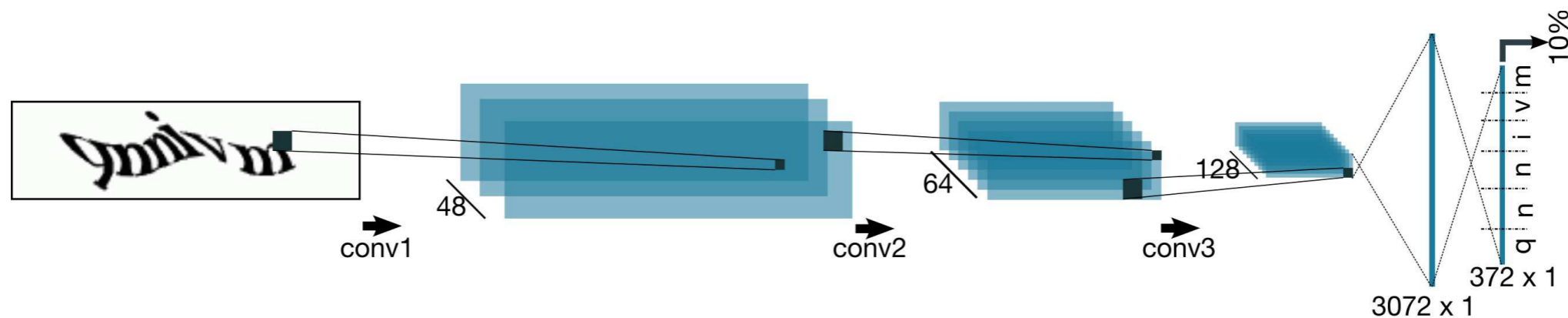


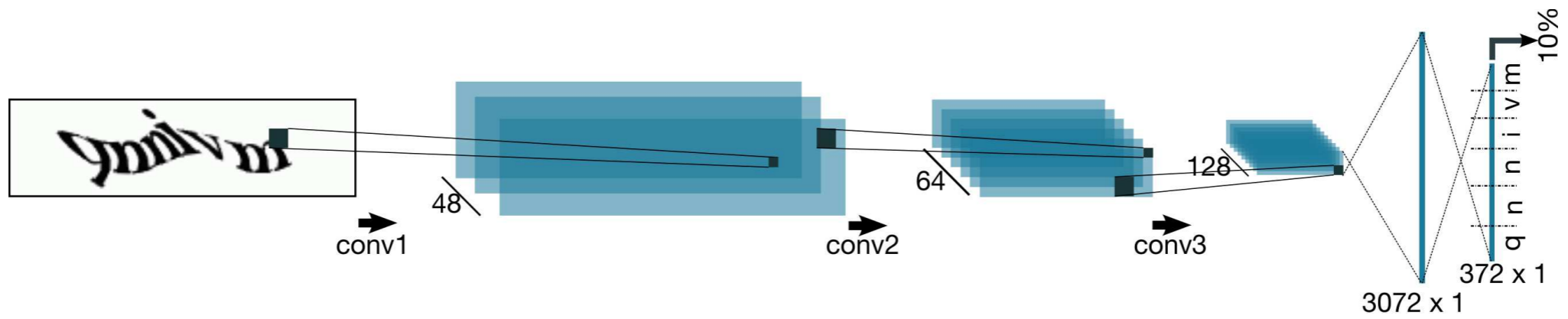
CAPTCHA Recognition with Active Deep Learning

