AdaCompress:

Adaptive Compression for Online Computer Vision Services

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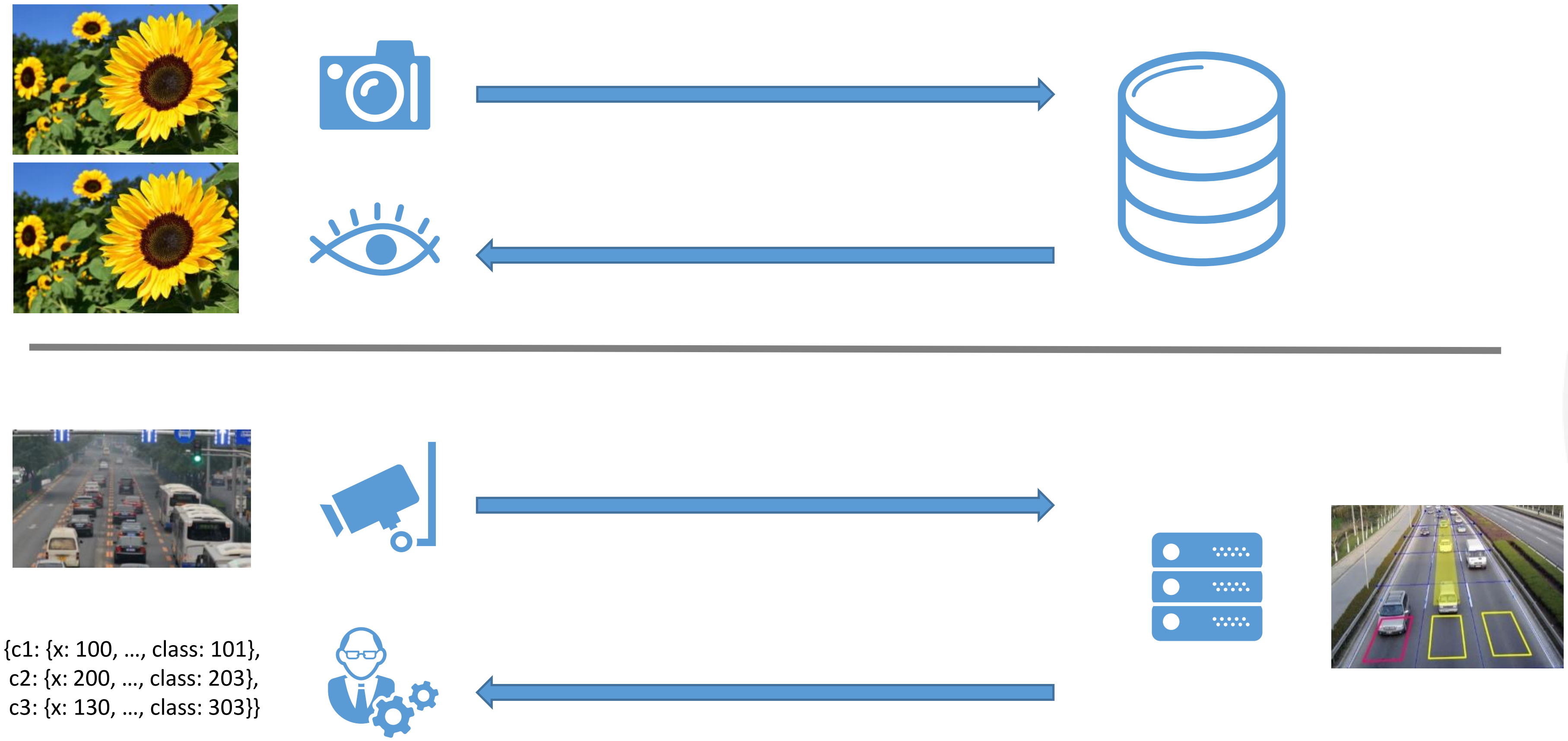
Graduate School in Shenzhen, Tsinghua University

Department of Computer Science and Technology, Tsinghua University

P5C-05

Background

- **More images are uploaded to DL services rather than human**



{c1: {x: 100, …, class: 101},
c2: {x: 200, …, class: 203},
c3: {x: 130, …, class: 303}}

Background

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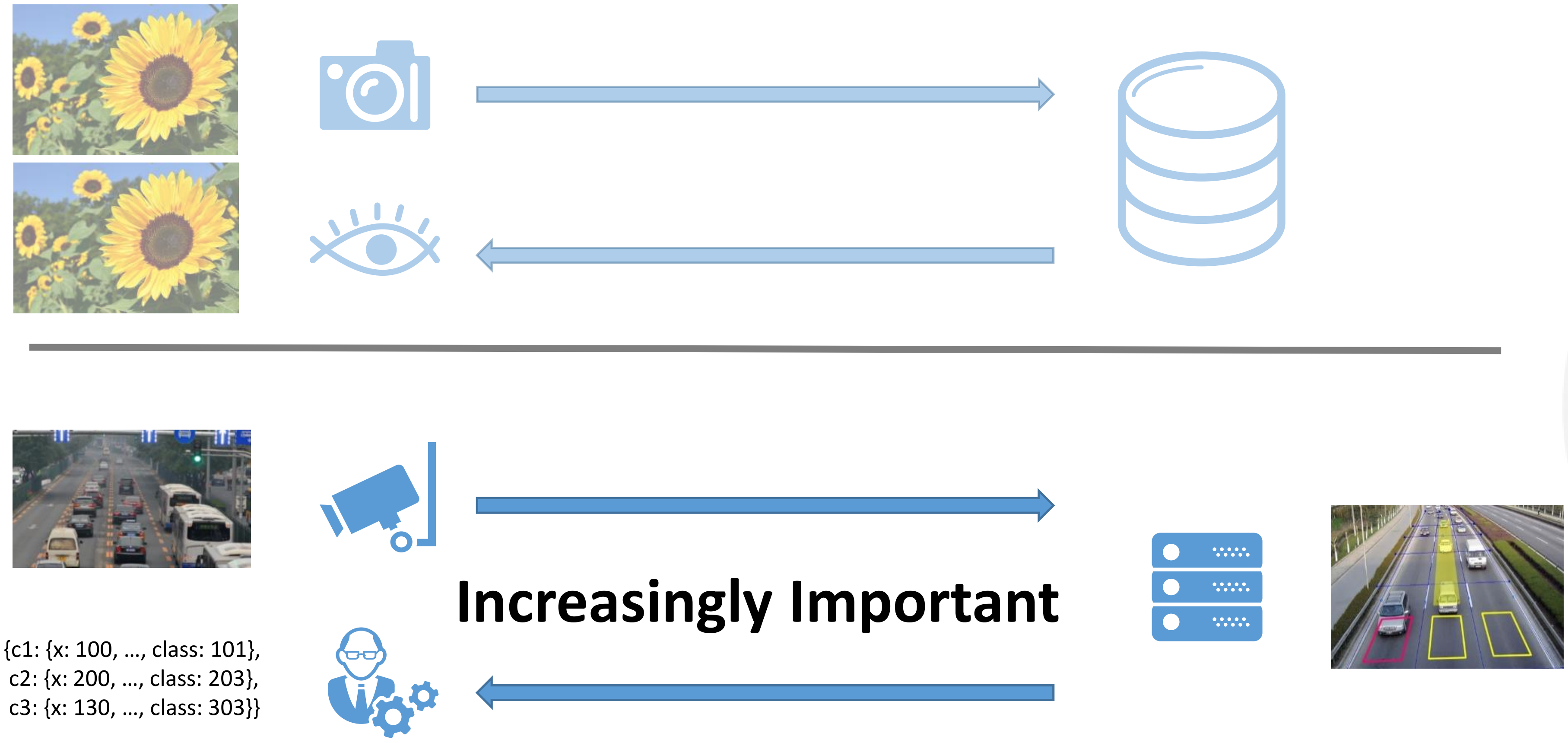

Increasingly Important

{c1: {x: 100, …, class: 101},
c2: {x: 200, …, class: 203},
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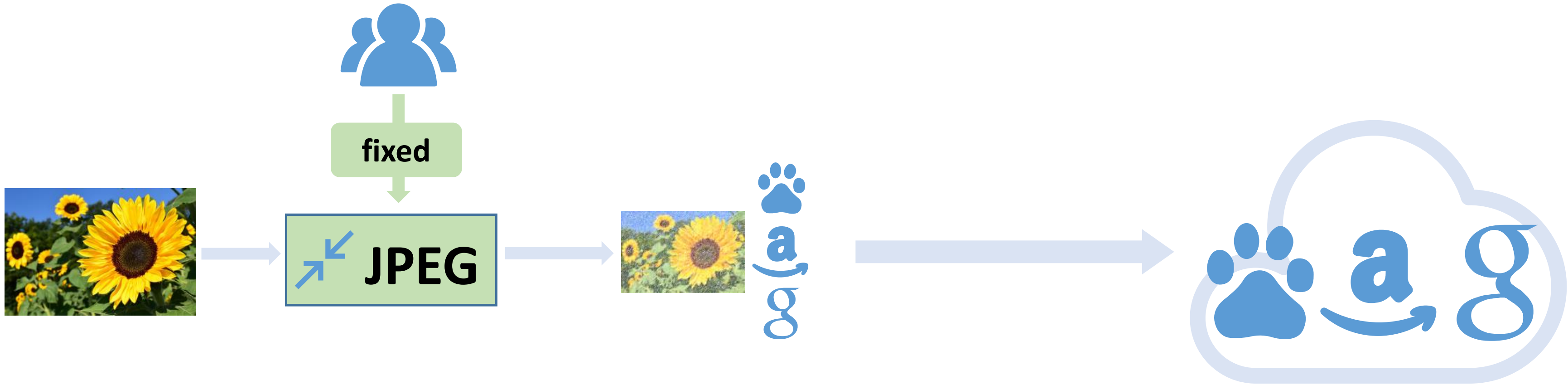

Conventional computer vision application framework

- JPEG etc..
- Fixed compression degree for all images
- Same compression strategy for different service providers

Background

- **Is the conventional solution efficient enough?**

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(1a) Q=75
Face++ prediction = ["donut"]

(1b) Q=55
Face++ prediction = []

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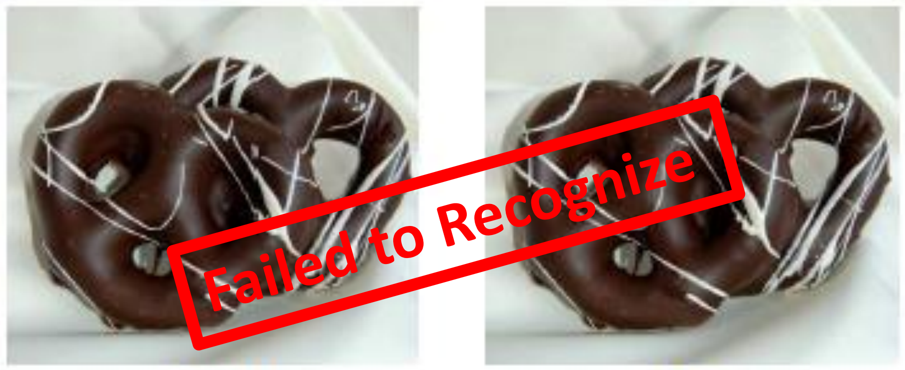

Failed to Recognize

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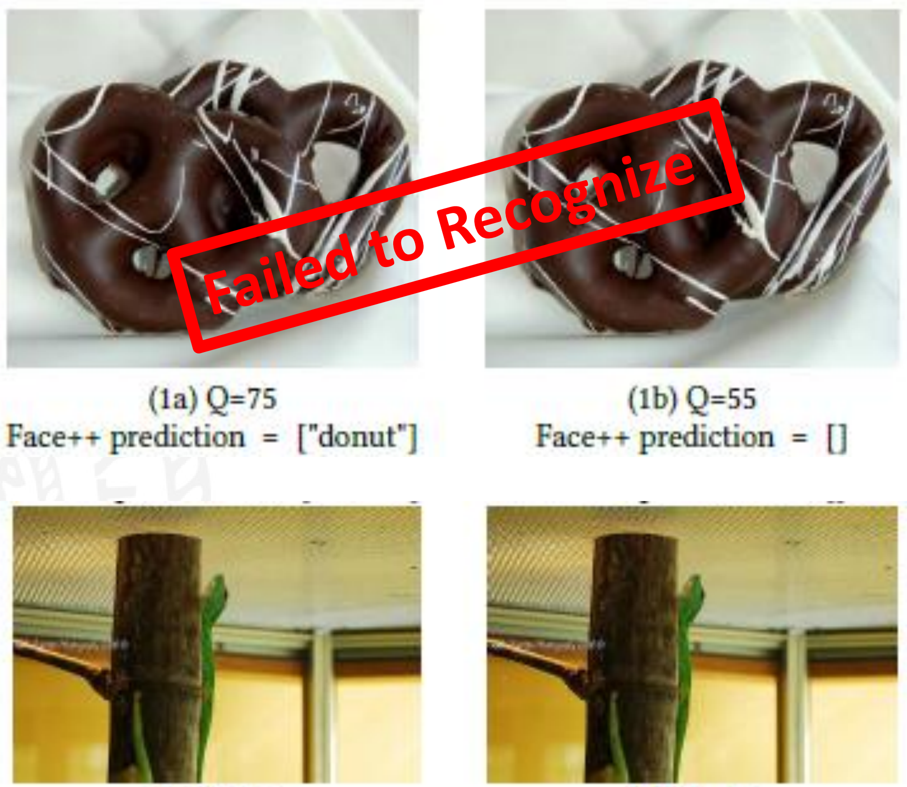

