Improving reliability of attention branch network by introducing uncertainty

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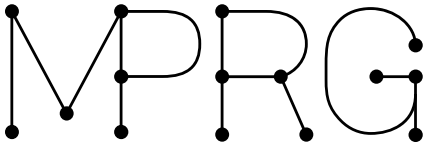

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Recognition system using machine learning

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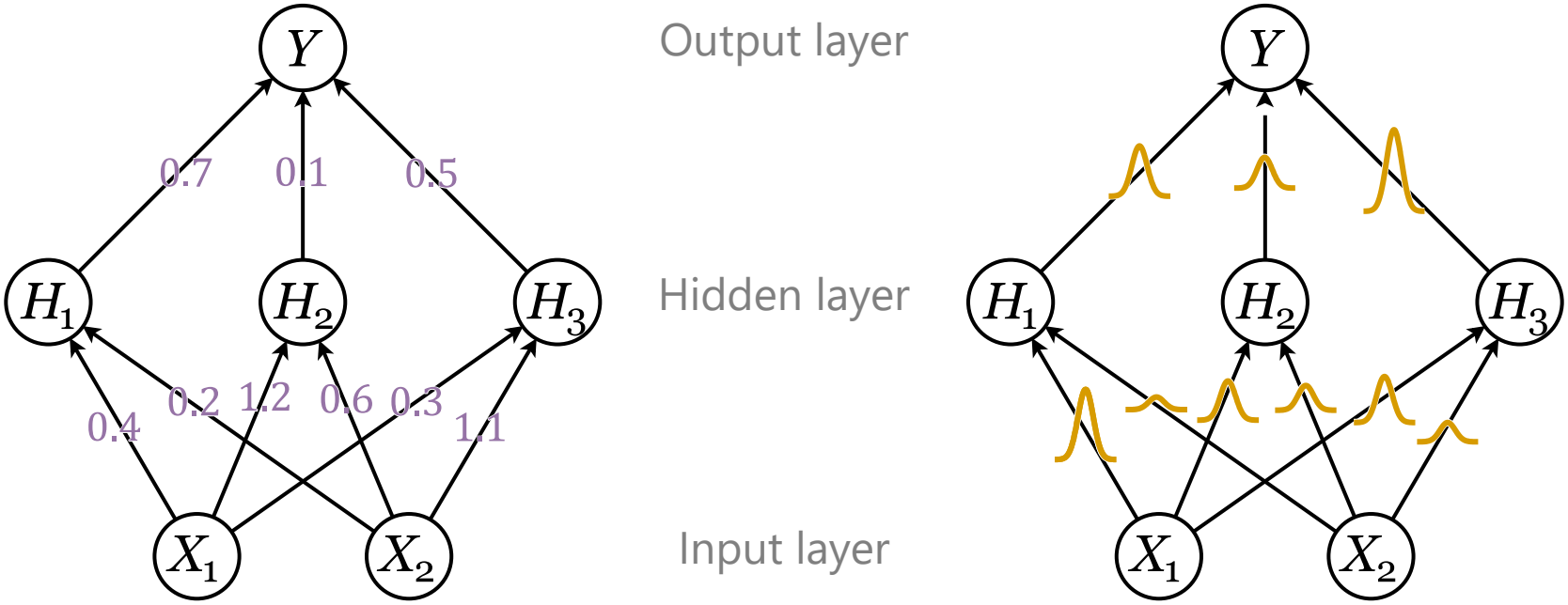
- Output recognition result and score (model reliability)
  - Do not consider the confidence of score
  - Ex. Driver assistance system
    - Misclassification the white side of the trailer as empty
      ➔ **Fatal accident**

https://goo.gl/dmezxd

Considering uncertainty leads suppression of misjudgment

Bayesian Neural Network (BNN) [Blundell+, ICML2015]