Caner Hazırbaş

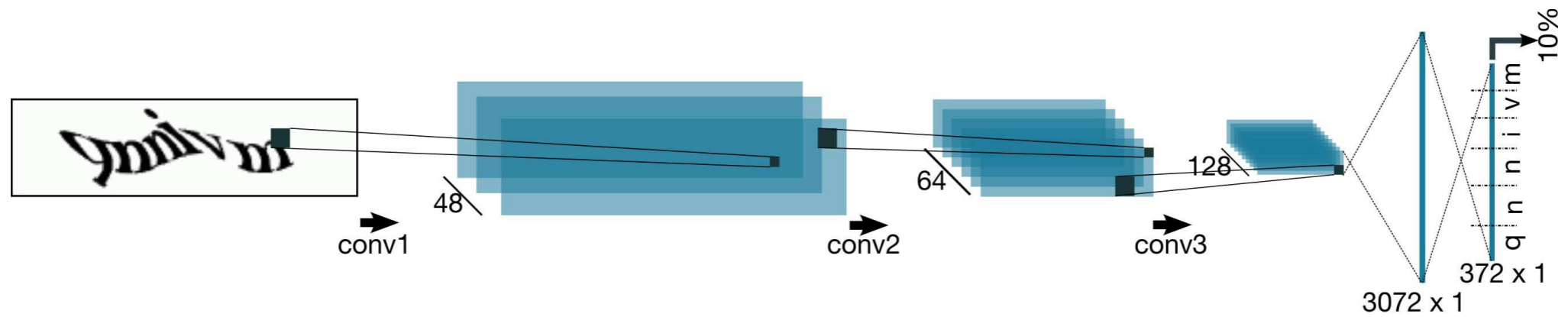


Joint work with Fabian Stark, Rudolph Triebel and Daniel Cremers

Deep CNN for CAPTCHA Recognition



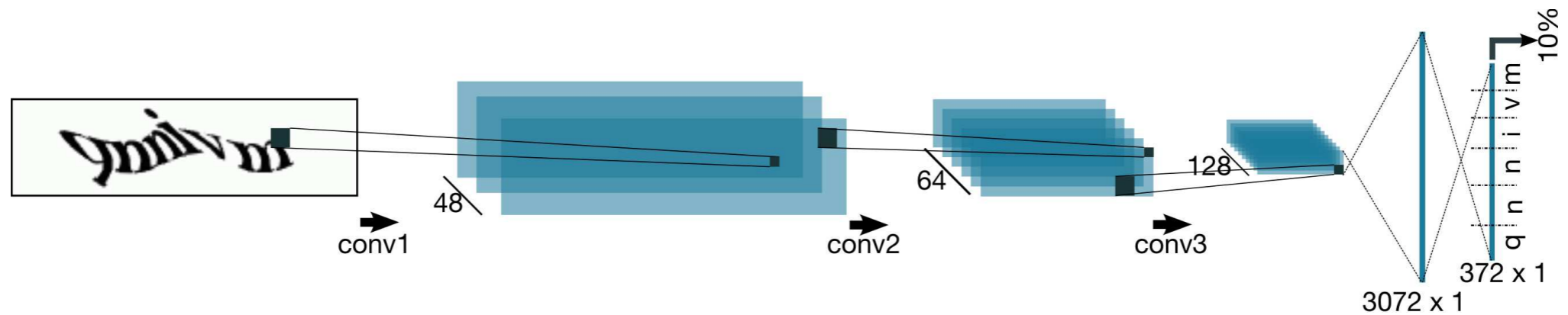
Deep CNN for CAPTCHA Recognition



Advantages

- ✓ No pre-segmentation
- ✓ Precise prediction

Deep CNN for CAPTCHA Recognition



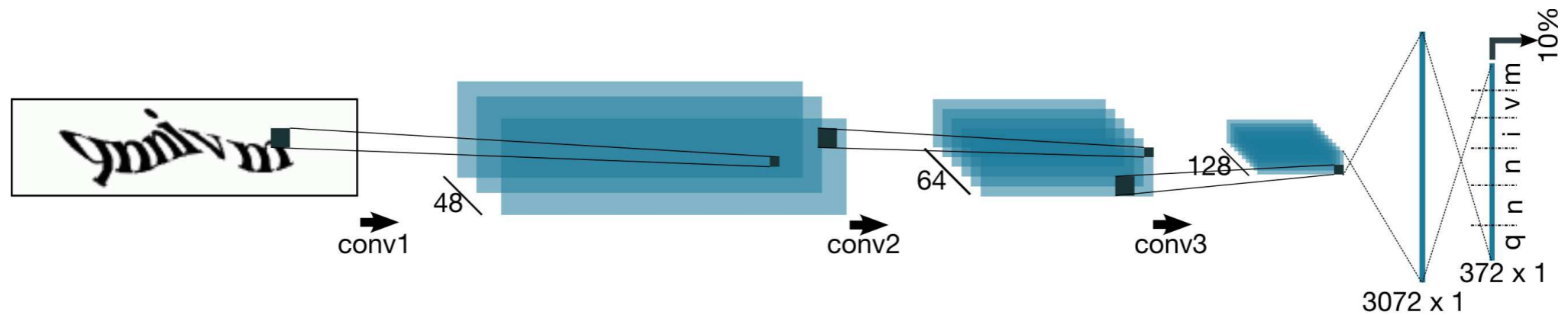
Advantages

- ✓ No pre-segmentation
- ✓ Precise prediction

Drawbacks

- ✦ Millions of parameters to learn
- ✦ Need of huge training set

Deep CNN for CAPTCHA Recognition



Advantages

- ✓ No pre-segmentation