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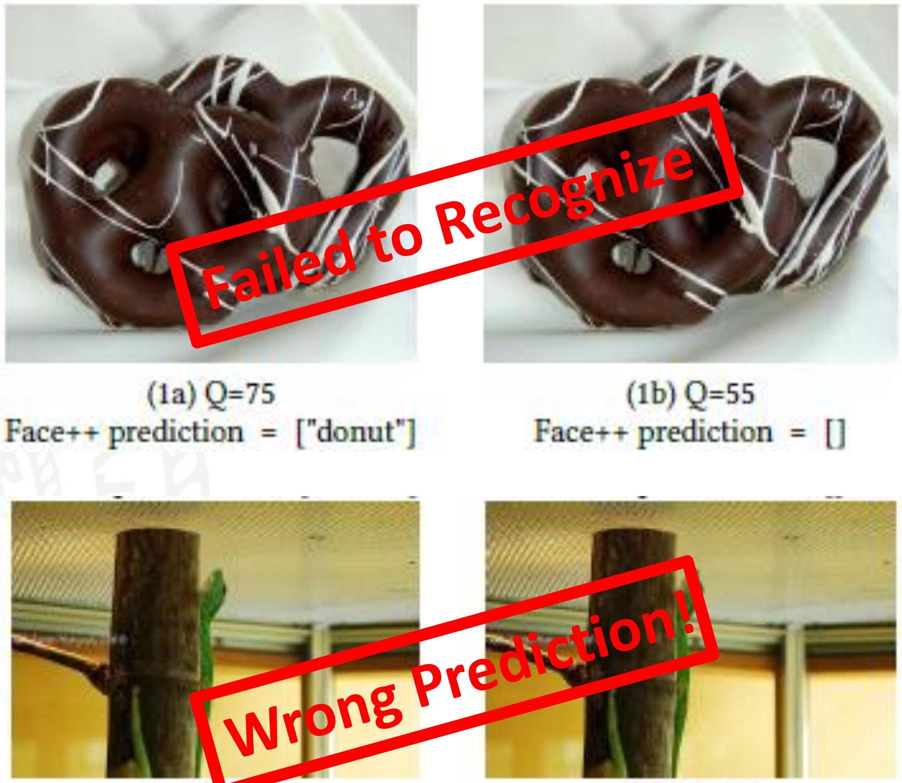

Failed to Recognize

Wrong Prediction!

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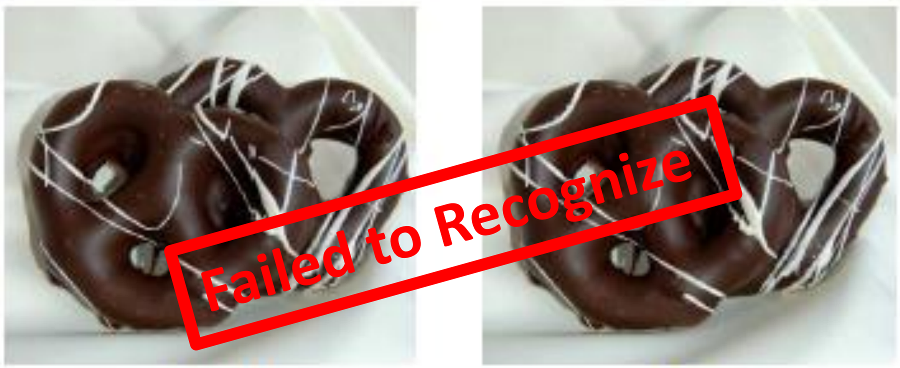

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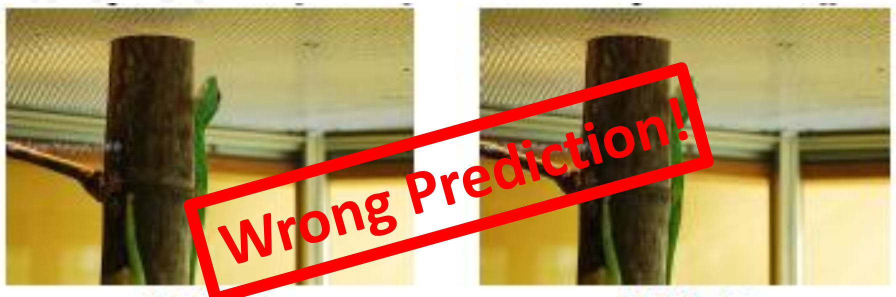

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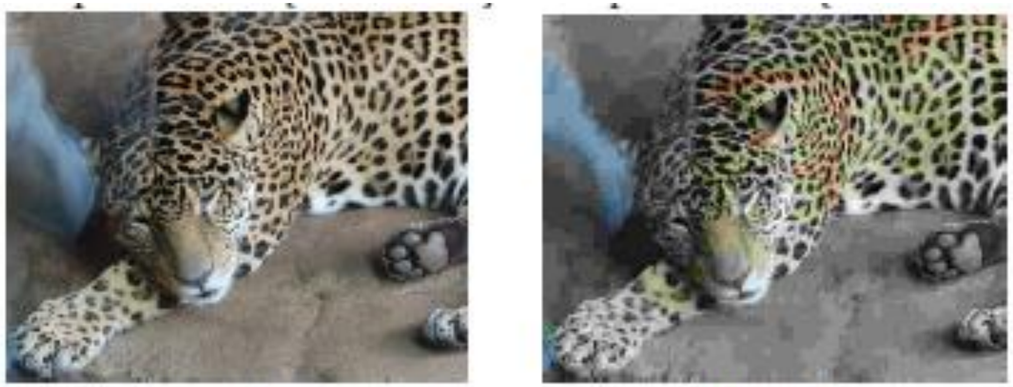

(3a) Q=75
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(3b) Q=5
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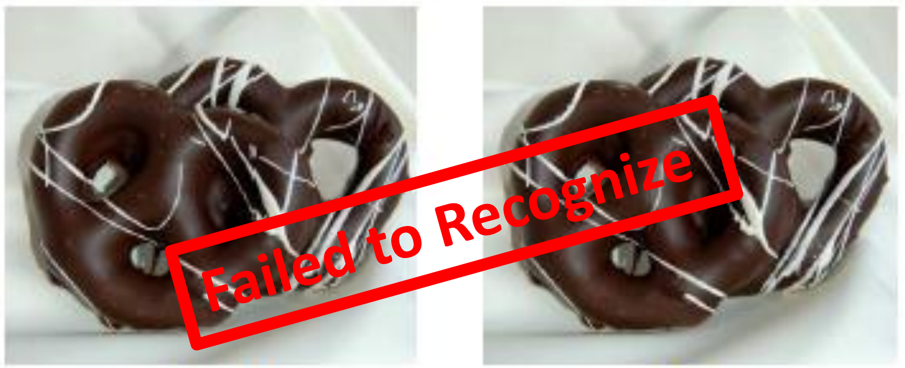

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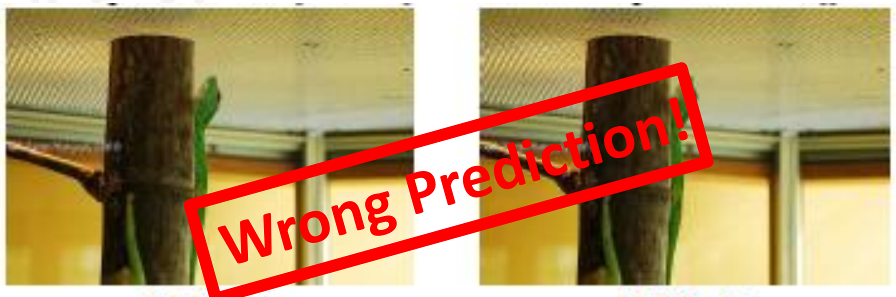

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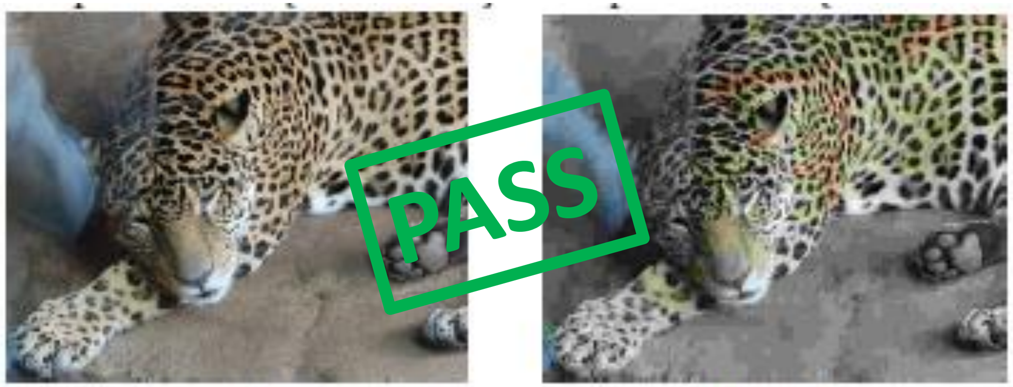

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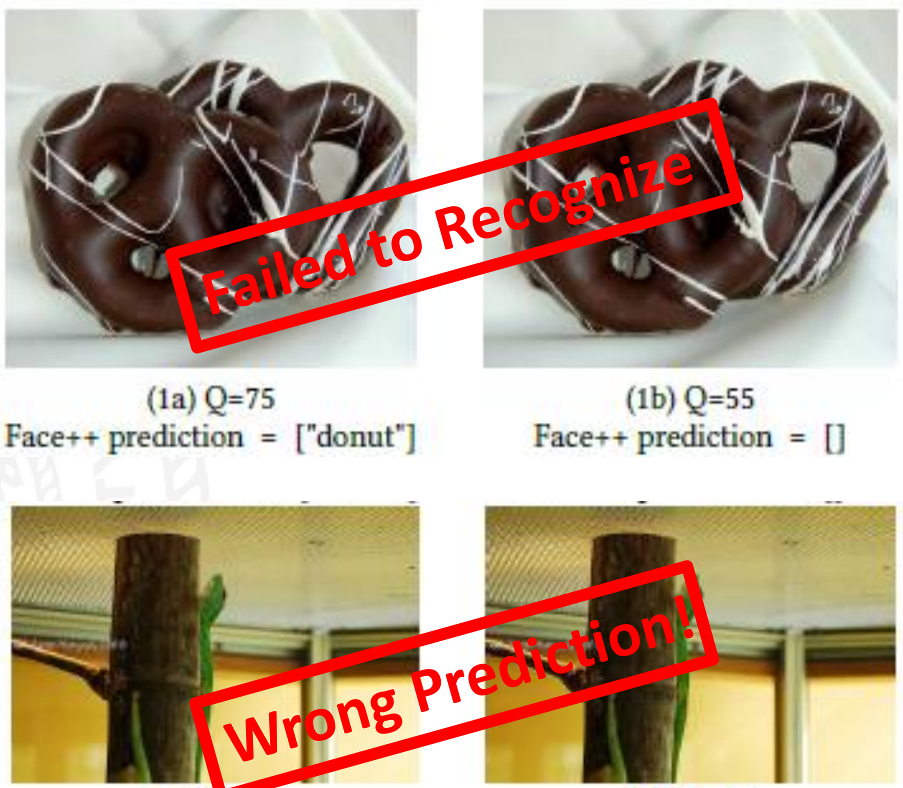

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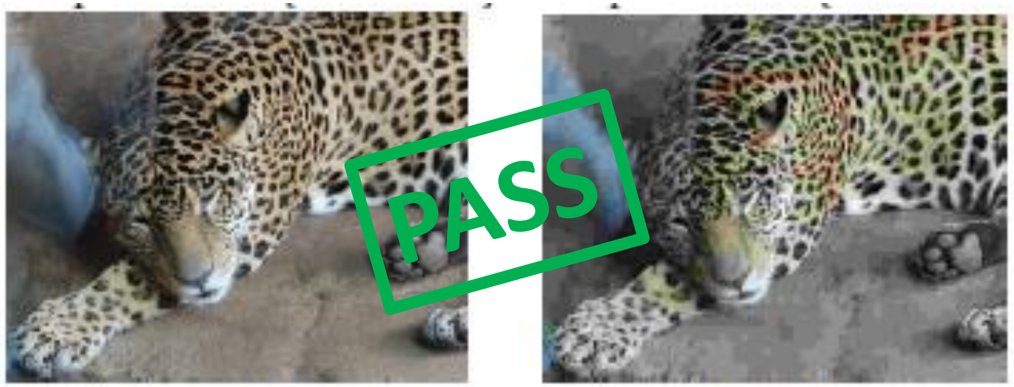