- Represent the weight of a network model by **probability distribution**



General NN

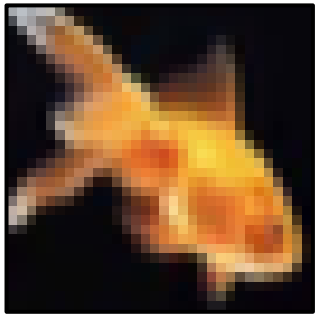
Weight is **unique**

BNN

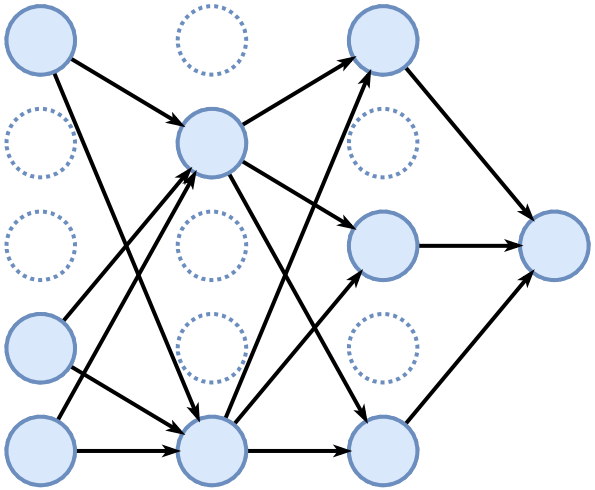
Weight is represented by **probability distribution**

Monte Carlo Dropout (MCDO) [Gal+, ICML2016]

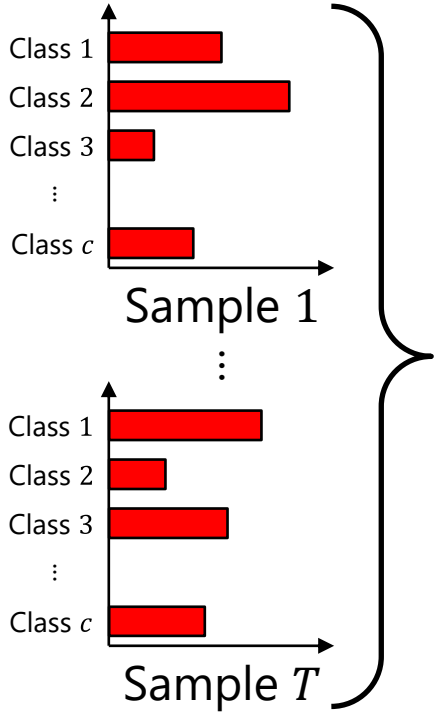
- Approximate inference of large-scale and complex models
  - Apply dropout on each layer



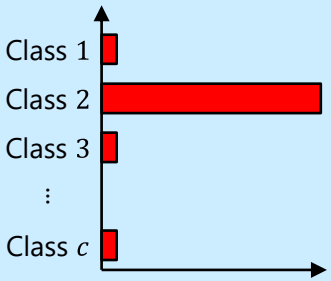
Input image



Dropout



Average



Inference result

Low entropy ➔ **Low** uncertainty

Monte Carlo Dropout (MCDO) [Gal+, ICML2016]