- ✓ Precise prediction

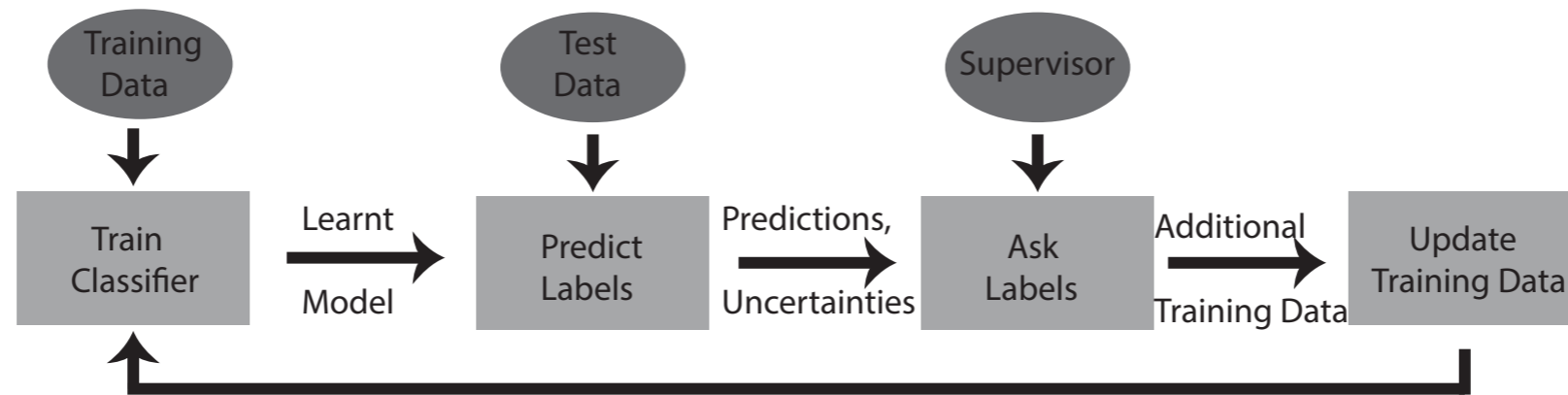
Drawbacks

- ✦ Millions of parameters to learn
- ✦ Need of huge training set

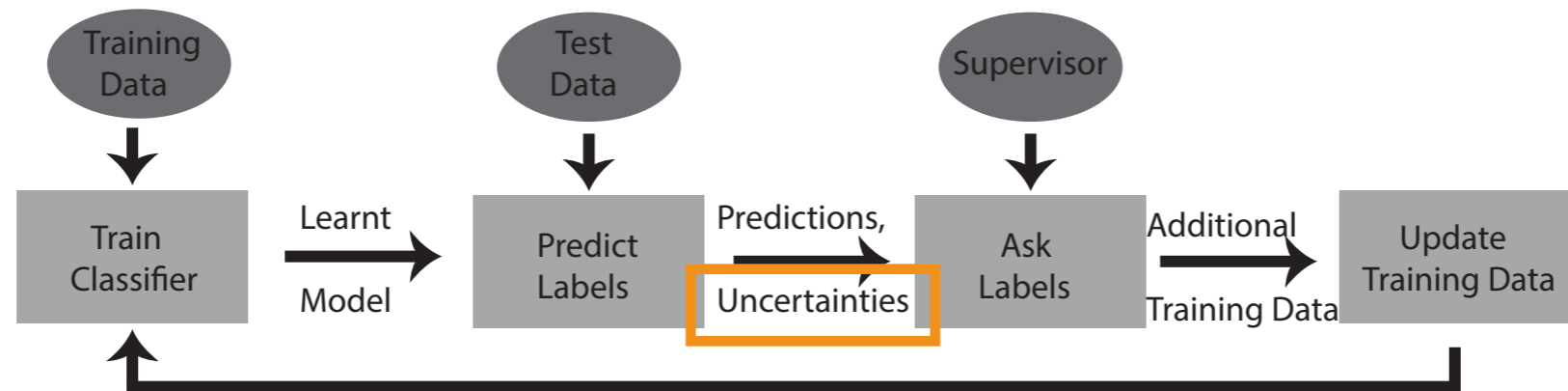
Solution

- ✓ Active Learning:
 - ⇓ required training data
 - ⇑ increase the accuracy

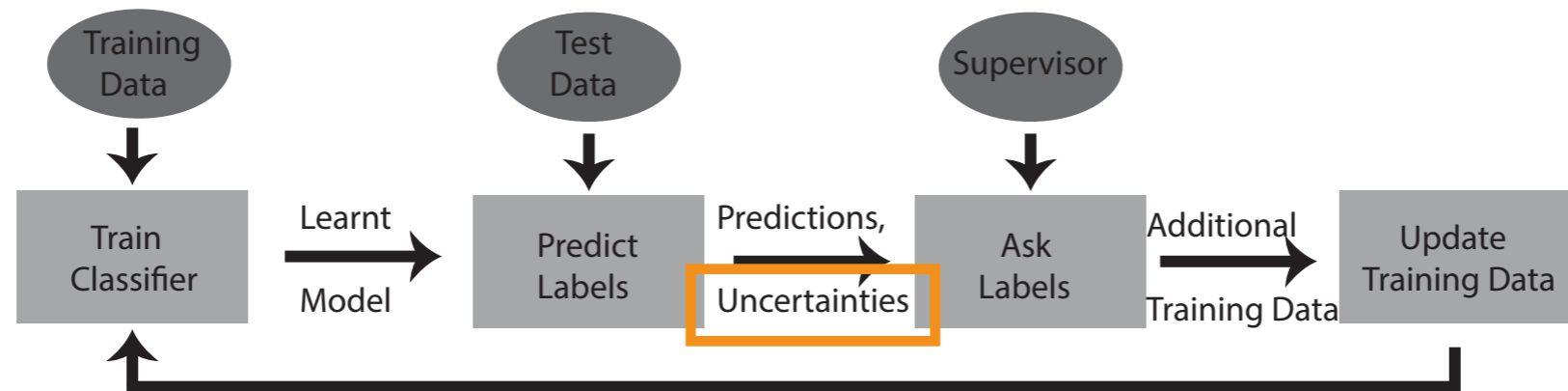
Active Learning for CAPTCHA Recognition



Uncertainty Estimation

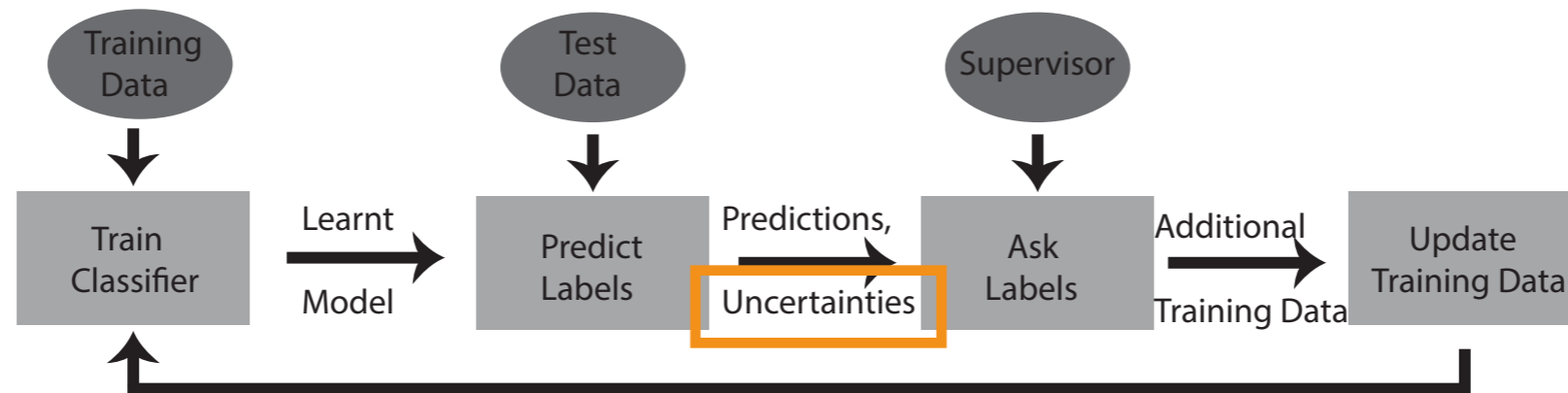


Uncertainty Estimation



“entropy ?”

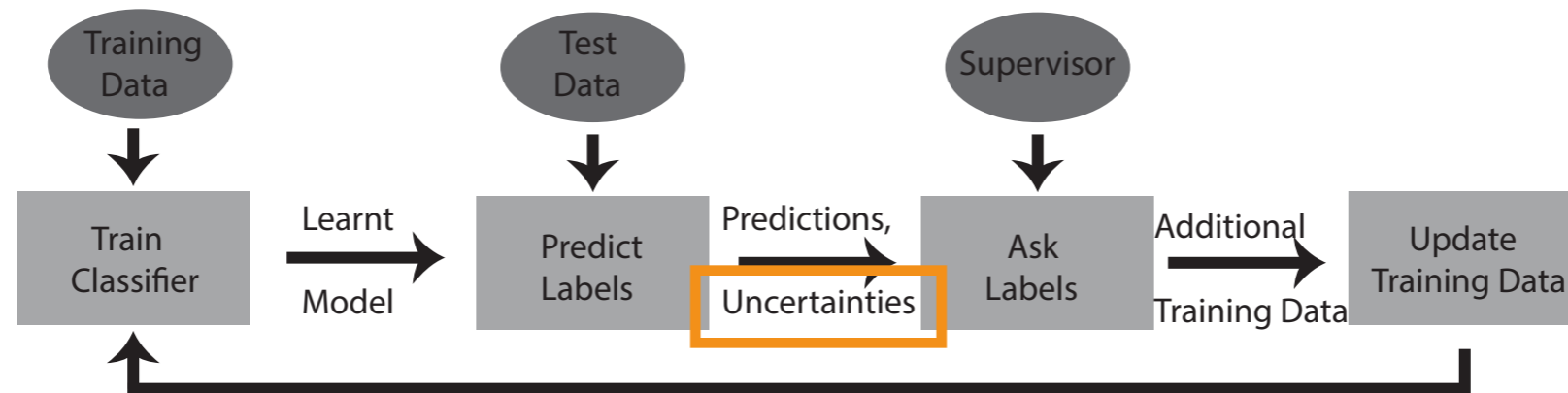
Uncertainty Estimation



“entropy ?”

Not a good measure in the case of multi-class problems !