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- **In some cases, prediction performance does not related to image quality**

Related Works

- **Relationship between compression and accuracy**
  - **Severe compression does not always deteriorate the model inference accuracy (Delac et al.)**
  - **Four types of quality distortions can affect the performance in deep learning inference (Dodge et al.)**

Related Works

- Relationship between compression and accuracy
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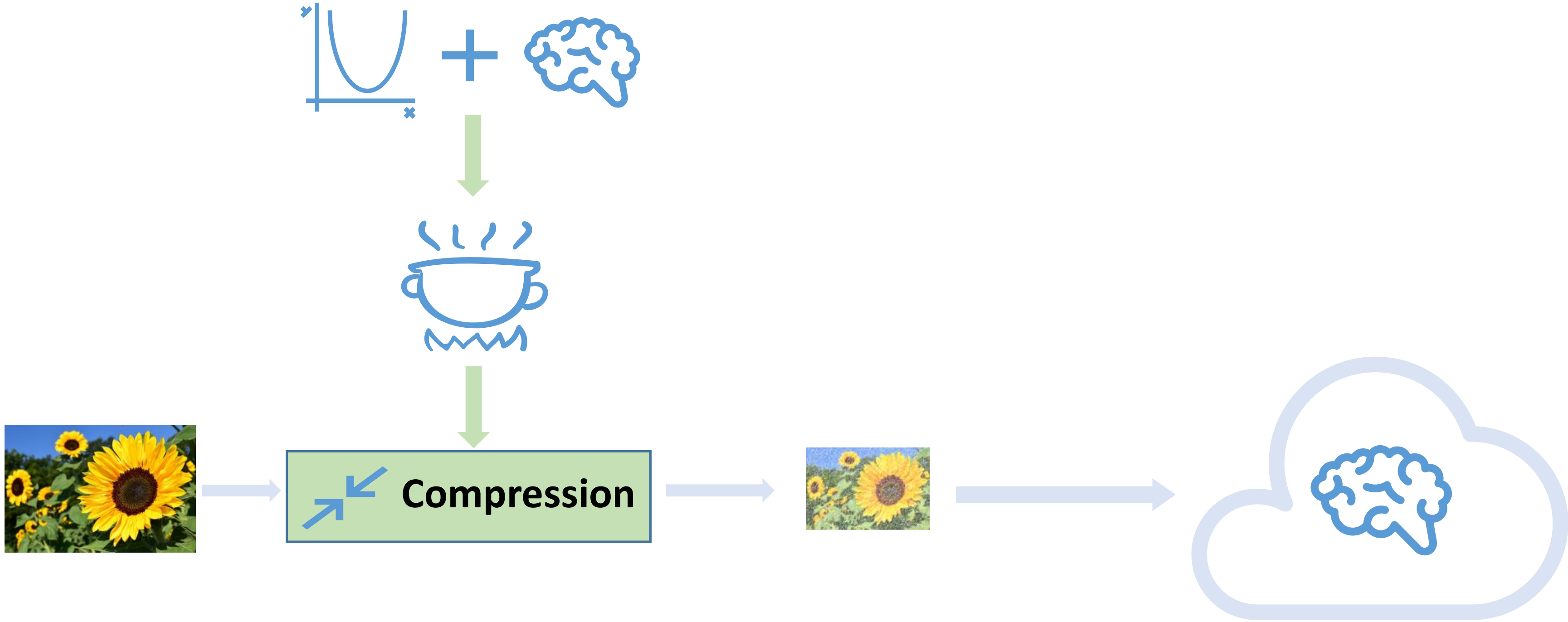
  - Four types of quality distortions can affect the performance in deep learning inference (Dodge et al.)

- Dedicated compression for DNNs
  - Train DNNs from the compressed representations of auto-encoder (Robert et al.)
  - Linear JPEG quantization table learned from the dataset (Liu et al.)
  - DNNs inference from block-wise DCT coefficients in JPEG (Baluja et al.)

Limitation of related works

- **Pre-knowledge of original model**



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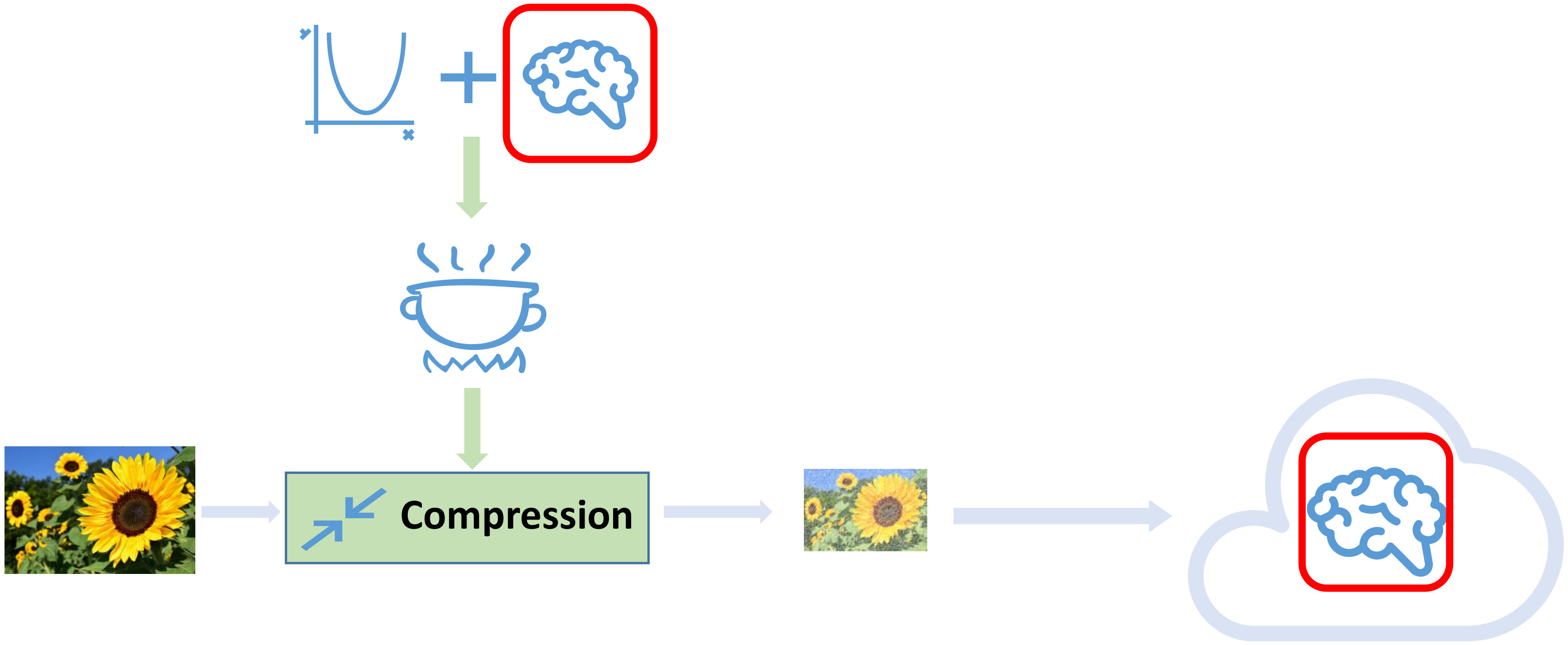

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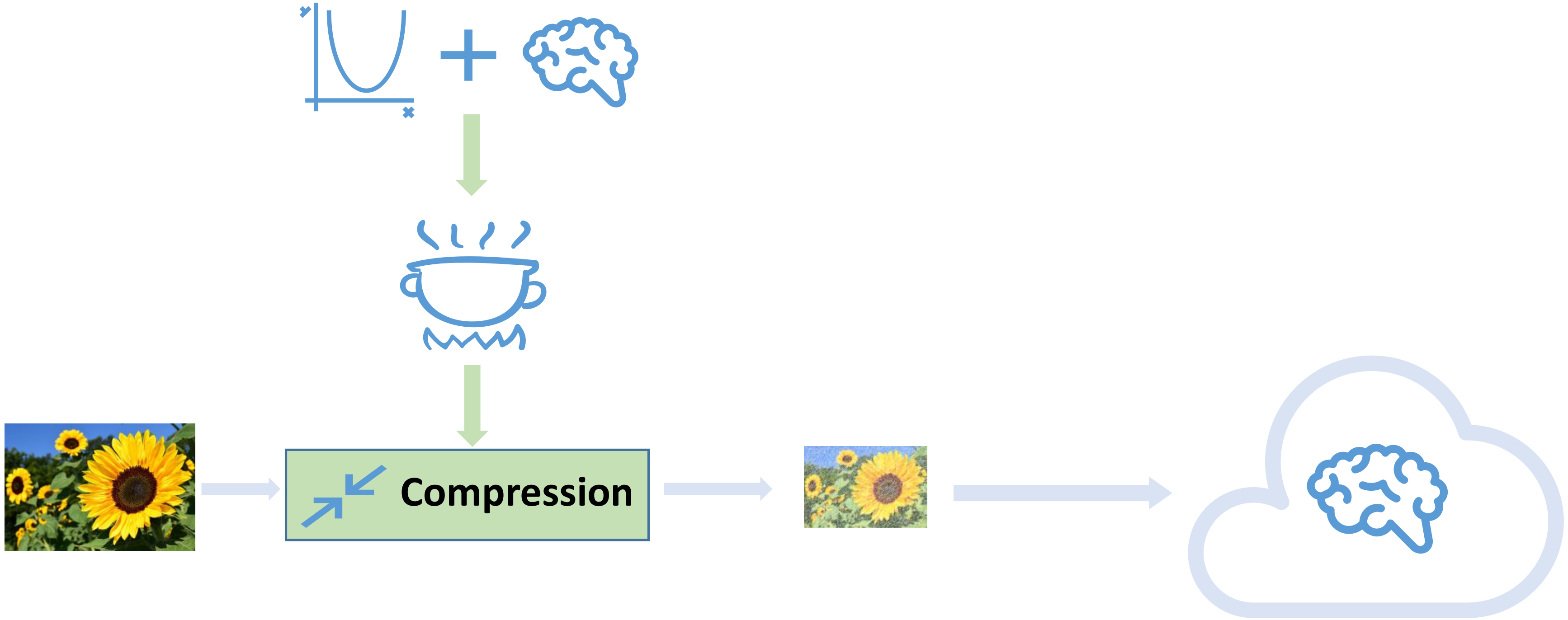

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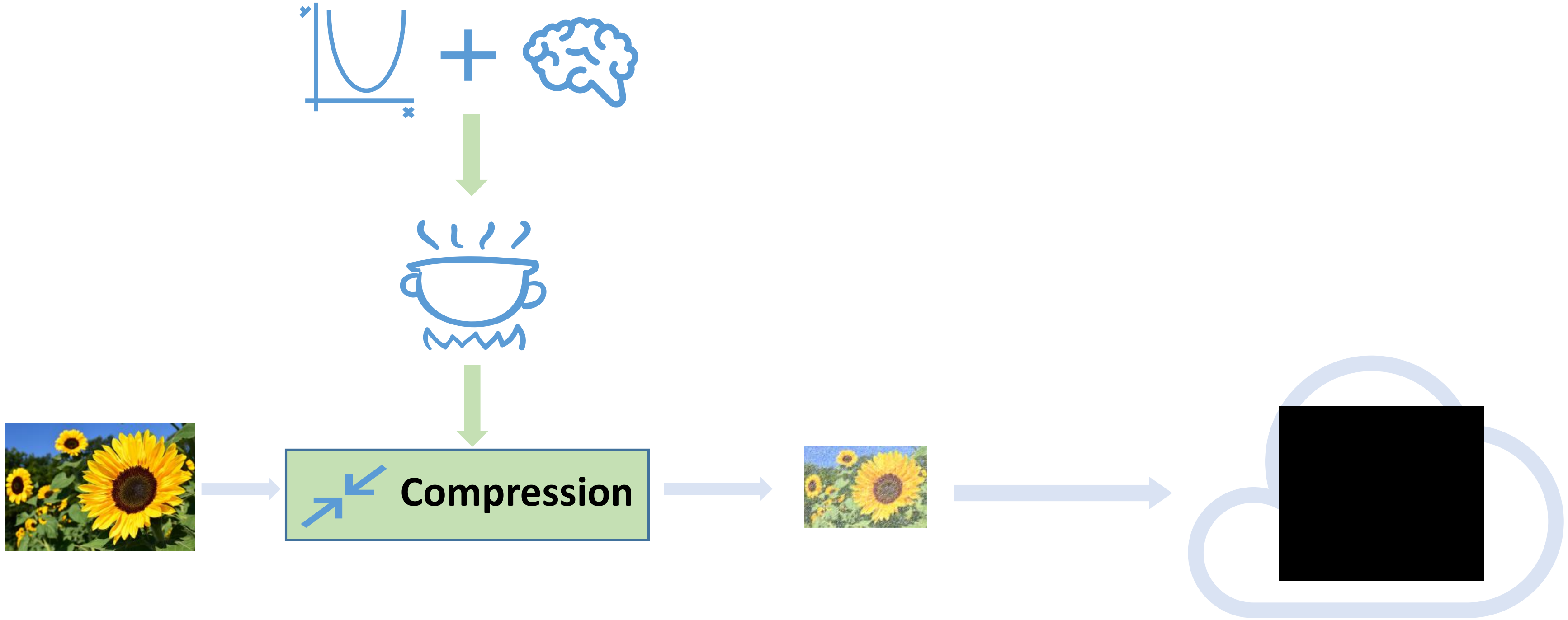

