Local Feature Alignment for Efficient TinyML Training on Low-Power Devices

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Model \rightarrow \text{Training} \rightarrow \text{Inference}
Model → Database → Training and/or inference

Training X Deployment
Learning rules for neural networks
Global learning rules
Local learning rules

“Neurons that fire together wire together.”
Donald O. Hebb
Feature Alignment
Feature Alignment

\[ \mathcal{L}(z_x, z_r) \rightarrow \hat{r} \]

argmin(\mathcal{L})
Feature Alignment
Local Feature Alignment
Training Locally

\[
\mathcal{L} = \| x_{l+1} - r_{l+1} \|_2^2
\]

\[
\hat{x}_l = -\frac{\partial \mathcal{L}}{\partial r_l}
\]

\[
C = \| x_l - r_l \|_2^2
\]

\[
\Delta \theta \leftarrow -\frac{\partial C}{\partial \theta_l}
\]
Training Locally
### Spatial Complexity

<table>
<thead>
<tr>
<th>Global Learning</th>
<th>Local Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>$O(LN)$</td>
<td>$O(N)$</td>
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</tbody>
</table>
Results
Network
Results: Regression
Network

Results: Classification

Classification neurons
Latent neurons
Test Set

Results: Classification
Conclusions
• We adapted the feature alignment technique to train neural networks locally;
● We adapted the feature alignment technique to train neural networks locally;

● We demonstrated that it can train MLPs on regression and classification problem of the MNIST;
Future Scope
• Improve feature approximation;
● Improve feature approximation;
● Different network architectures;
● Improve feature approximation;
● Different network architectures;
● Other problems and datasets;
● Improve feature approximation;
● Different network architectures;
● Other problems and datasets;
● Train neural networks on real resource-constrained devices.
Thanks!

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