Uncertainty Estimation

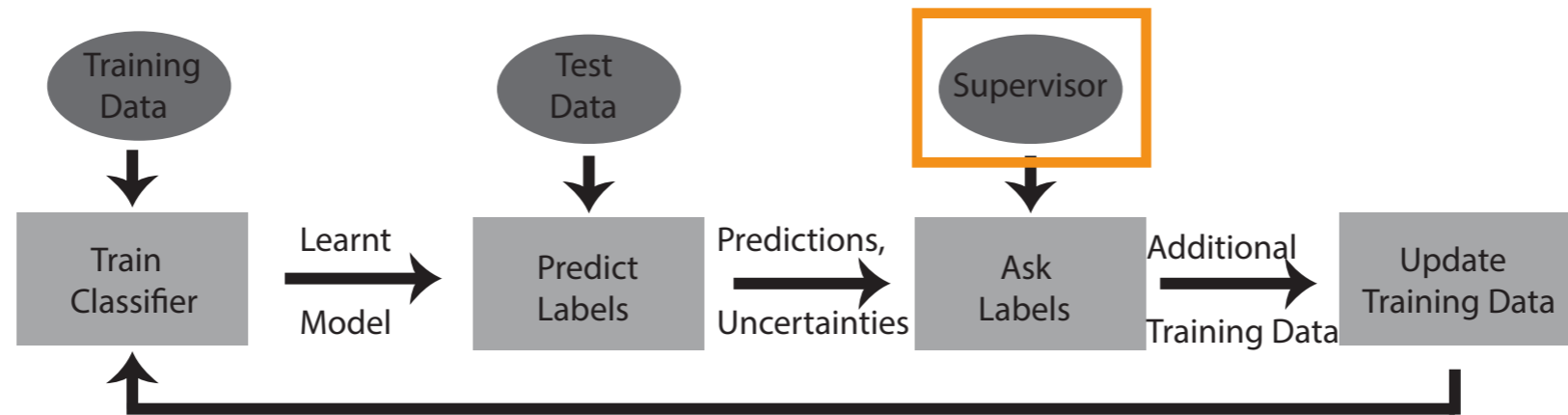


“best-vs-second-best”

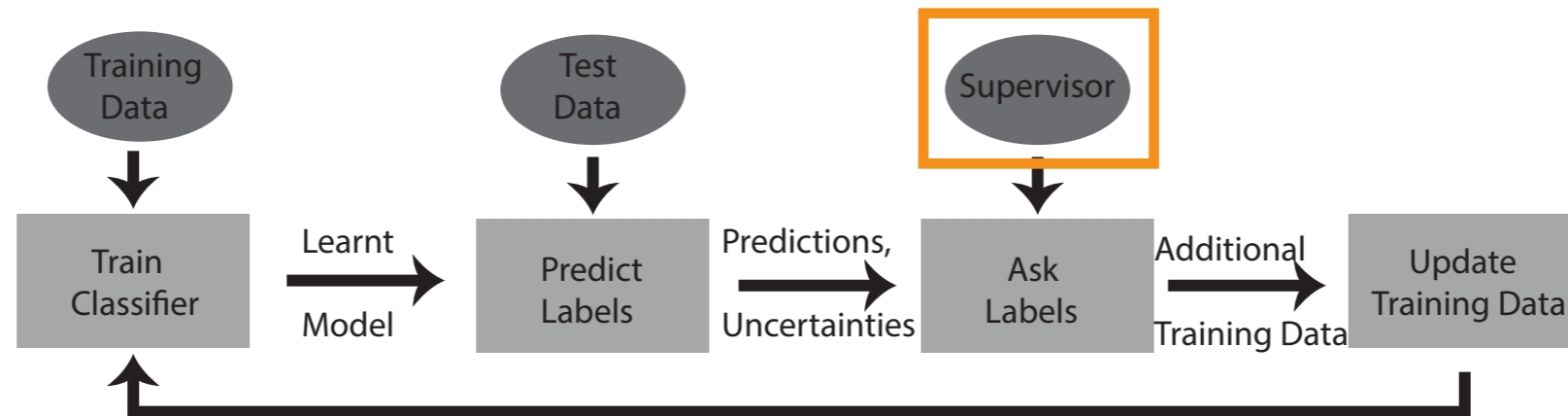
$$\eta = \frac{1}{d} \cdot \sum_{i=1}^d \frac{\arg \max \mathcal{P}(x_i) \setminus \arg \max \mathcal{P}(x_i)}{\arg \max \mathcal{P}(x_i)}$$