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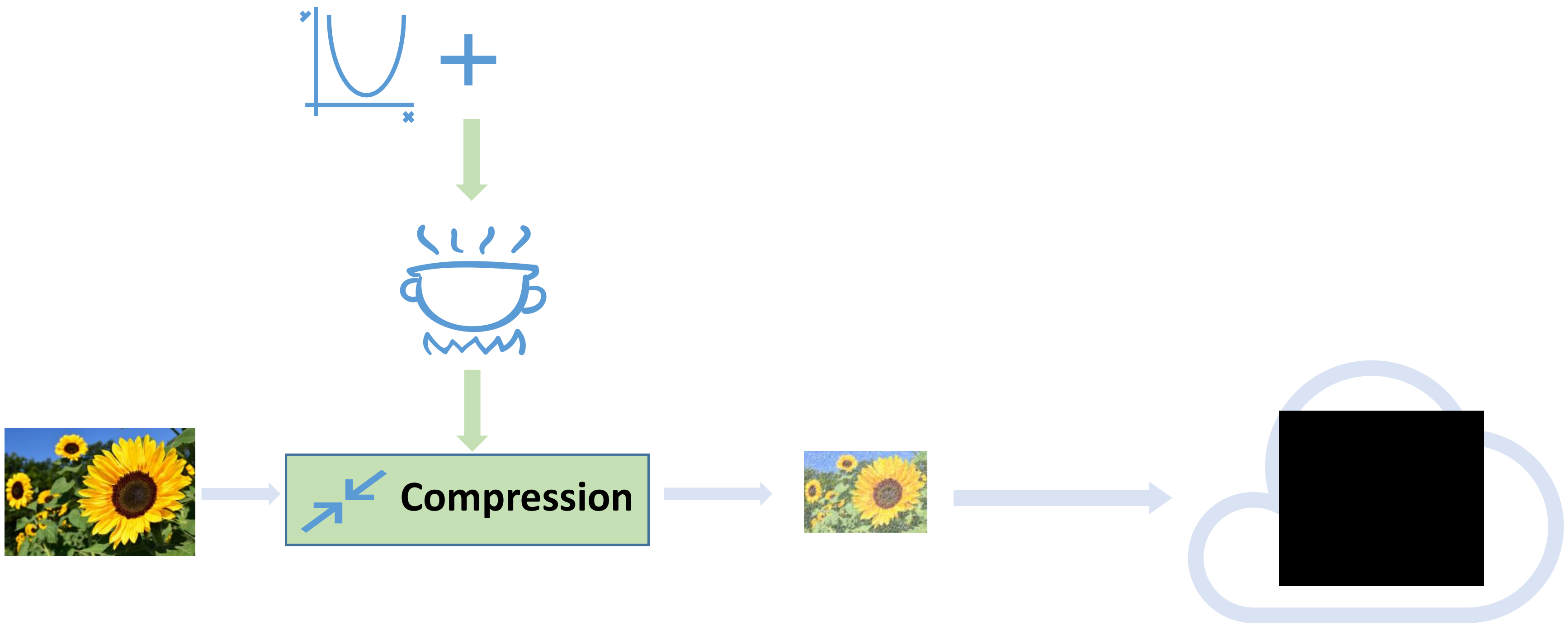
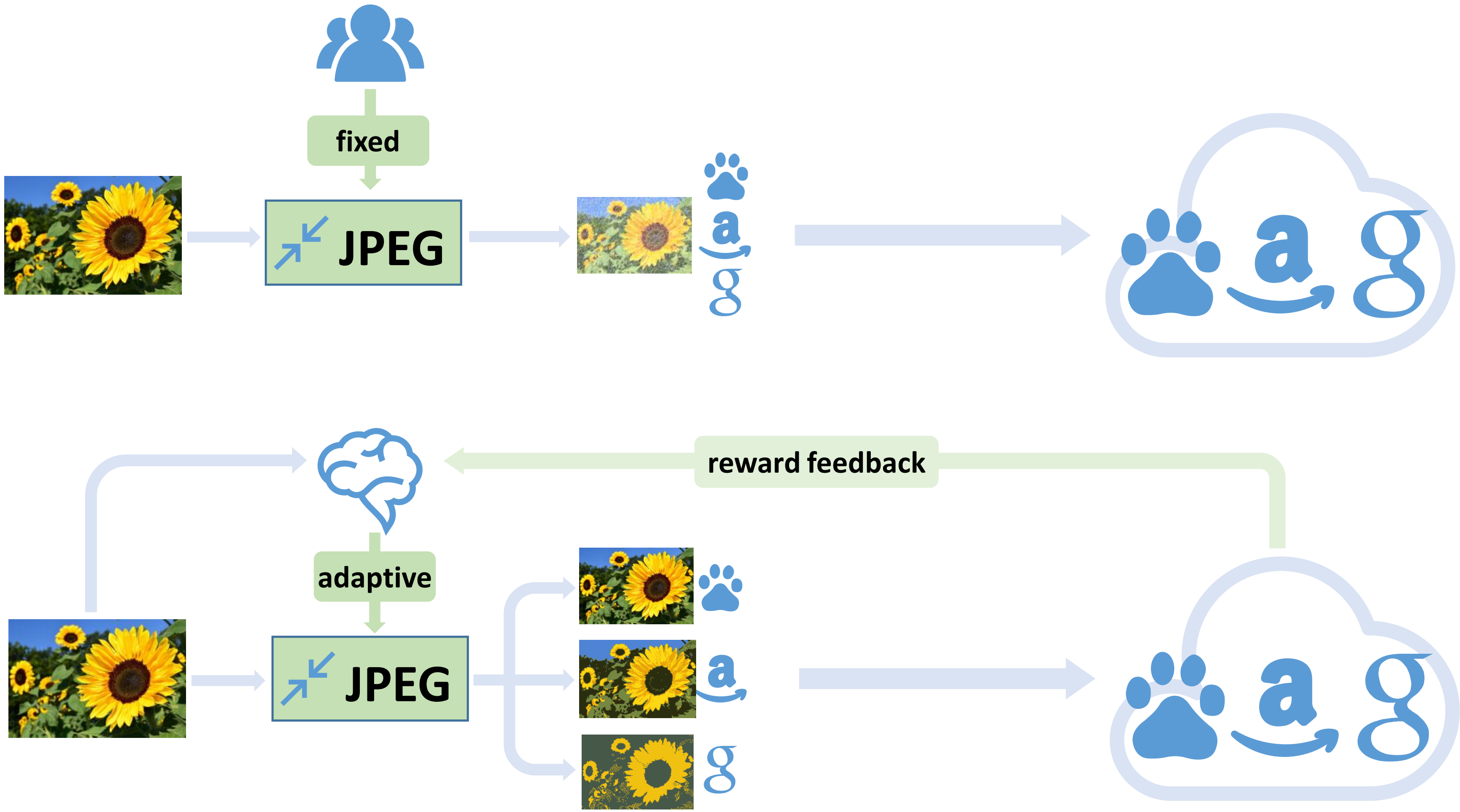


Solution



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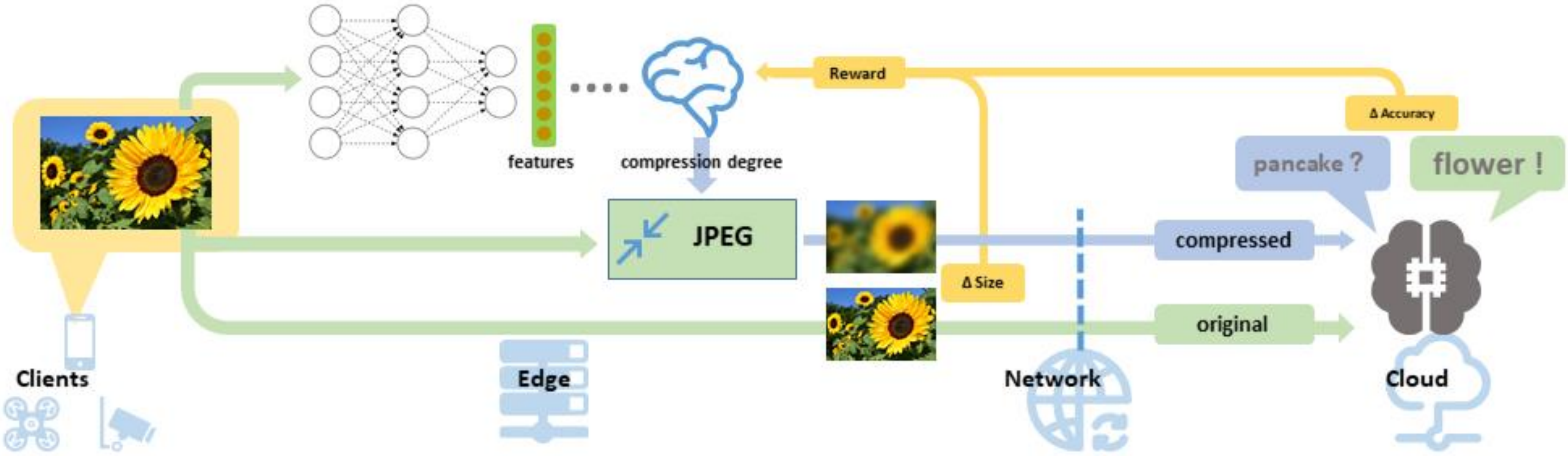
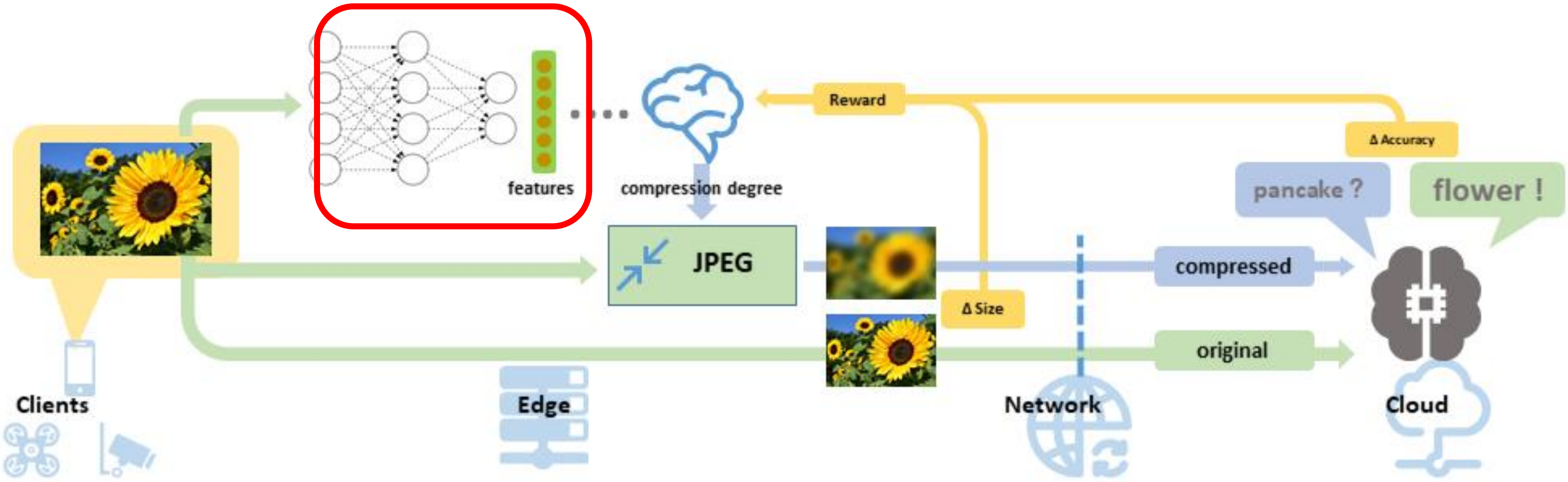


- **Reward**
  - **Δsize – Δaccuracy**
- **States**
  - **Features of the input images**
- **Actions**
  - **10 discrete compression levels**

