Variational On-the-Fly Personalization

Jangho Kim[*,1,2], Jun−Tae Lee[*,1], Simyung Chang[1], Nojun Kwak[2]

[1] Qualcomm AI Research
[2] Seoul National University
kjh91@snu.ac.kr, juntlee@qti.qualcomm.com, simychan@qti.qualcomm.com, nojunk@snu.ac.kr

[*] Equal contribution
Jangho Kim completed the research in part during an internship at Qualcomm Technologies, Inc.
[1] Qualcomm AI Research is an initiative of Qualcomm Technologies, Inc

Jangho Kim
Interim Engineering Intern
Qualcomm Korea YH

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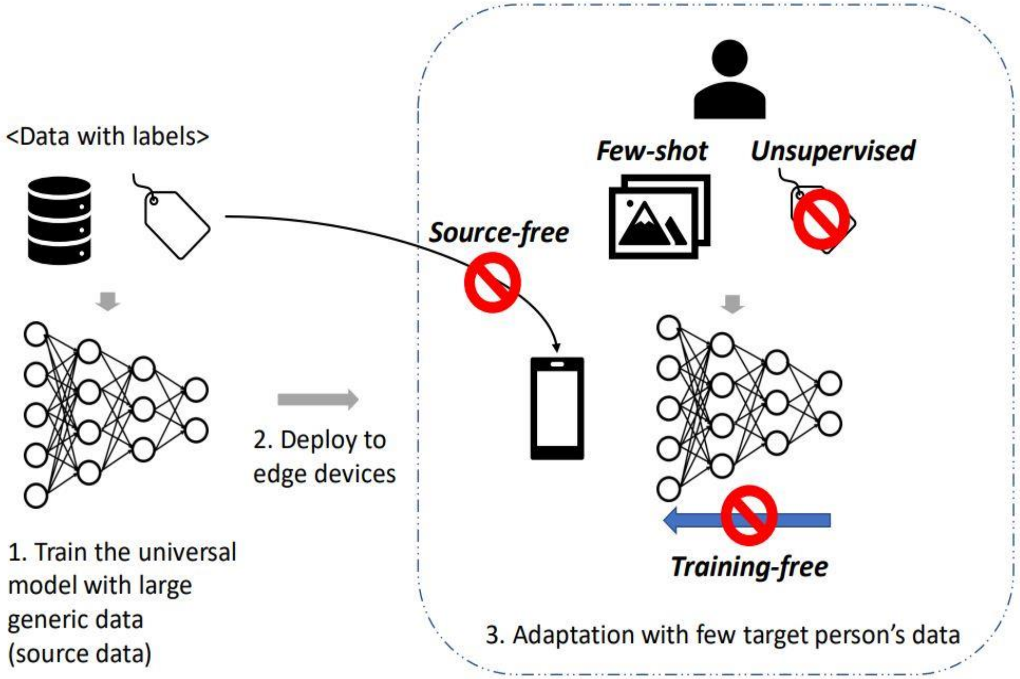
Source sample text

Introduction

- Problem
  - In edge devices, such as mobile phones and IoT sensors, deep models are required to process (learn or infer) a personal domain where data are generated in a specific environment, which is called *personalization*
  - Despite the importance of personalization, there has been little progress due to practical constraints of edge devices
    - Source-free
    - Few-shot
    - Unsupervised
    - Training-free
- Goal
  - we propose a novel personalization method, Variational On-the-Fly Personalization (VoP) satisfying the constraints (Source-free, few-shot ,unsupervised ,training-free)



<Data with labels>
Few-shot
Unsupervised
Source-free
2. Deploy to edge devices
1. Train the universal model with large generic data (source data)
Training-free
3. Adaptation with few target person's data

Figure 1: Our personalization scenario on edge devices with practically crucial constraints

Method

- Variational On-the-Fly Personalization
  - We compute the weights of layers specialized to its personality on-the-fly via forwarding only a few personal data
  - The key of our method lies in a small detachable module, the variational hyper-personalizer which is trained to produce an approximated posterior distribution of weights of a layer based on the personality
  - We assume that the data in a personal domain share the same personality

$$KL(\overset{\text{Variational distribution}}{\underline{q_\theta(\omega|x_i^k)}}||\overset{\text{True k-th personality posterior distribution}}{\underline{p(\omega|x_i^k, y_i^k)}}) = \int q_\theta(\omega|x_i^k) \ln \frac{q_\theta(\omega|x_i^k)}{p(\omega|x_i^k, y_i^k)} d\omega$$

$$= \int q_\theta(\omega|x_i^k) \ln \left(\frac{q_\theta(\omega|x_i^k)}{p(\omega|x_i^k)} \frac{p(y_i^k|x_i^k)}{p(y_i^k|x_i^k, \omega)} \right) d\omega$$

$$= KL(q_\theta(\omega|x_i^k)||p(\omega|x_i^k))$$

$$- \mathbb{E}_{\omega \sim q_\theta(\omega|x_i^k)}[\ln p(y_i^k|x_i^k, \omega)] + \ln p(y_i^k|x_i^k).$$

Approximating the posterior distribution

Method

- Variational On-the-Fly Personalization
  - Colors in input samples represent personalities for each input sample
  - In the training phase, VoP trains the encoding module and hyper-personalizer to estimate sample-specific weights via black dashed and blue bold arrows
  - At testing phase, for each personality, VoP generates personal weights by forwarding a few enrollment samples via black and red dashed arrows, once