← second-best
← best

No Human Intervention



No Human Intervention



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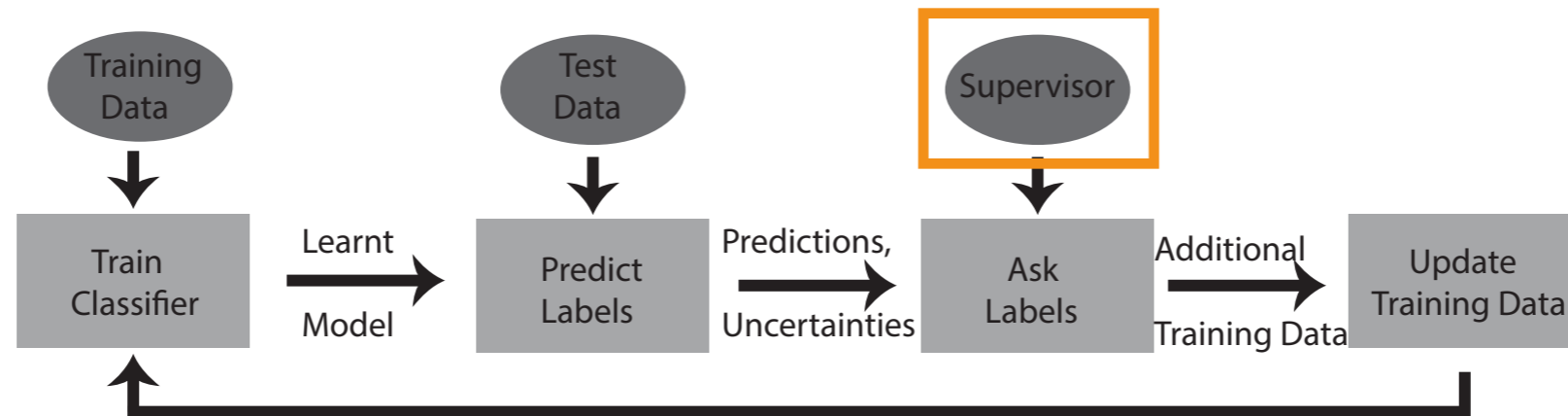
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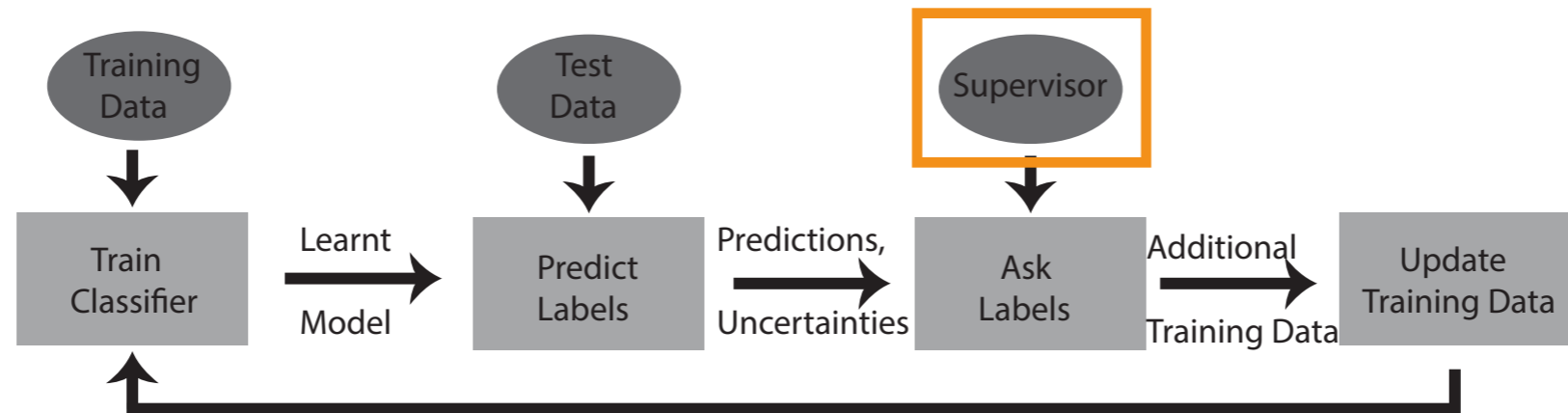
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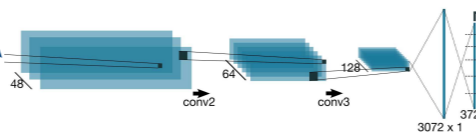
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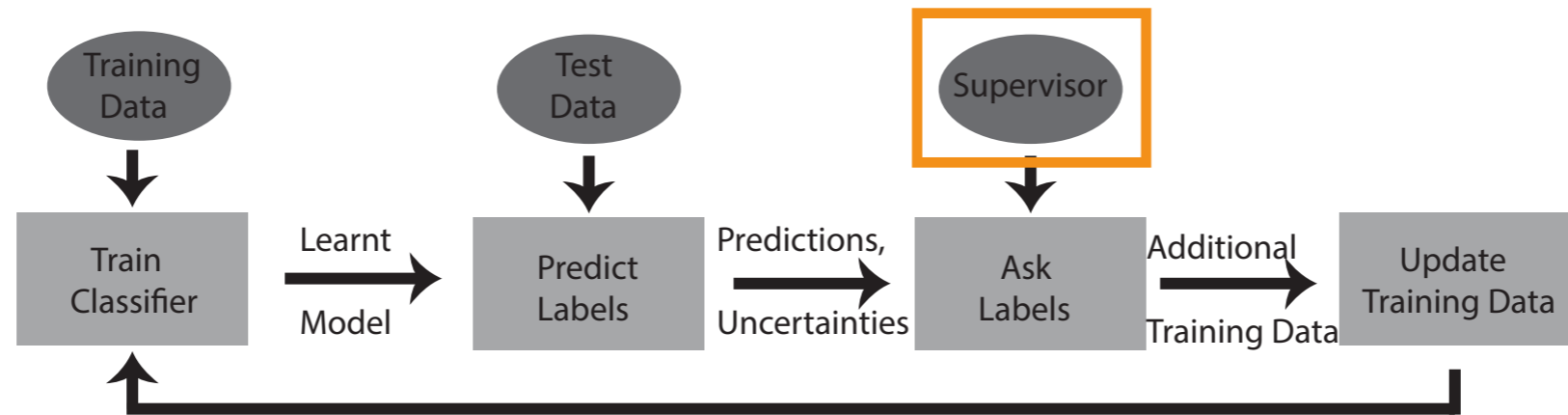
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xwmhcz



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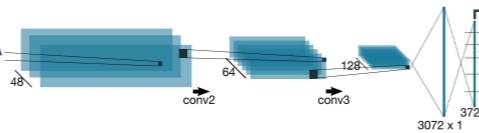
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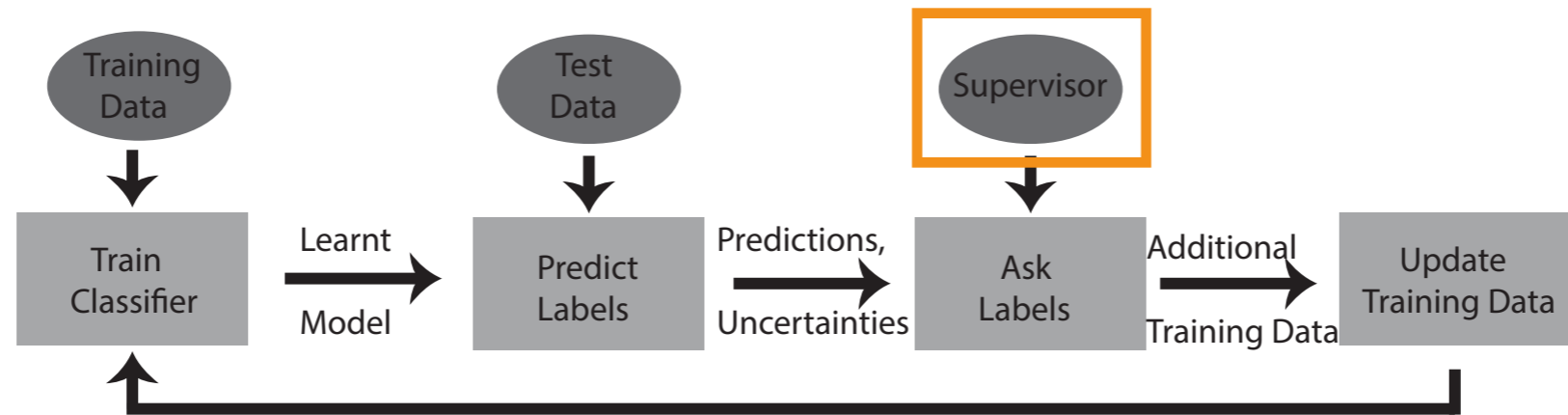
xwmhZ



