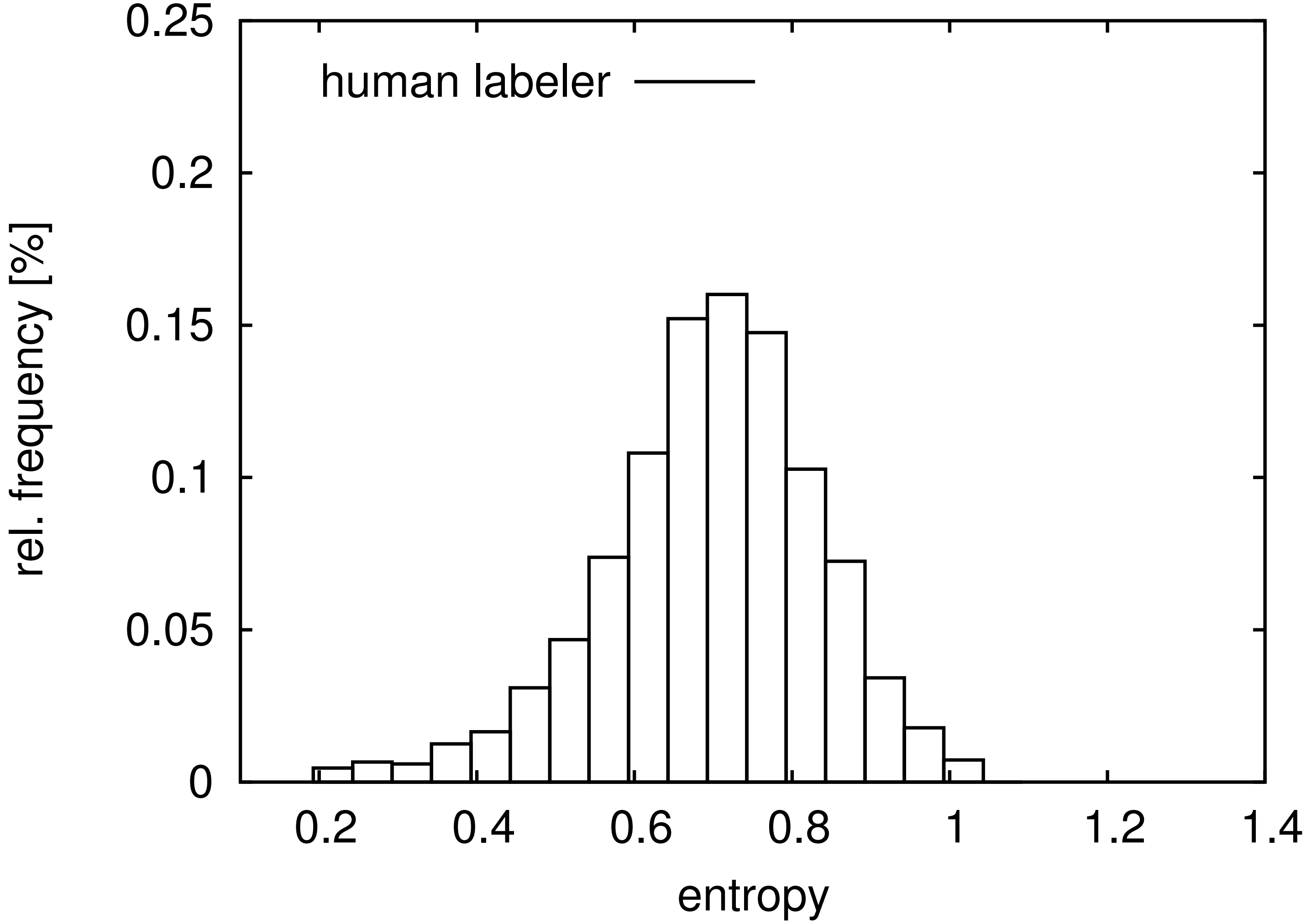
Is the recognition problem solved? Definitely not!