Solution



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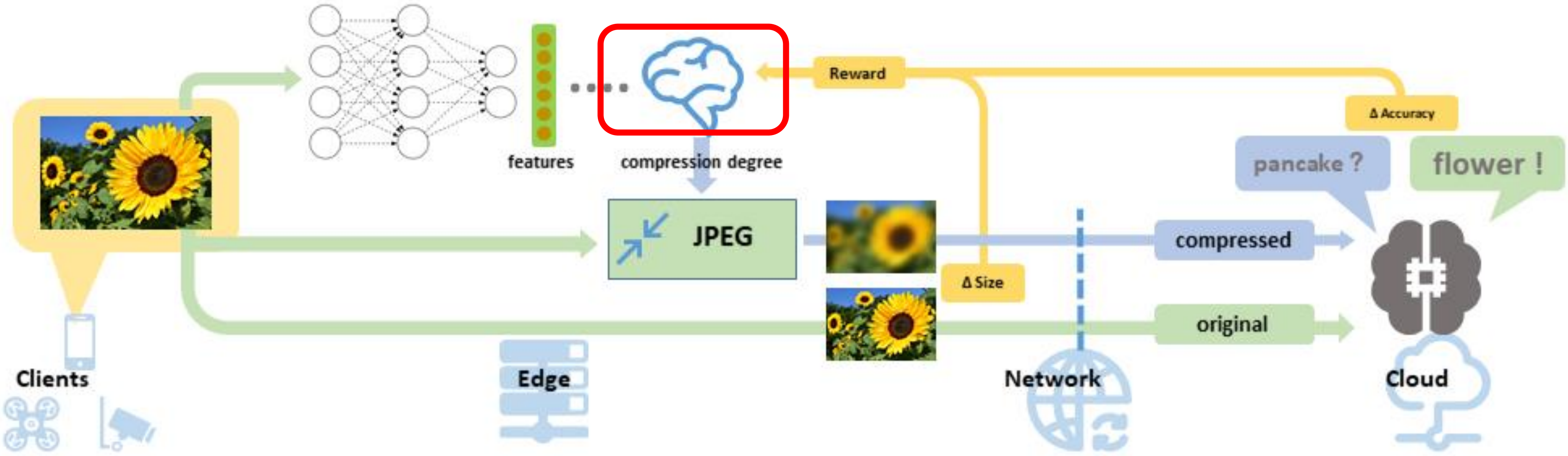

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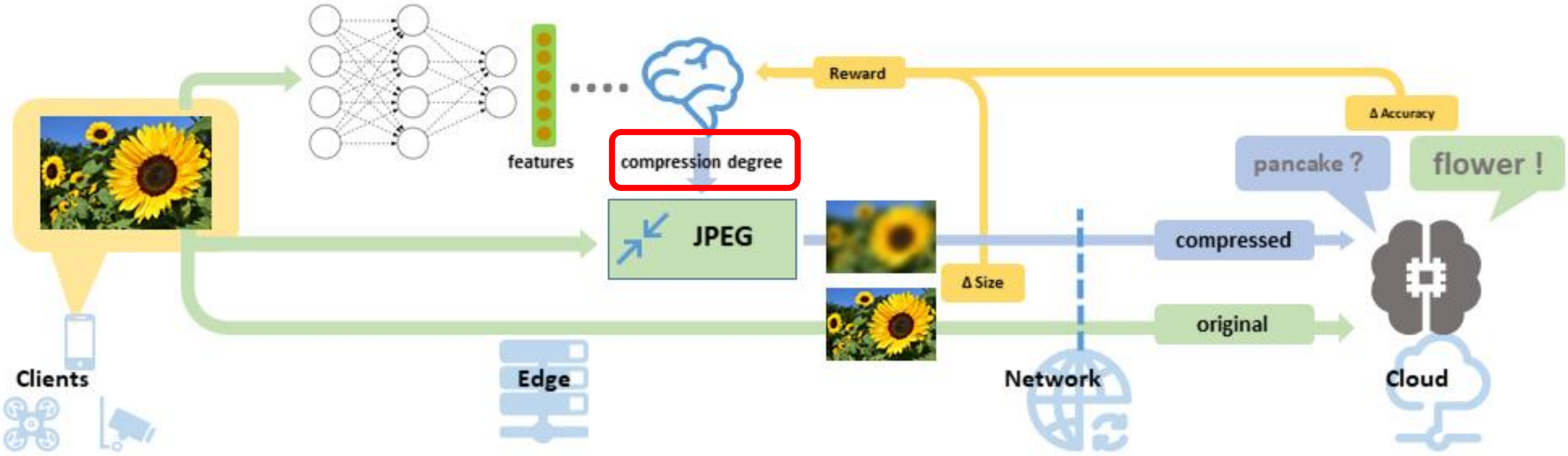

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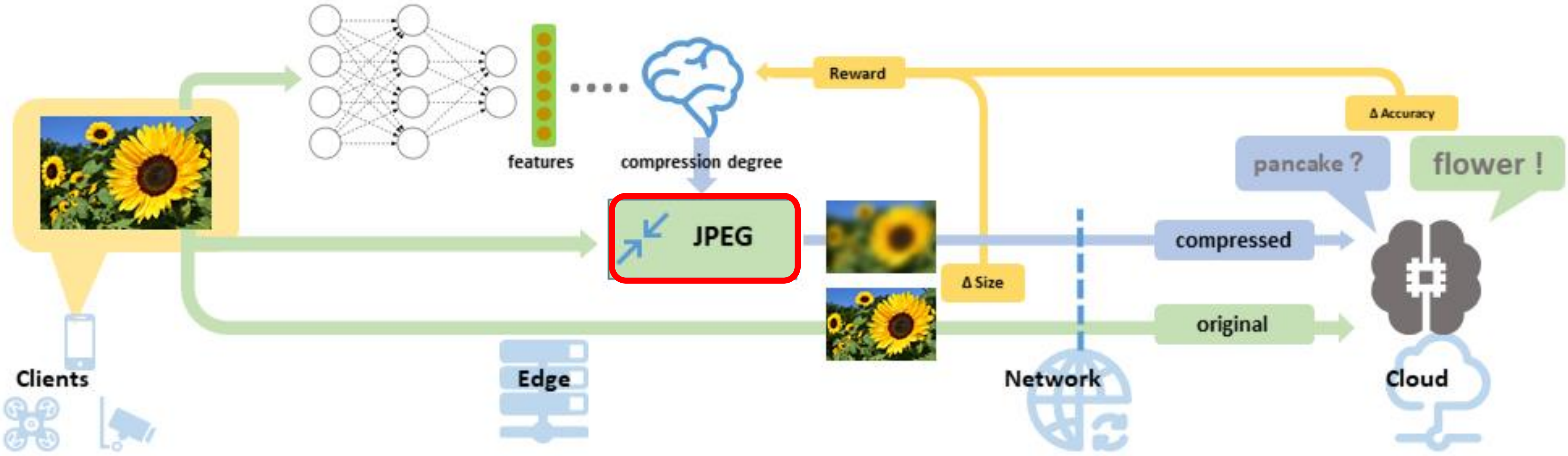

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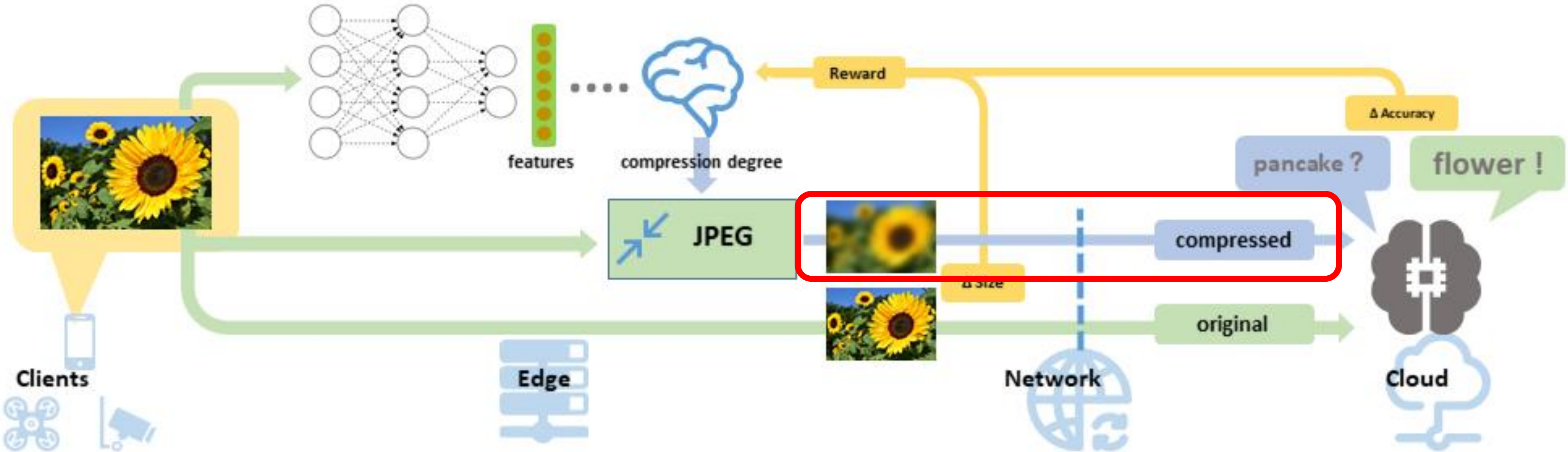

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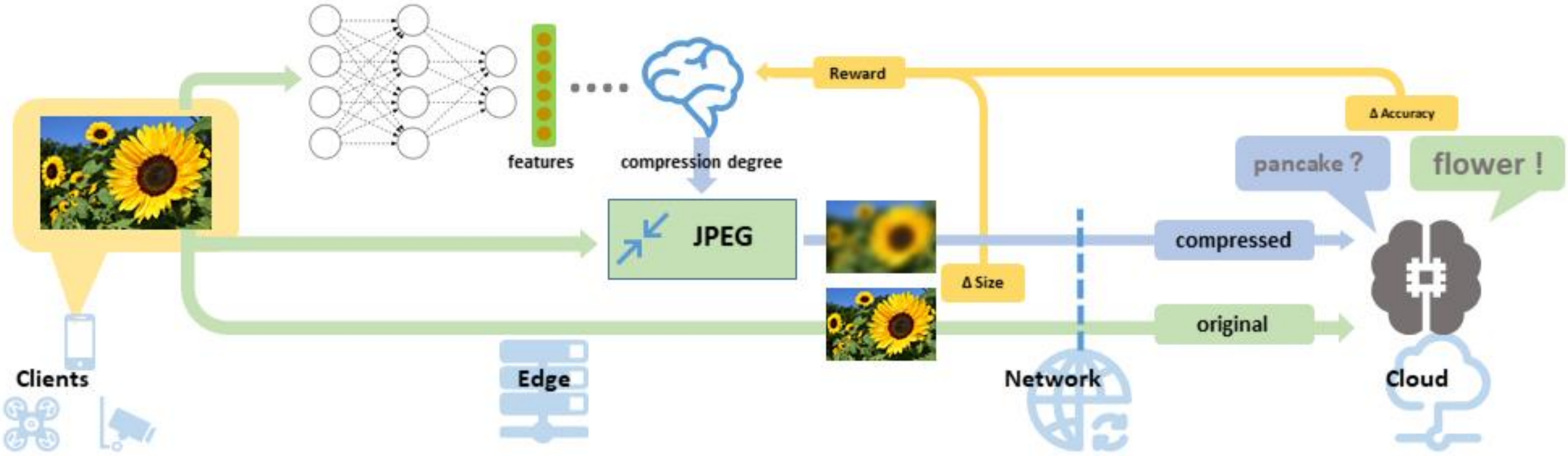

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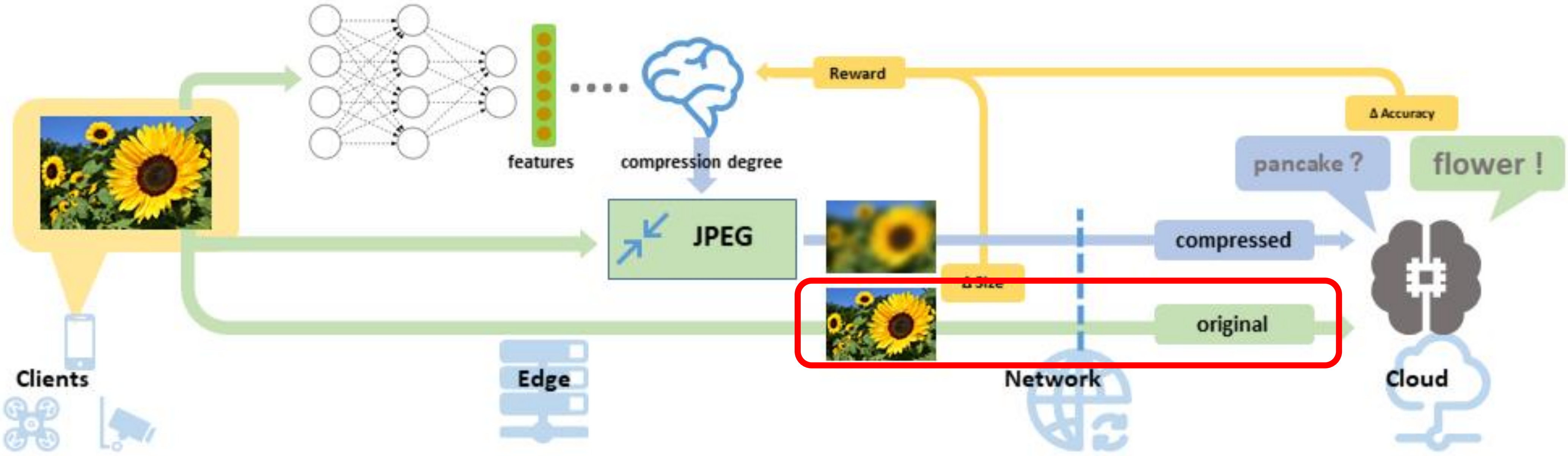