xwmhZ 40%

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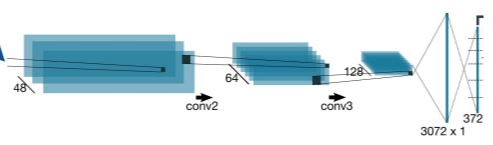
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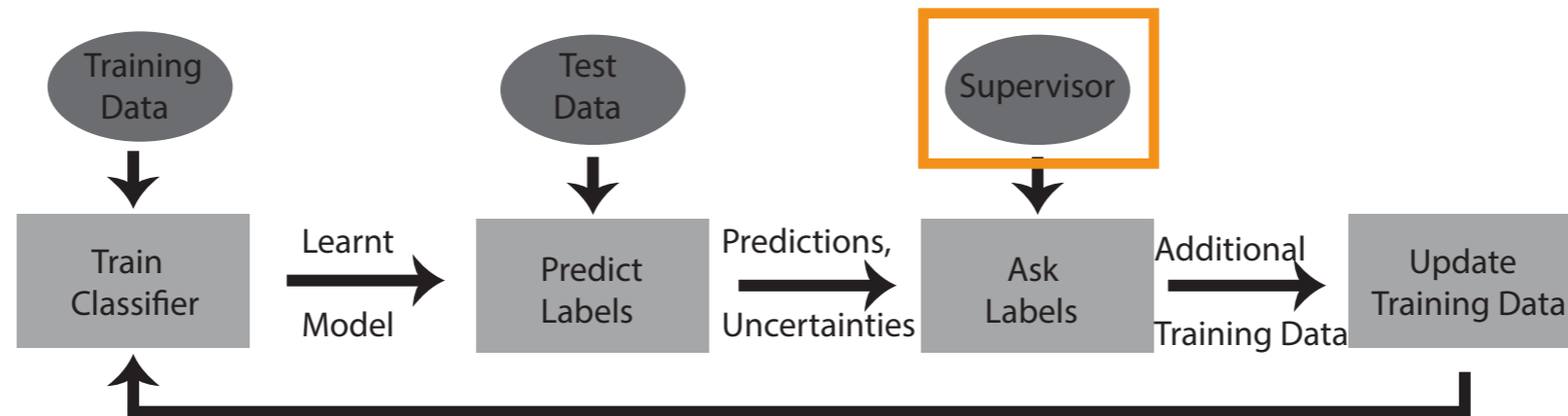
xwmhZ



xwmhZ 40%

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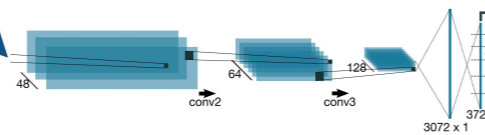
Password:

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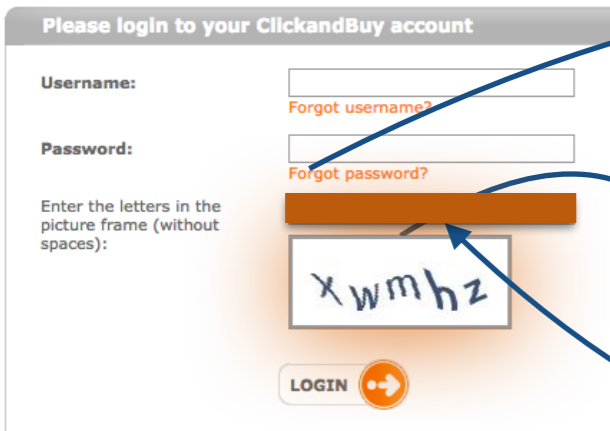
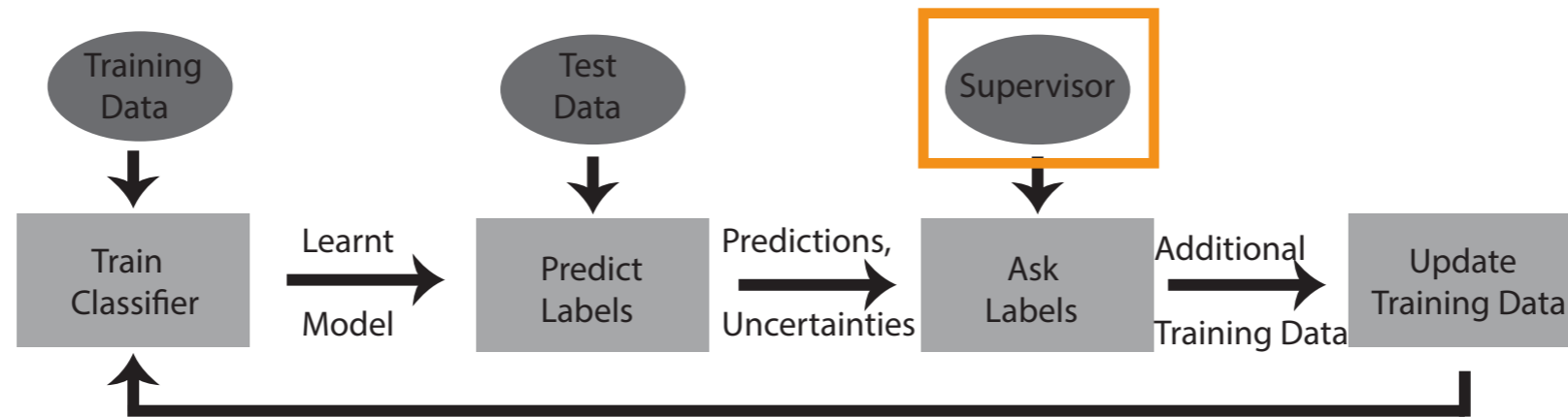
is correct ?