Goal: classification as the majority does

Entropy Histogram



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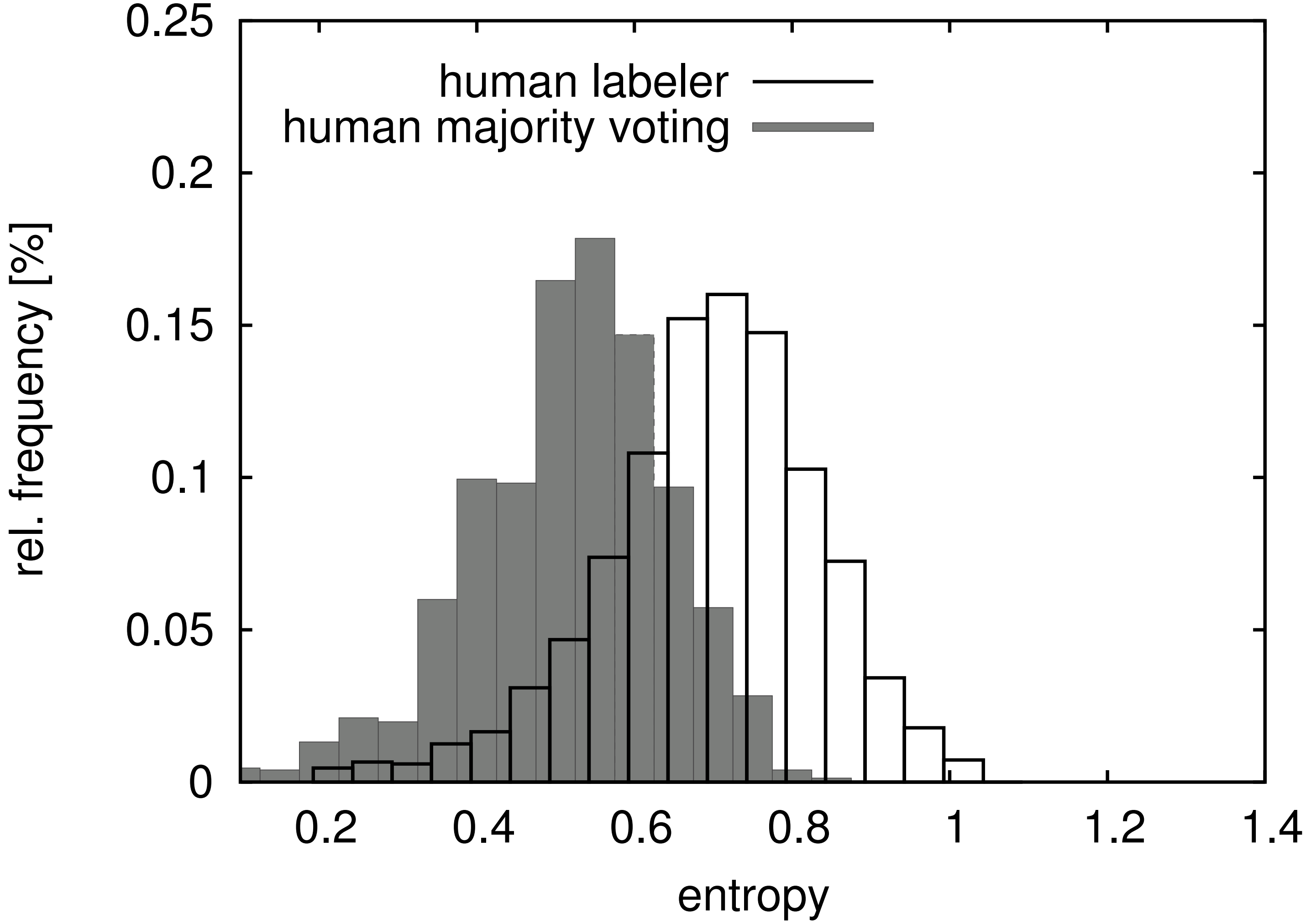

Summary

- Evaluation of decoders with an entropy based measure which
  - ⋆ uses a soft reference
  - ⋆ requires > 2 labellers
  - ⋆ implicitely weights classification "errors" according to the likelihood that both emotions are confused by the labellers

End