- Approximate inference of large-scale and complex models
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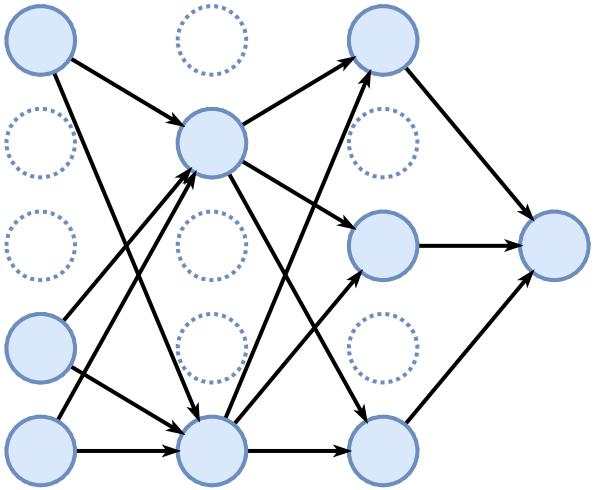
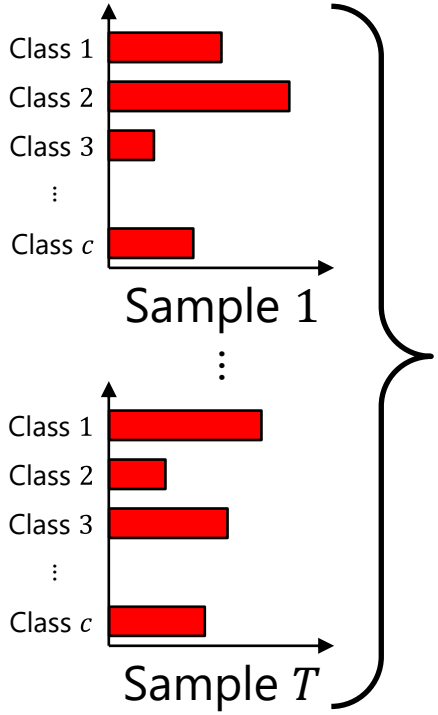
Input image



Dropout



Average

Inference result

High entropy → **High** uncertainty

Research objective

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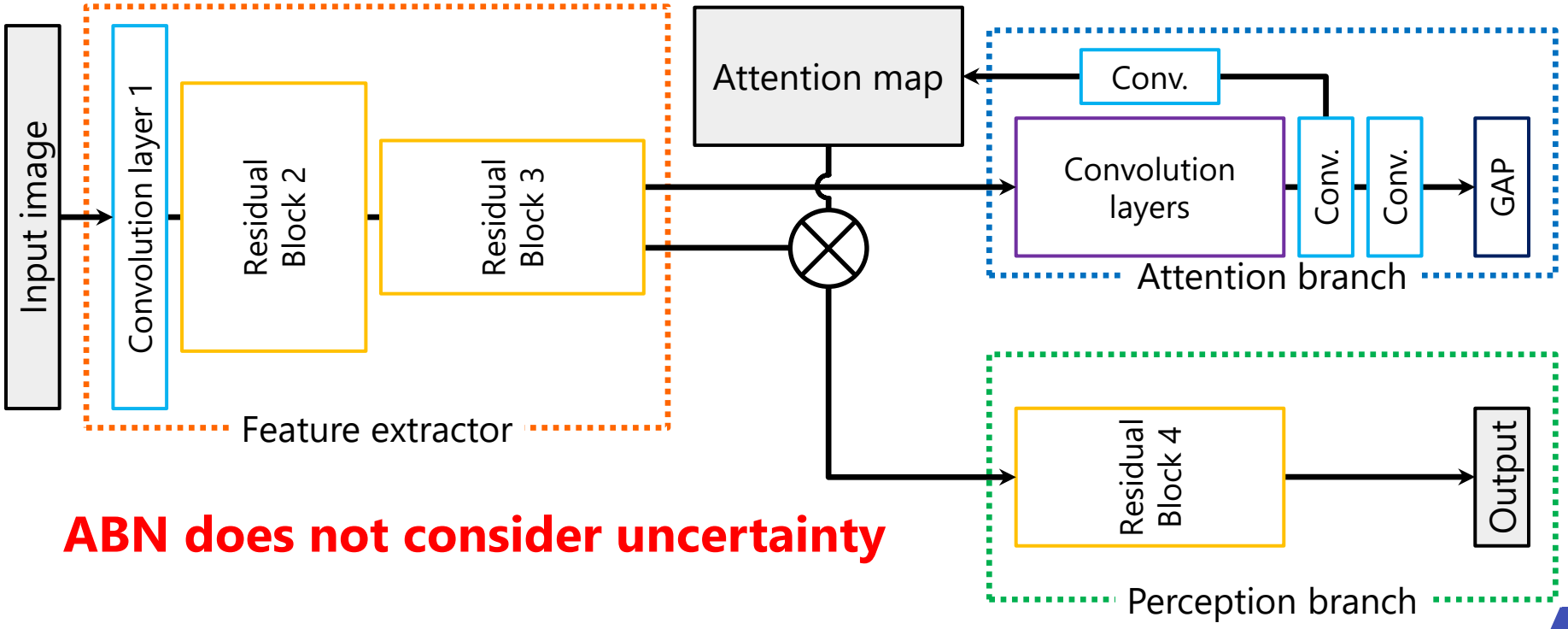
- Improving CNN reliability by considering uncertainty