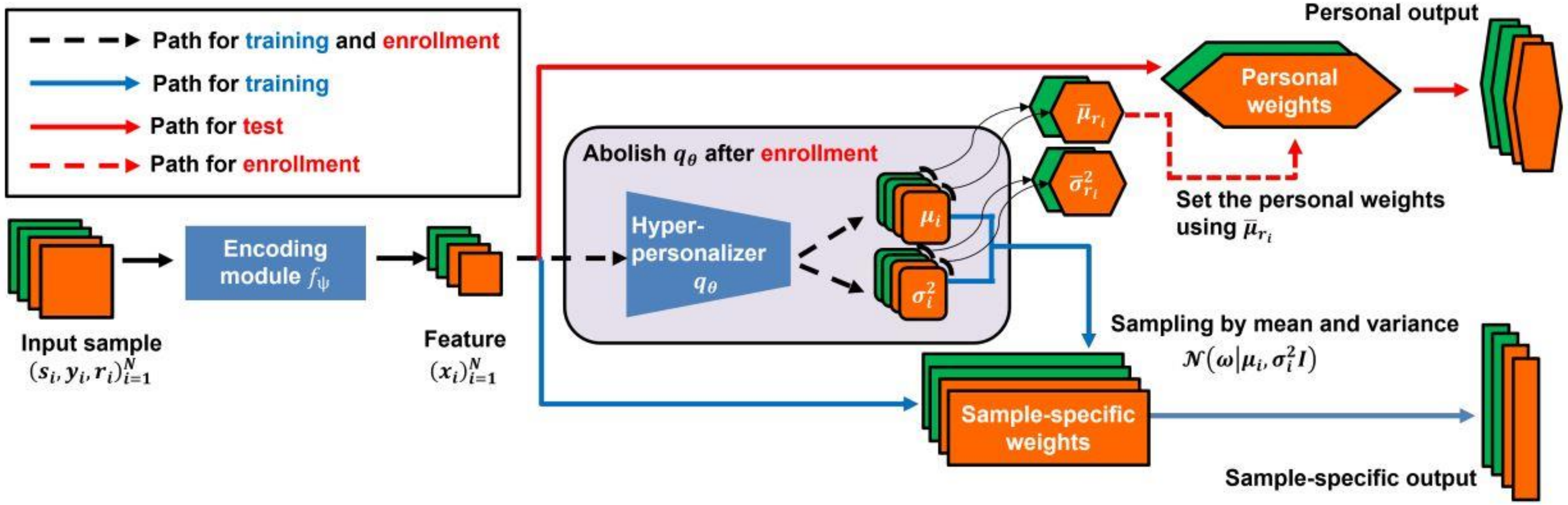
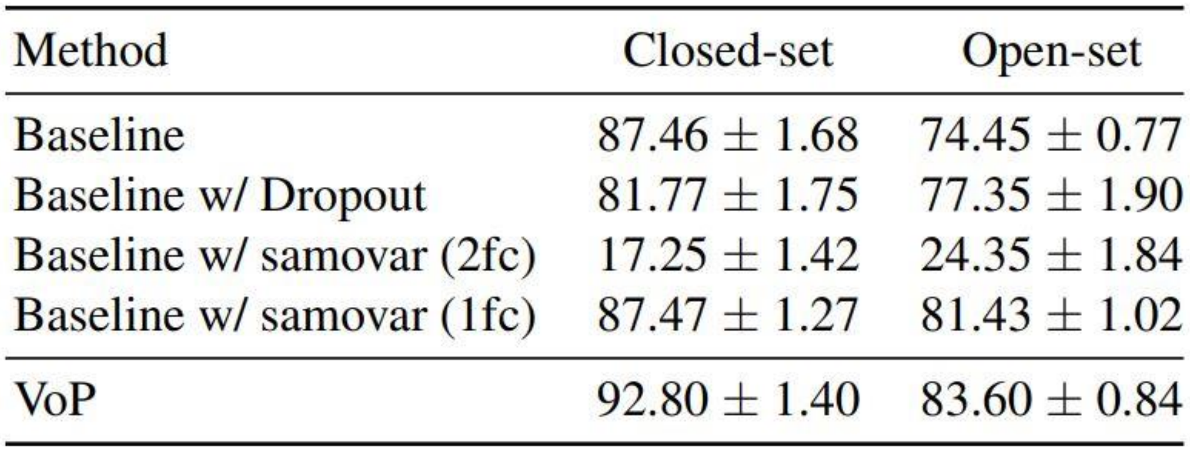


Figure 2: Overall Process of VoP

Experiment results

- To verify the proposed VoP, we apply it to three tasks: keyword spotting, speaker verification and few-shot classification (Details of other experiments are in the paper)



Method	Closed-set	Open-set
Baseline	87.46 ± 1.68	74.45 ± 0.77
Baseline w/ Dropout	81.77 ± 1.75	77.35 ± 1.90
Baseline w/ samovar (2fc)	17.25 ± 1.42	24.35 ± 1.84
Baseline w/ samovar (1fc)	87.47 ± 1.27	81.43 ± 1.02
VoP	92.80 ± 1.40	83.60 ± 0.84

Table 1: Keyword spotting accuracy on Qualcomm keyword speech dataset

Conclusion

- We proposed Variational On-the-Fly Personalization (VoP), a novel personalization method that can produce a personalized network via forwarding a small amount of personal data on-the-fly
- The proposed VoP can effectively estimate the weight distribution suitable for an individual without additional training using a large amount of personal data
- we showed that VoP successfully generates an accurately personalized model without increasing the computational cost

Source sample text

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