xwmhZ 40%

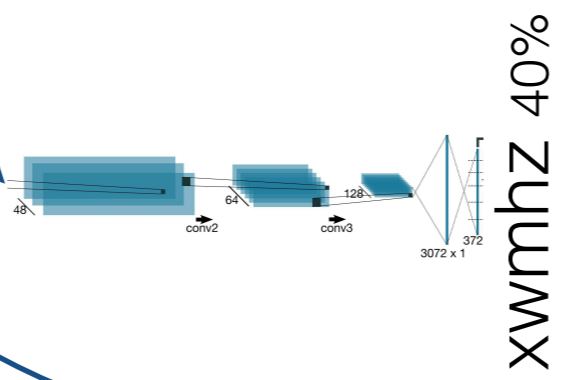
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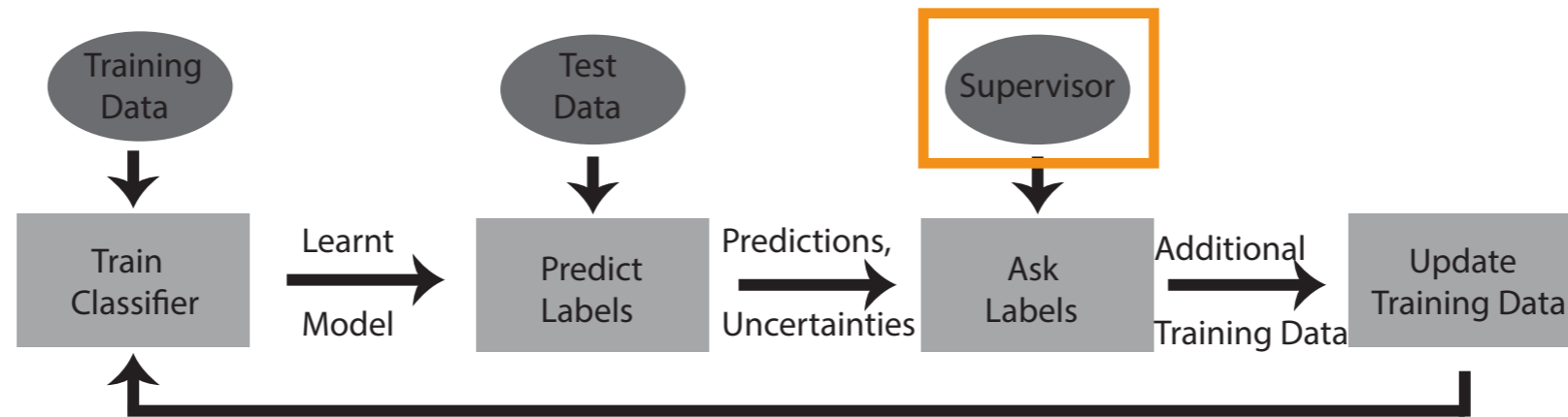
is correct ?

yes —> new training sample
no —> no ground truth :/



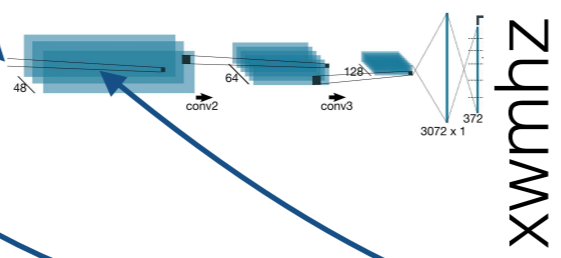
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No Human Intervention



is correct ?

yes —> new training sample
no —> no ground truth :/



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Results on Auto-generated CAPTHAs