Proposed method

- Bayesian Attention Branch Network
  - Apply MCDO to Attention Branch Network
    - Uncertainty of the prediction result could be taken into account
    - Increased accuracy and reliability of CNN

Attention Branch Network (ABN) [Fukui+, CVPR2019]

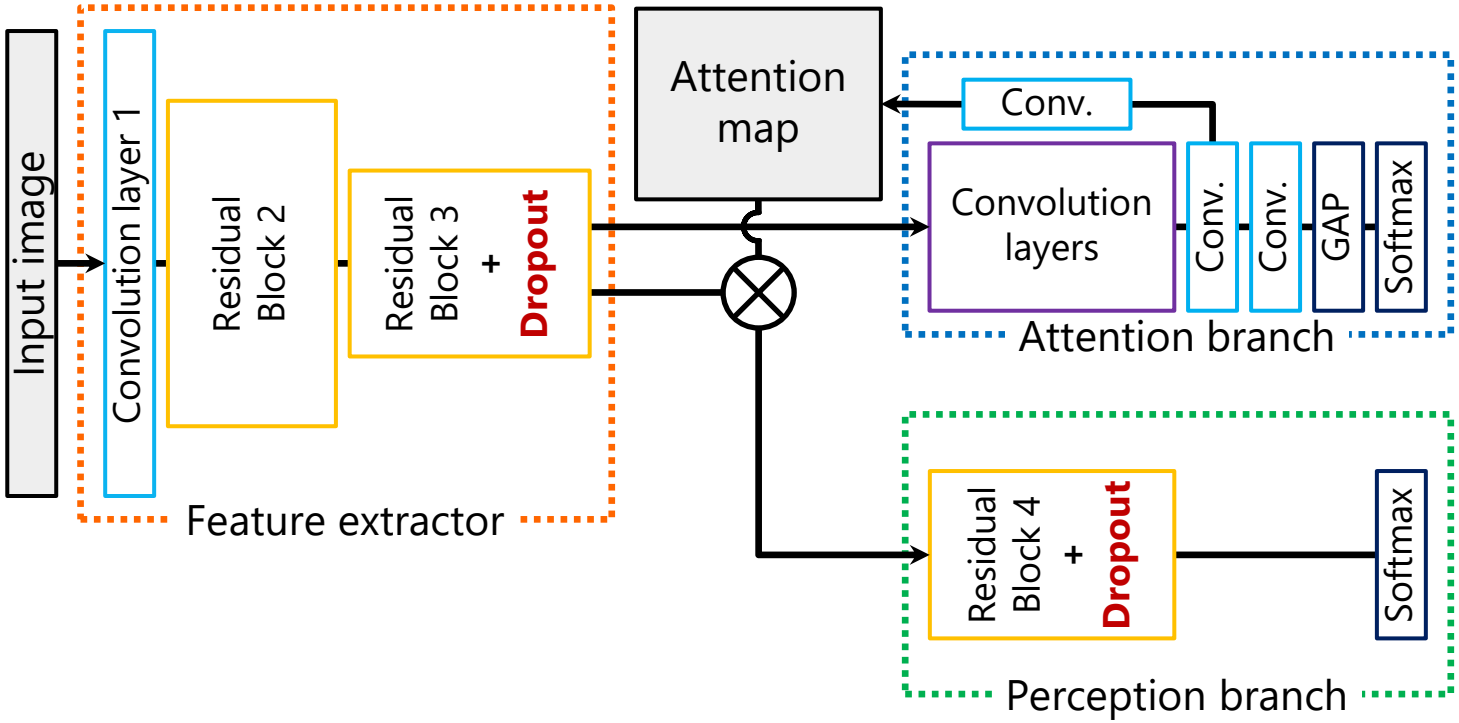
- CNN method applying attention mechanism
  - Attention mechanism improves CNN recognition accuracy
  - Provides visual explanation by attention map