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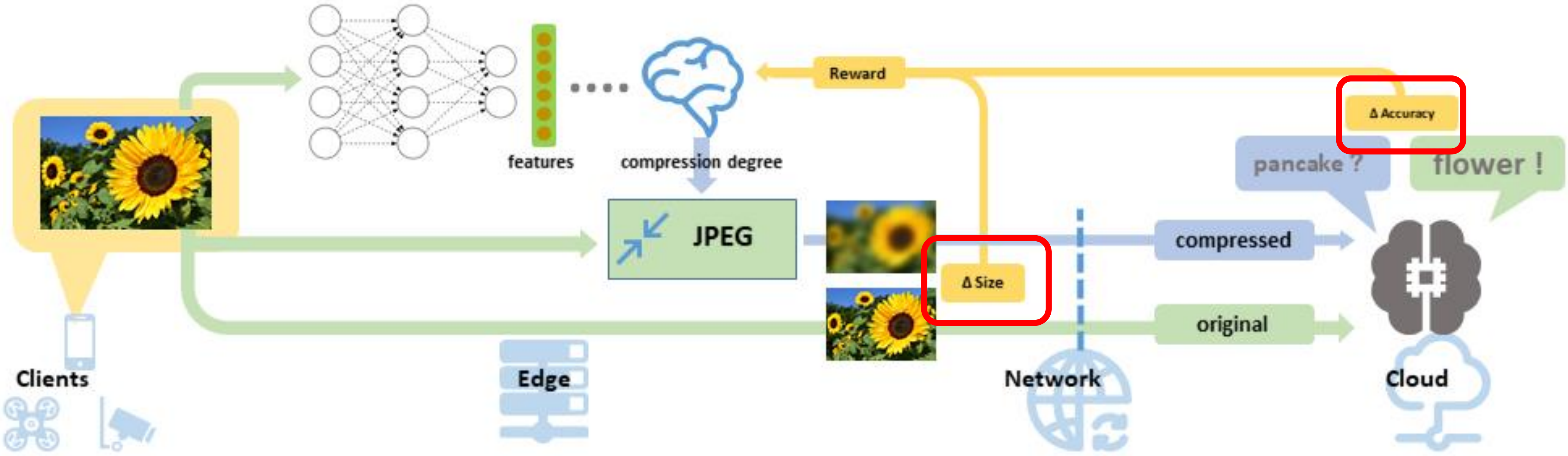

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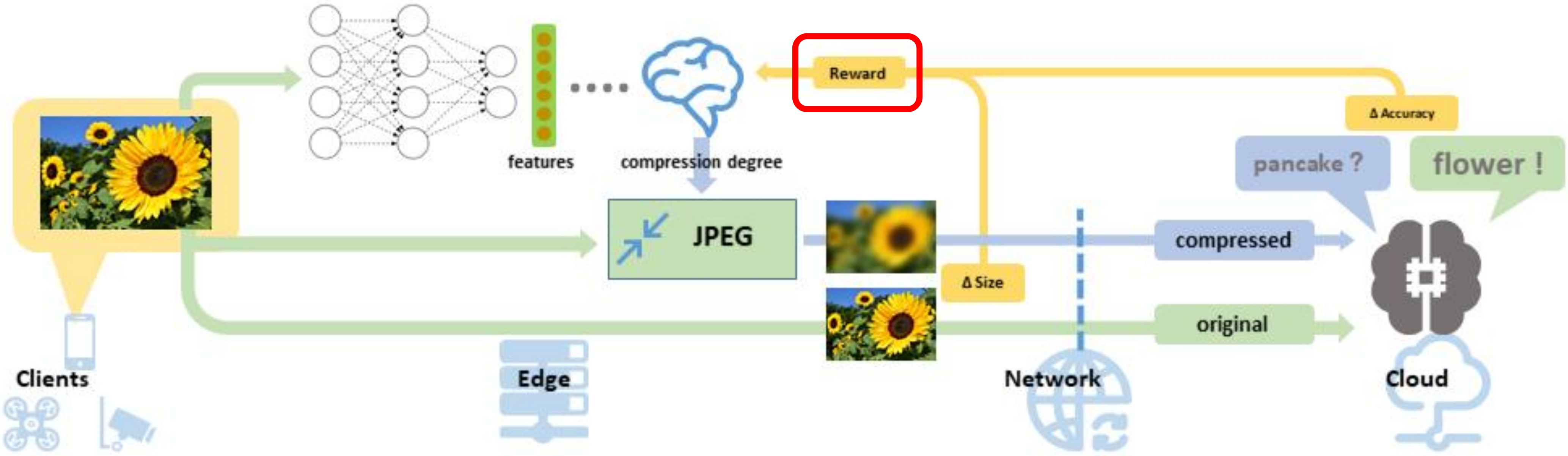

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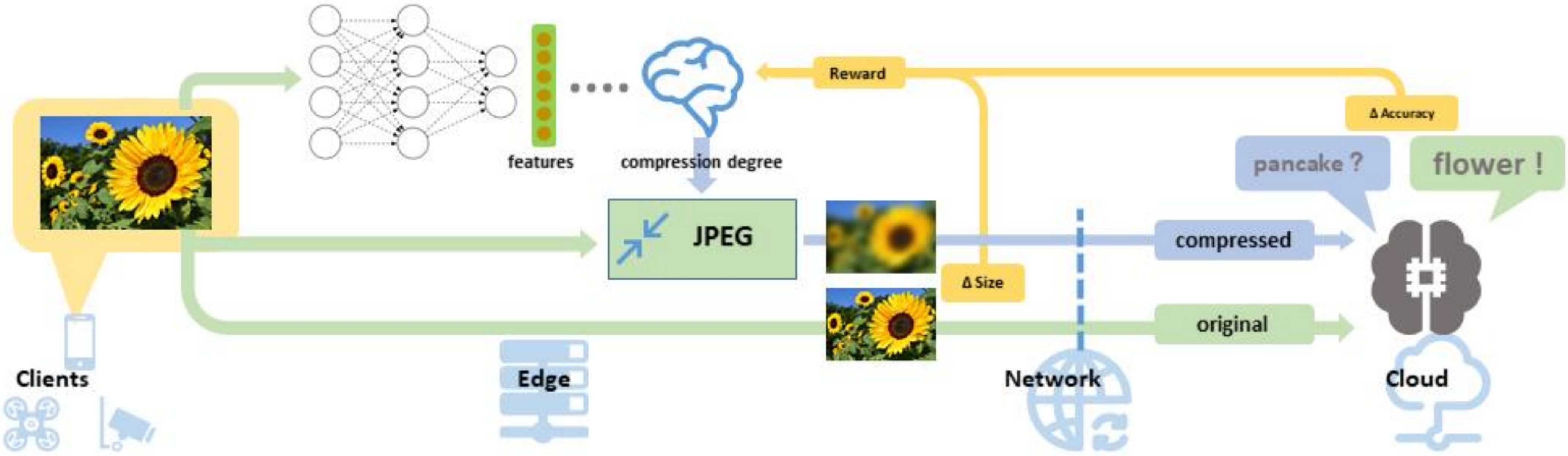

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Performance

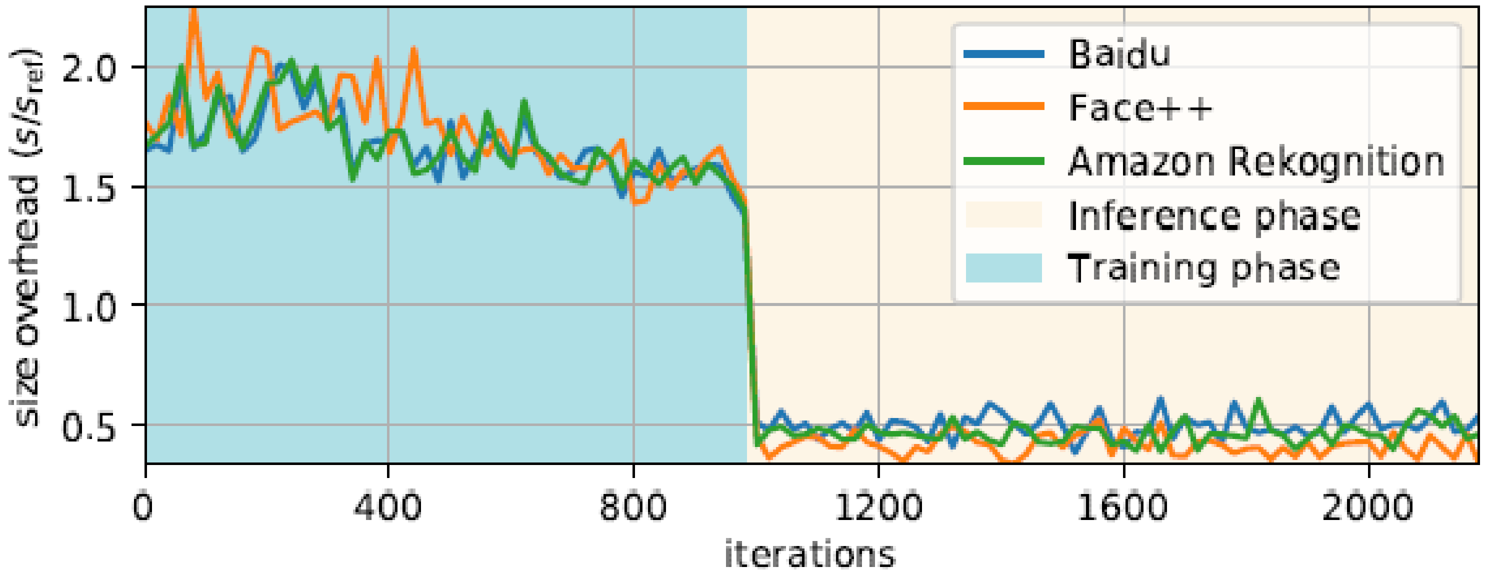
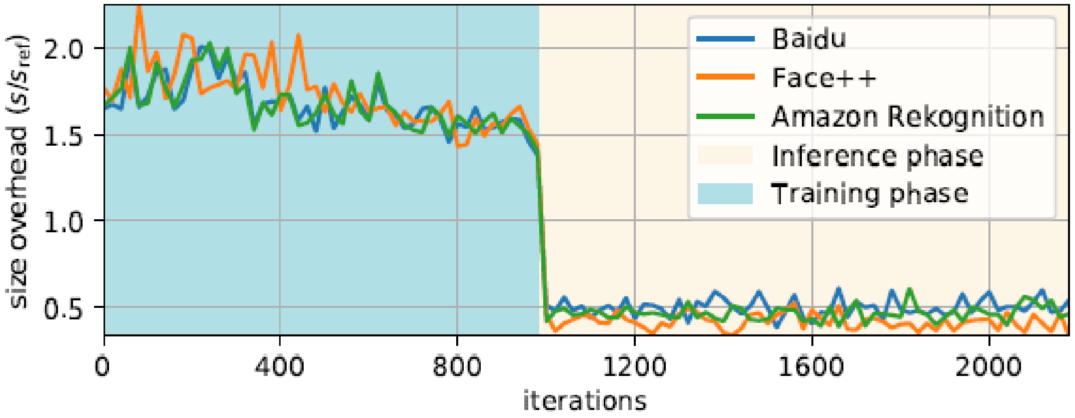


Figure 8: Upload size overhead in training and inference phase

- Size overhead in training phase
- Inference phase is longer than training phase

Performance



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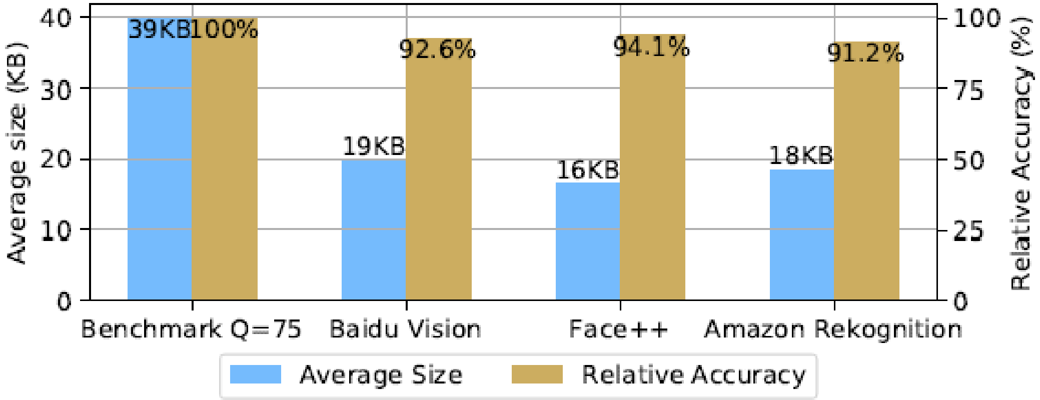