edrgj

gydmnb

spgyqs

ghpwnp

fvsioy

fgptol

eznmny

eehuoj

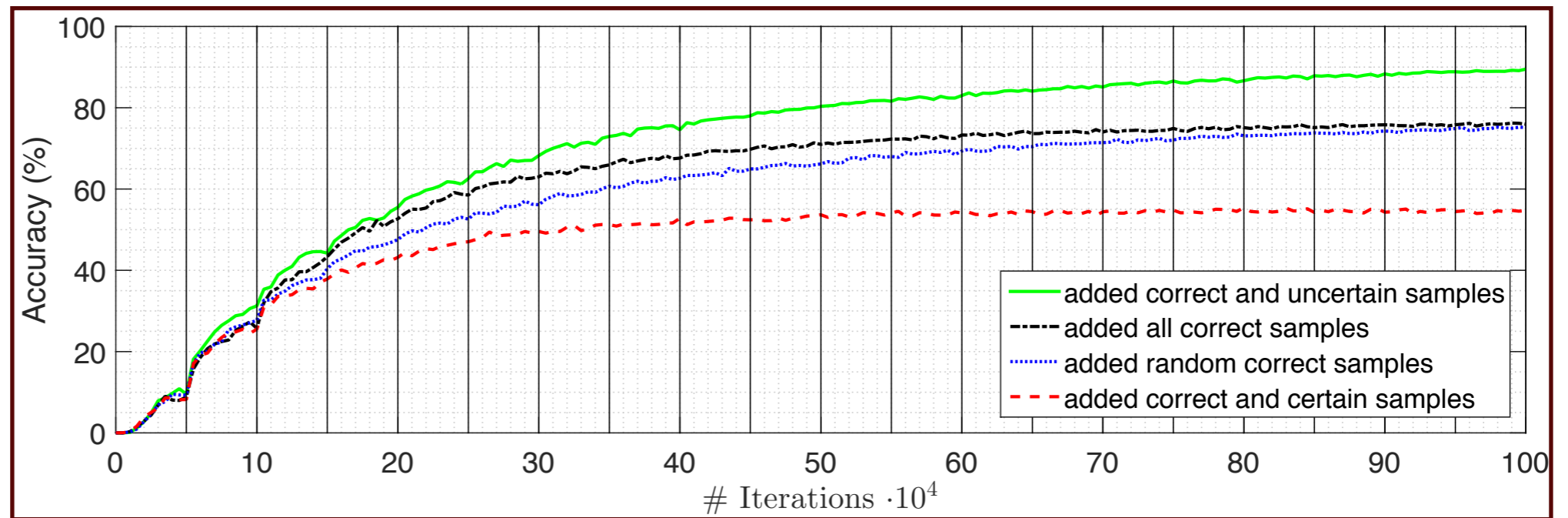
ddinjd

ctodvt

zzutoj

Results on Auto-generated CAPTHAs

Increasing training set



edrqj

gydmnb

spgyqs

ghpwnp

fvisoy

fgptol

eznmy

eehuoj

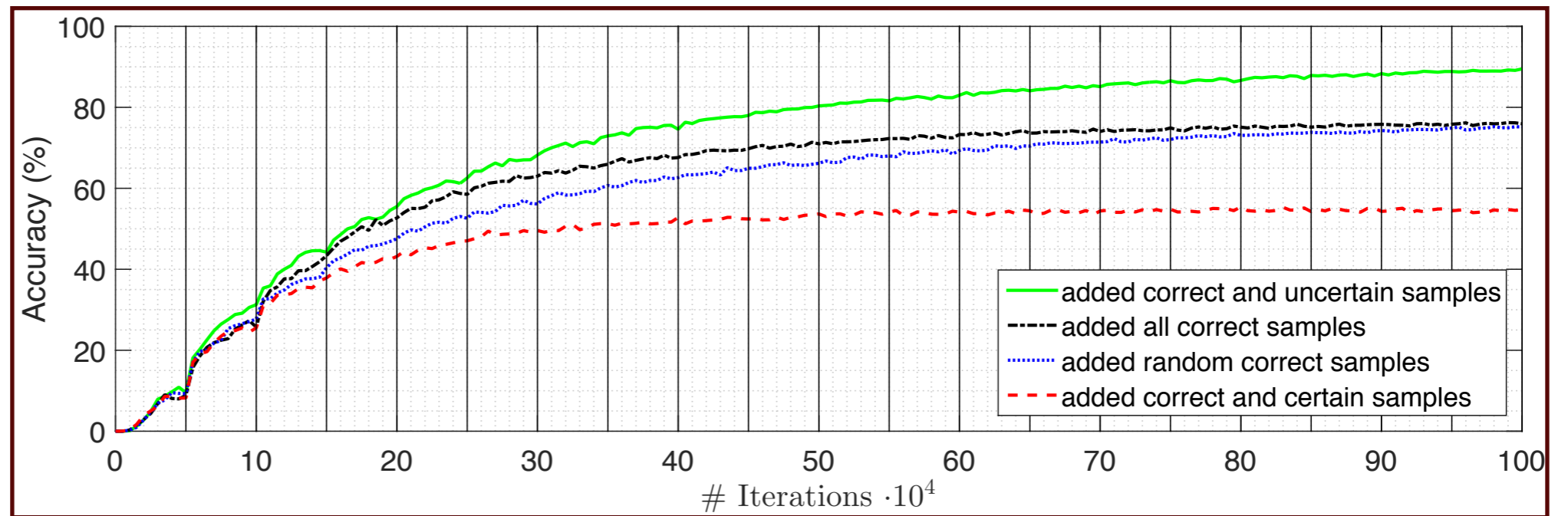
ddinjd

cvodvt

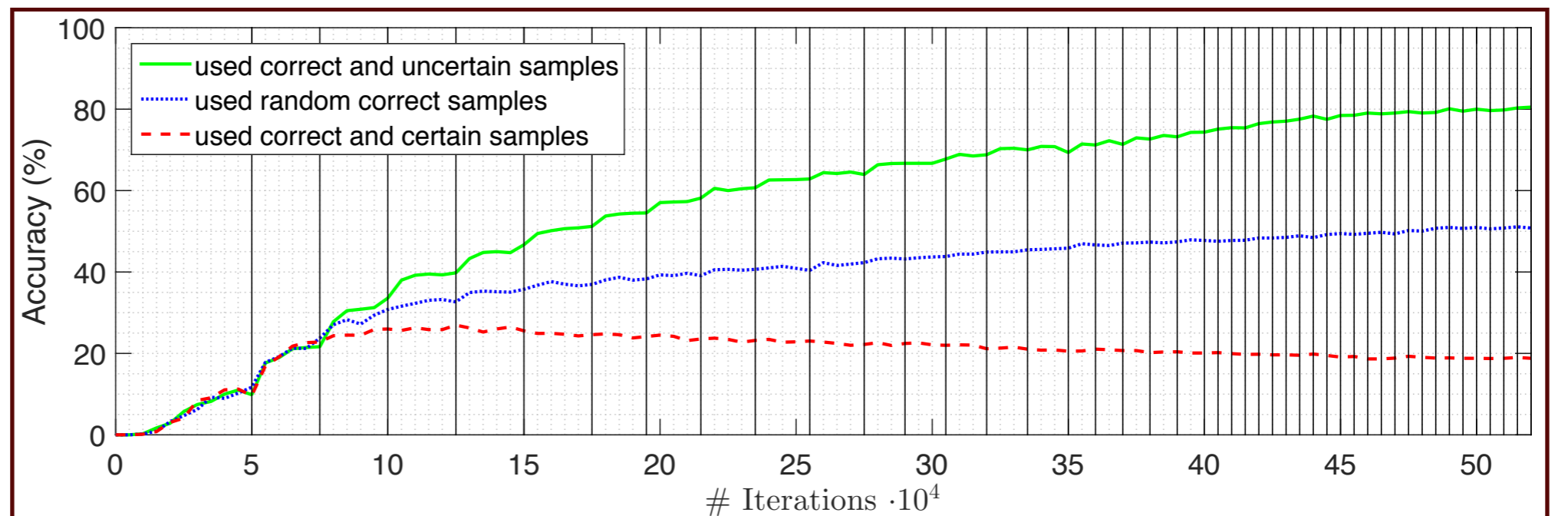
zzutoj

Results on Auto-generated CAPTHAs

Increasing training set

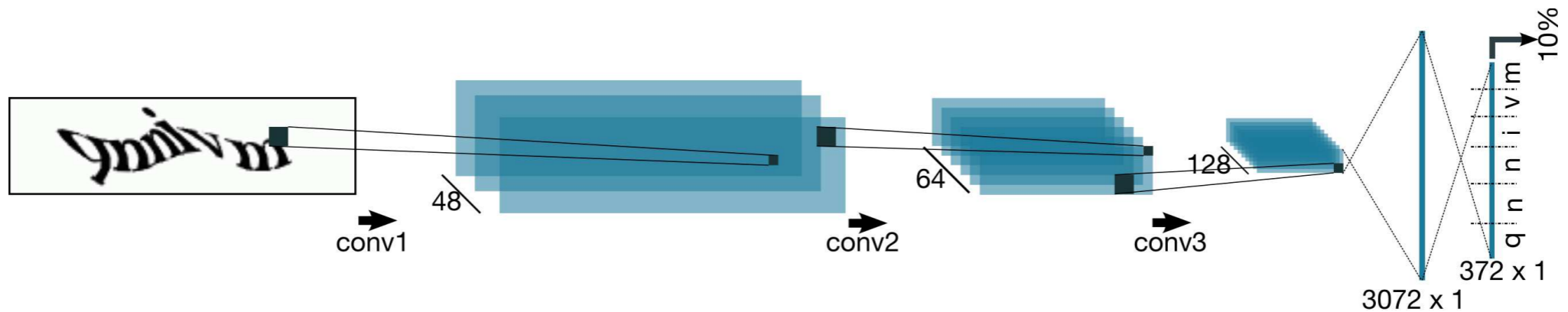


Fine-tuning on the new set



CAPTCHA Recognition with Active Deep Learning

Caner Hazırbaş | hazırbaş@cs.tum.edu



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is correct ?

yes → new training sample

no → no ground truth :/

xwmhz 40%



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