ABN does not consider uncertainty

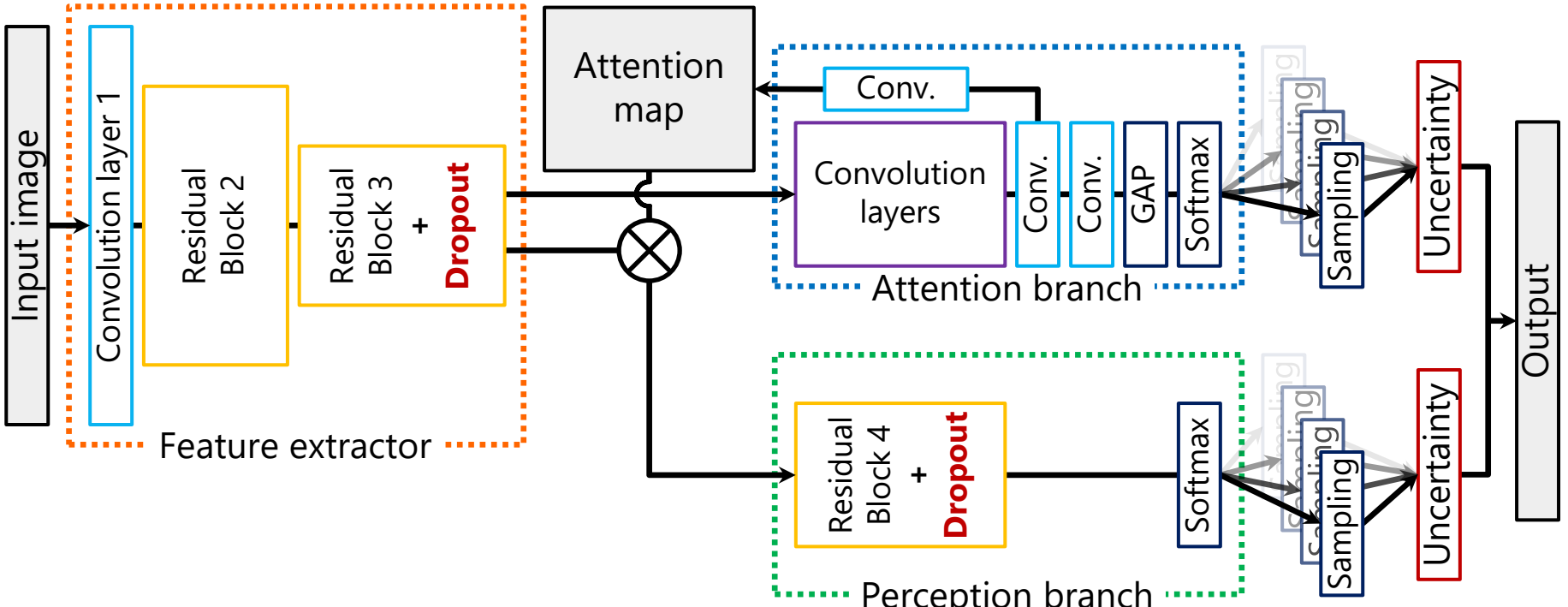
Bayesian Attention Branch Network [1 / 2]

- Introduce uncertainty estimation into ABN
  - Apply MCDO
    - Added dropout to residual blocks 3 and 4
    - Use dropout during learning and evaluation



Bayesian Attention Branch Network [2 / 2]

- Introduce uncertainty estimation into ABN
  - Sampling by MCDO
    - Average : Output result estimation
    - Entropy : Uncertainty estimation
  - Adopt the result of branch with low uncertainty as the result