Figure 9: Average size and relative accuracy on different cloud services

- **Size overhead in training phase**
- **Inference phase is longer than training phase**

Insight

- **Different compression strategies in different environments**

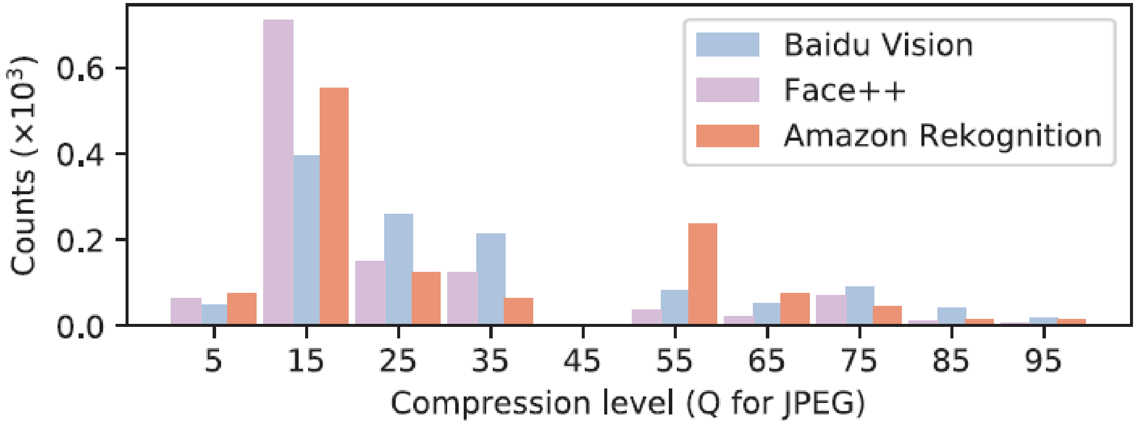


Figure 5: Histogram of RL agent's best compression level selection for different cloud services

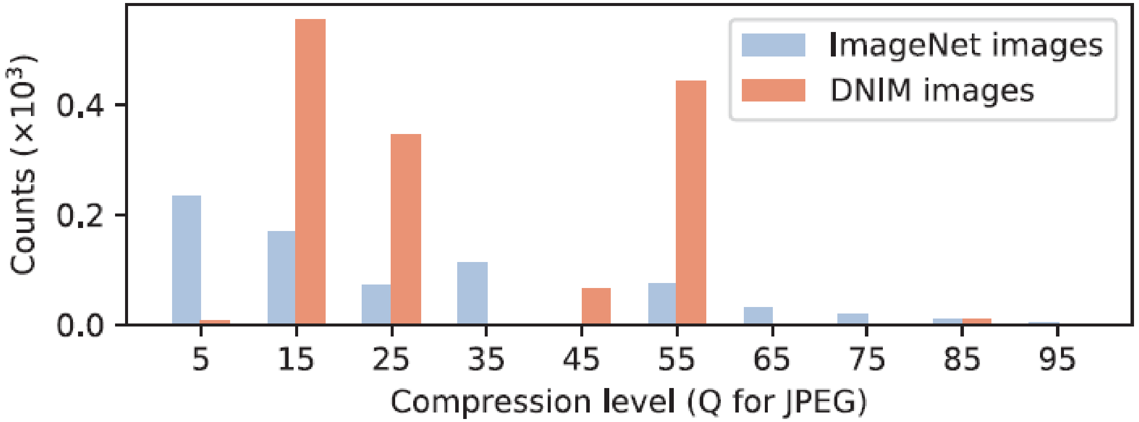
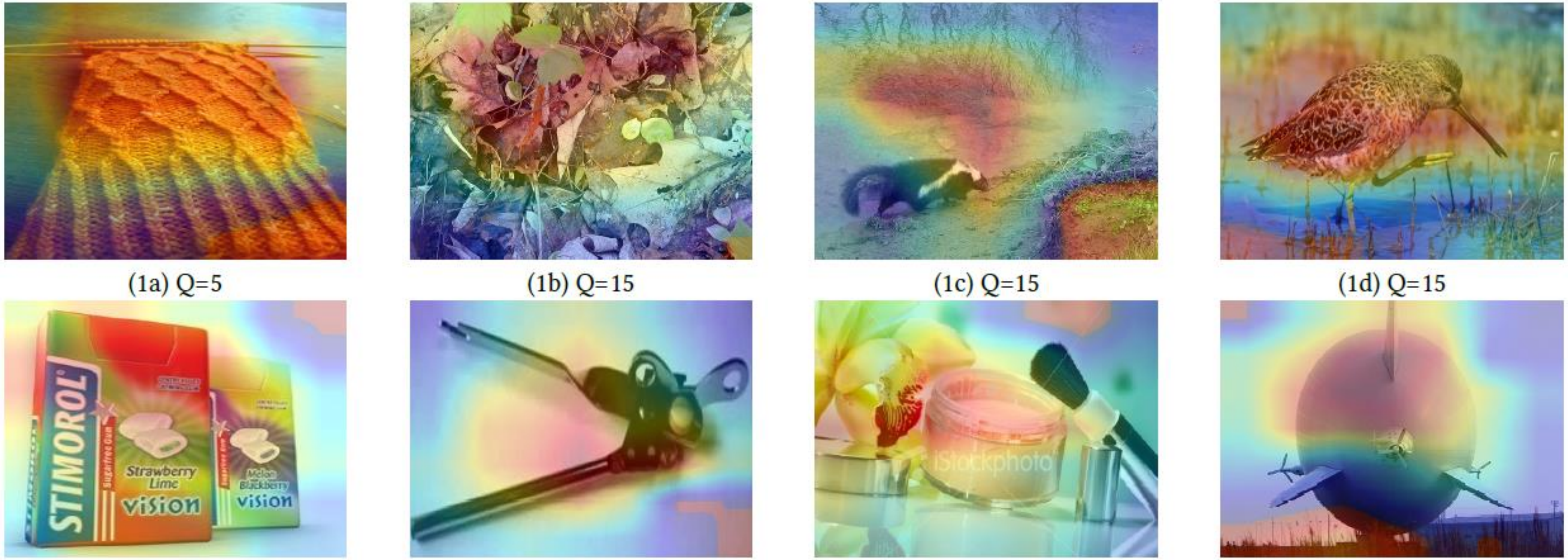


Figure 6: Histogram of RL agent's best compression level selection for different scenery image inputs

Insight

- **Grad-Cam**
- **High quality for smooth region**



(1a) Q=5 (1b) Q=15 (1c) Q=15 (1d) Q=15

(2a) Q=85 (2b) Q=85 (2c) Q=75 (2d) Q=75

Figure 7: Visualization of the importance map for the RL agent to choose a compression quality

Scenery change

- Scenery change (day to night, sunny to rainy etc.)
- State machine with 3 states
- Occasionally estimate system accuracy
- Retrain when necessary