Evaluation

- Dataset : ImageNet dataset
- Base network : ResNet (152 layers)

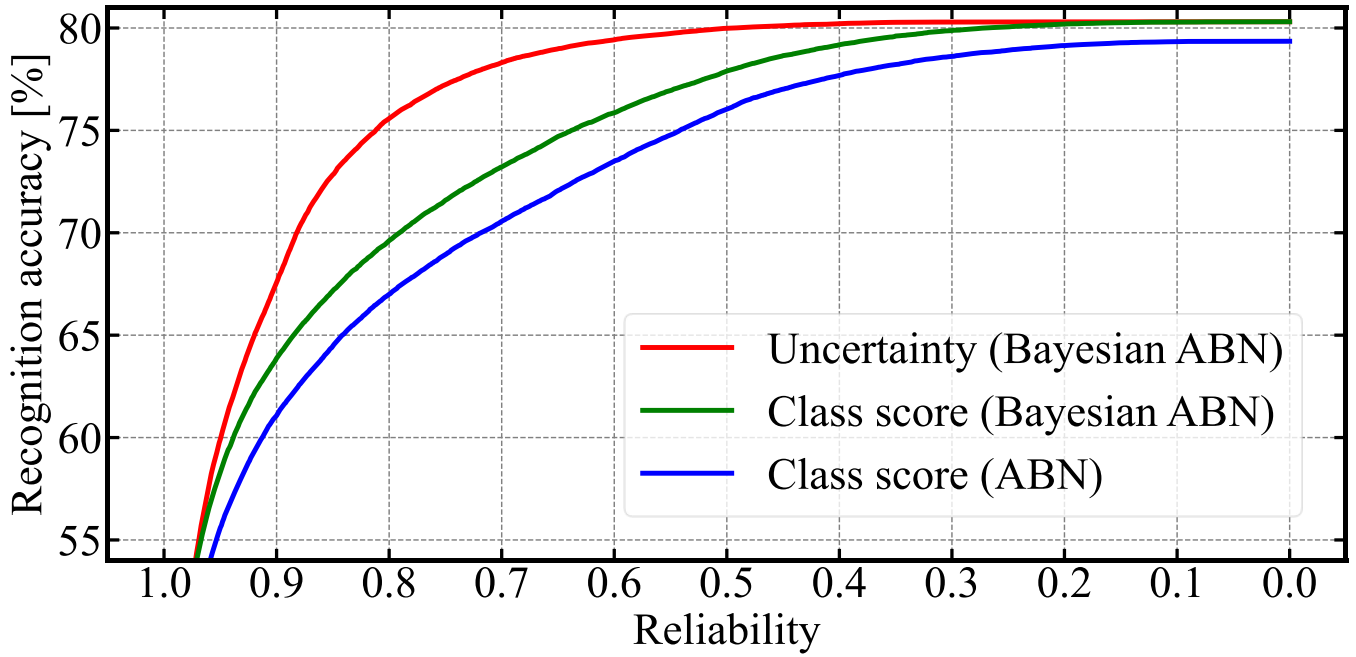
Methods	Top-1 accuracy [%]	Top-5 accuracy [%]
ResNet	77.81	–
ABN	79.35	94.55
Bayesian ABN	**80.31**	**95.01**

0.96 pt **0.49 pt**

Bayesian ABN achieved the highest recognition accuracy

Assessing the effectiveness of uncertainty

- Recognition accuracy over different reliability threshold
  - Use the following values as a reliability
    - Uncertainty
    - Class score



Introducing uncertainty improves reliability

Summary

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- We propose a Bayesian ABN
  - Improve recognition accuracy by introducing uncertainty
    - Top-1 accuracy : **0.96 points** improvement compared to ABN
    - Top-5 accuracy : **0.49 points** improvement compared to ABN
  - Uncertainty can be used to improve model reliability
    - **Reliability is improved** by using uncertainty