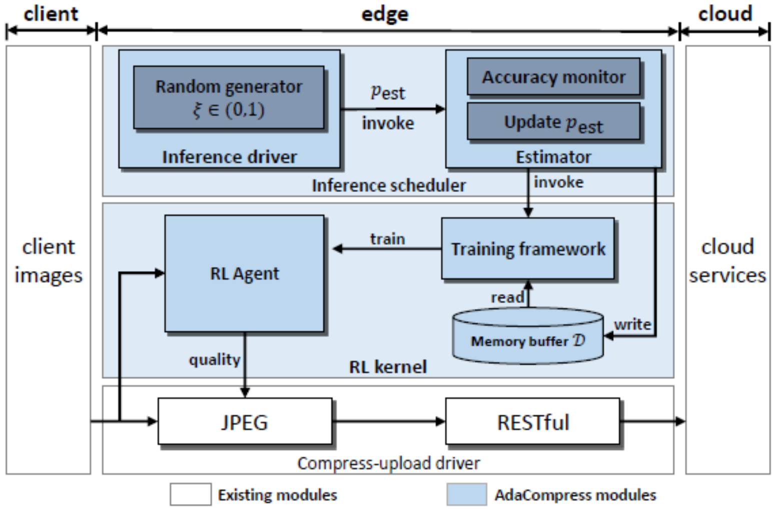


Figure 3: Diagram of AdaCompress architecture

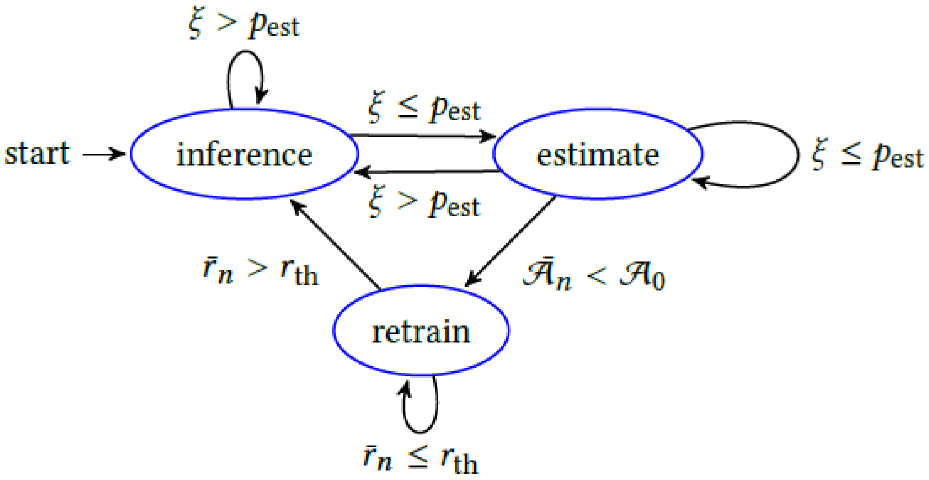


Figure 4: State switching policy

Performance upon scenery change

- **Imitate scenery change by changing dataset**

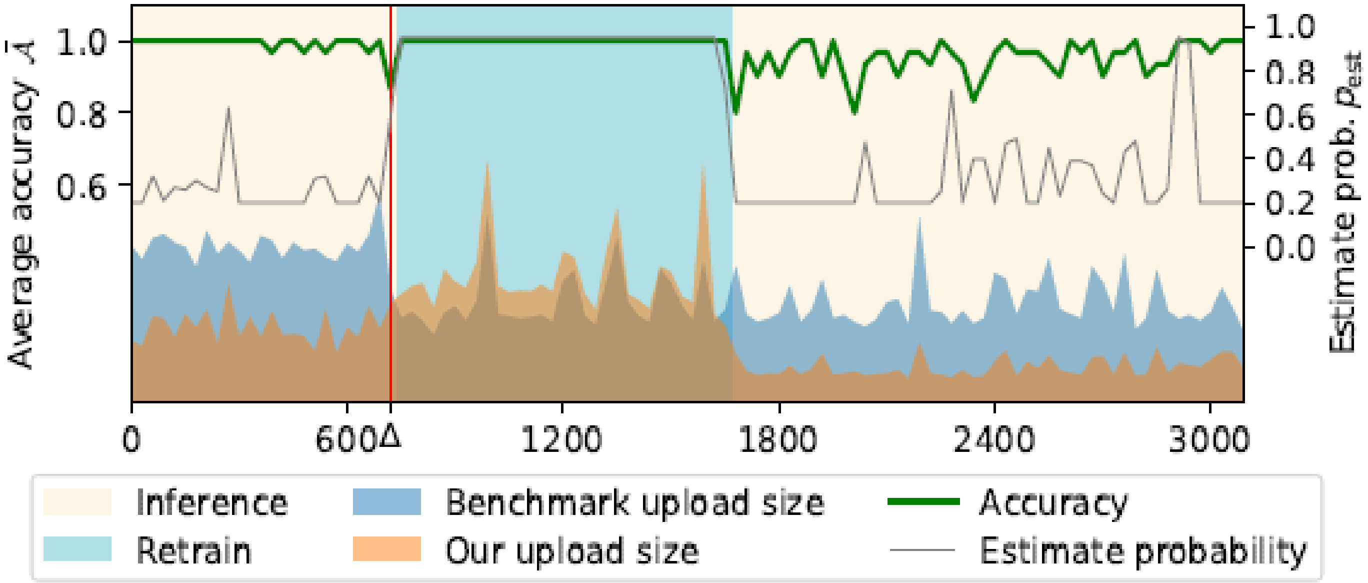


Figure 10: AdaCompress's reaction upon scenery change

Performance upon scenery change

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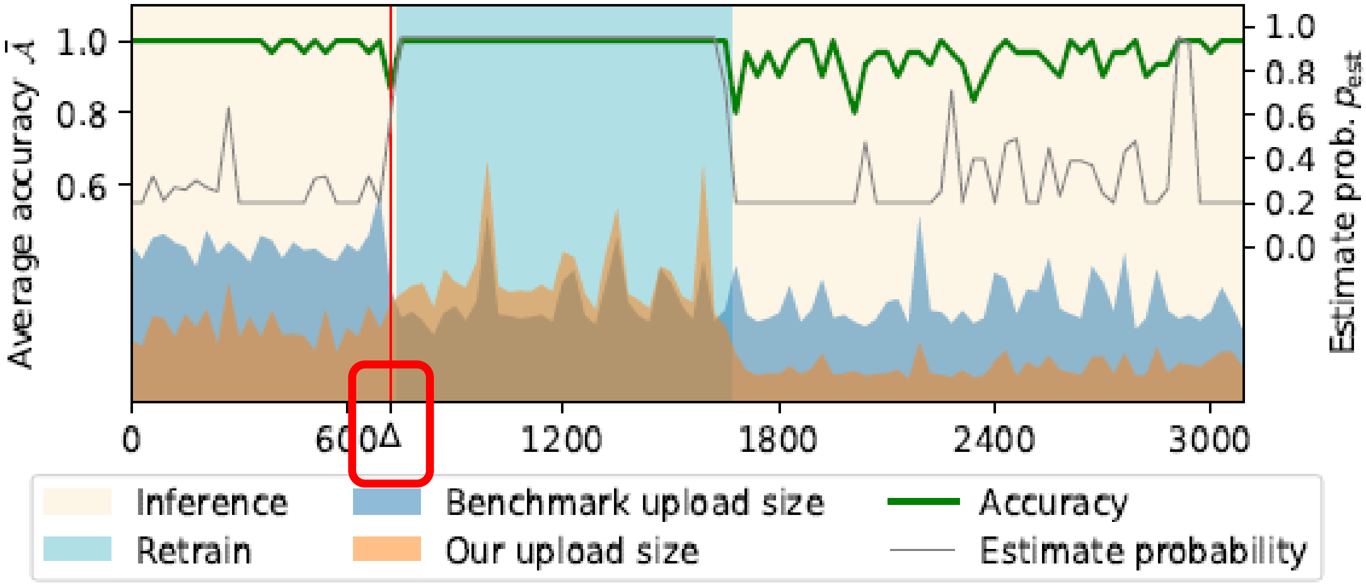

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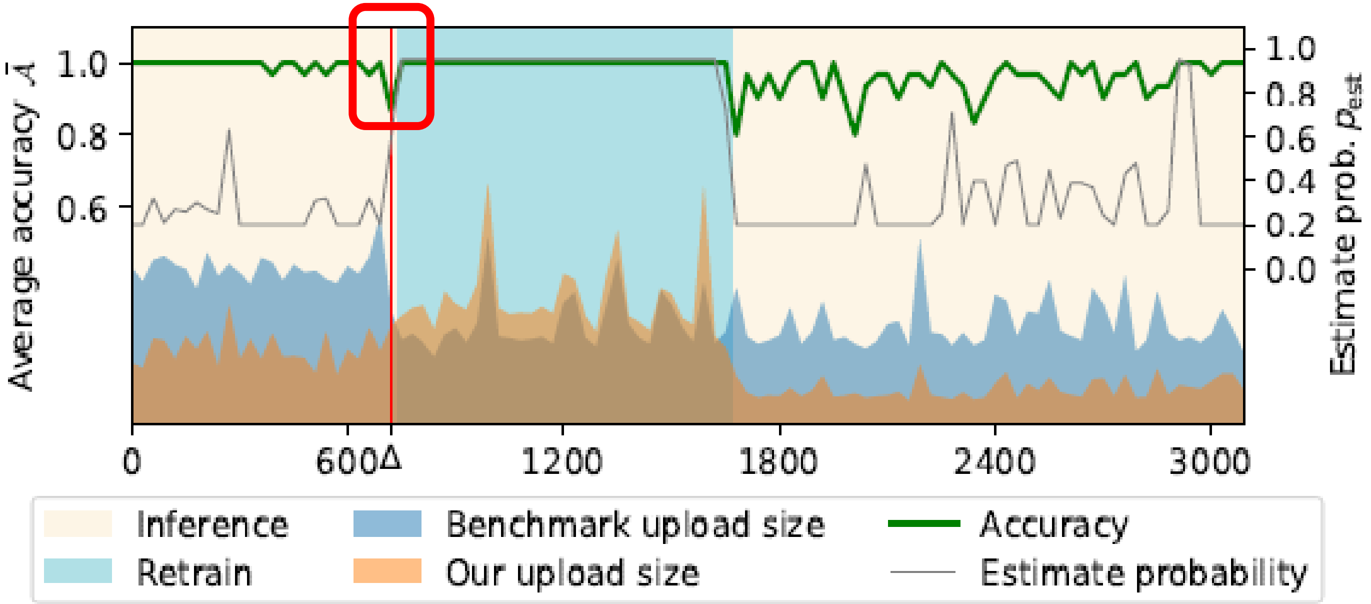

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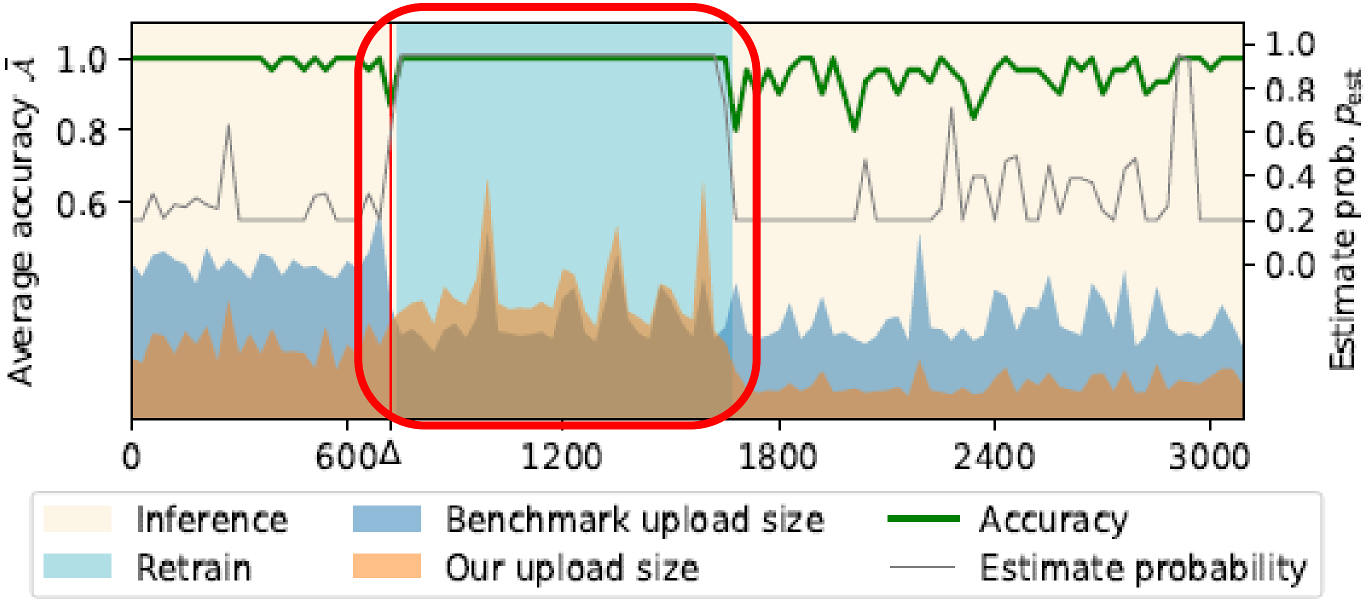

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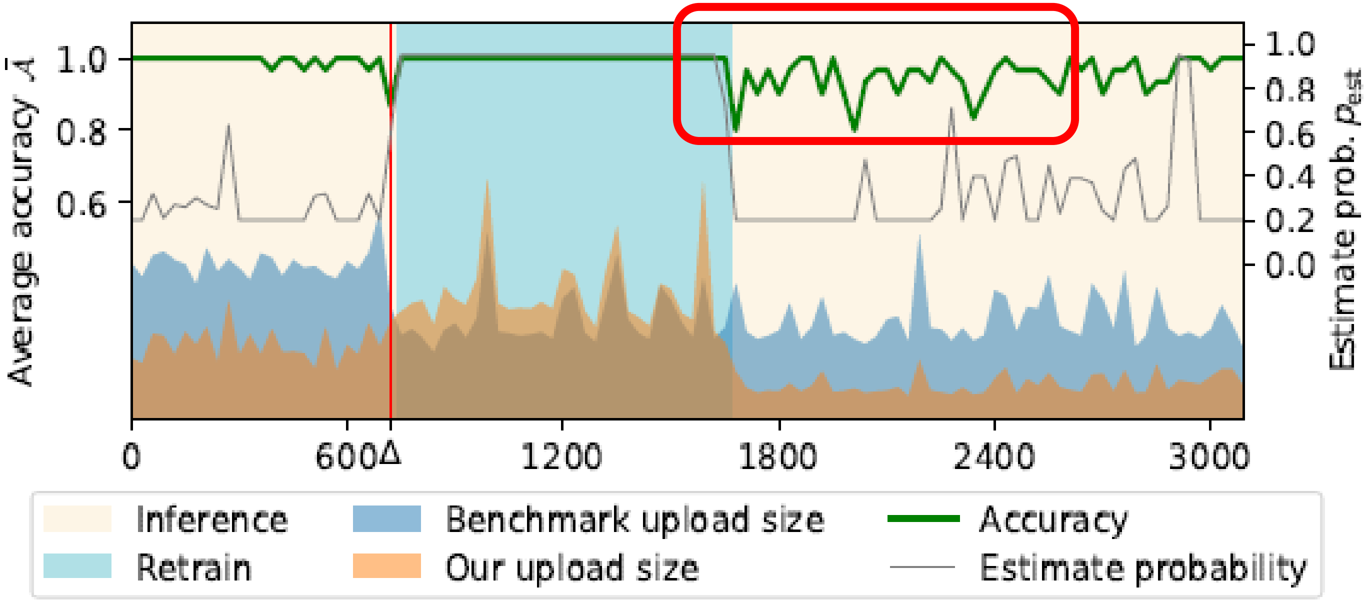

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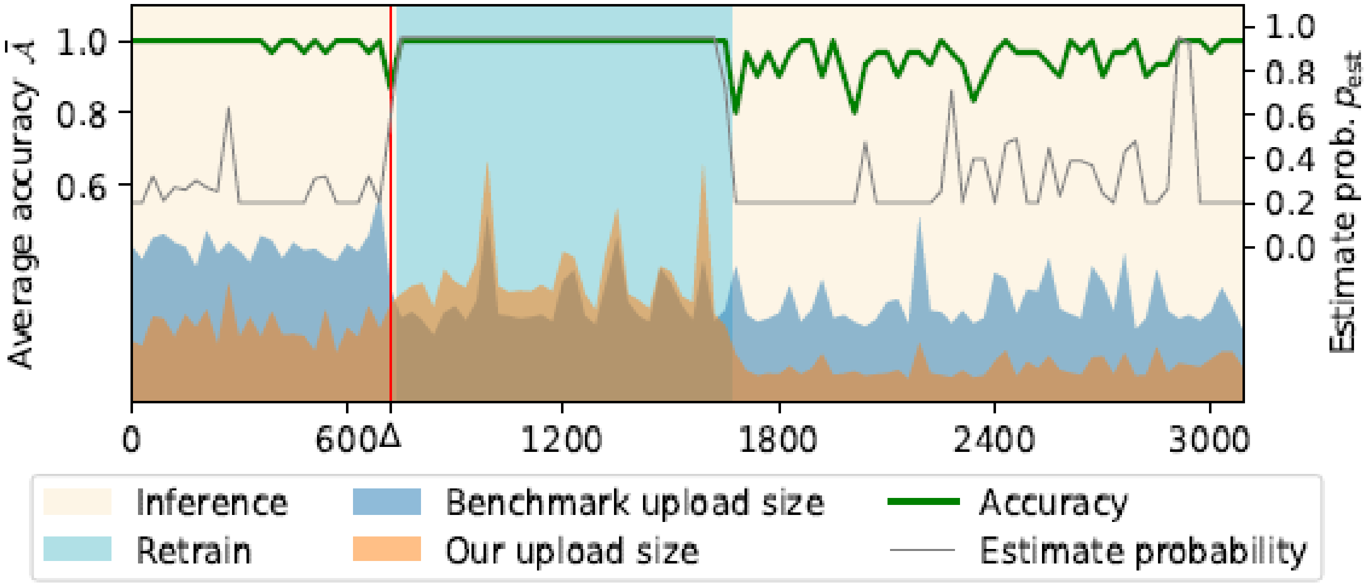

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Thank You

Source Code:

https://github.com/hosea1008/AdaCompress