

OPTIMISING LLS IN CNNs

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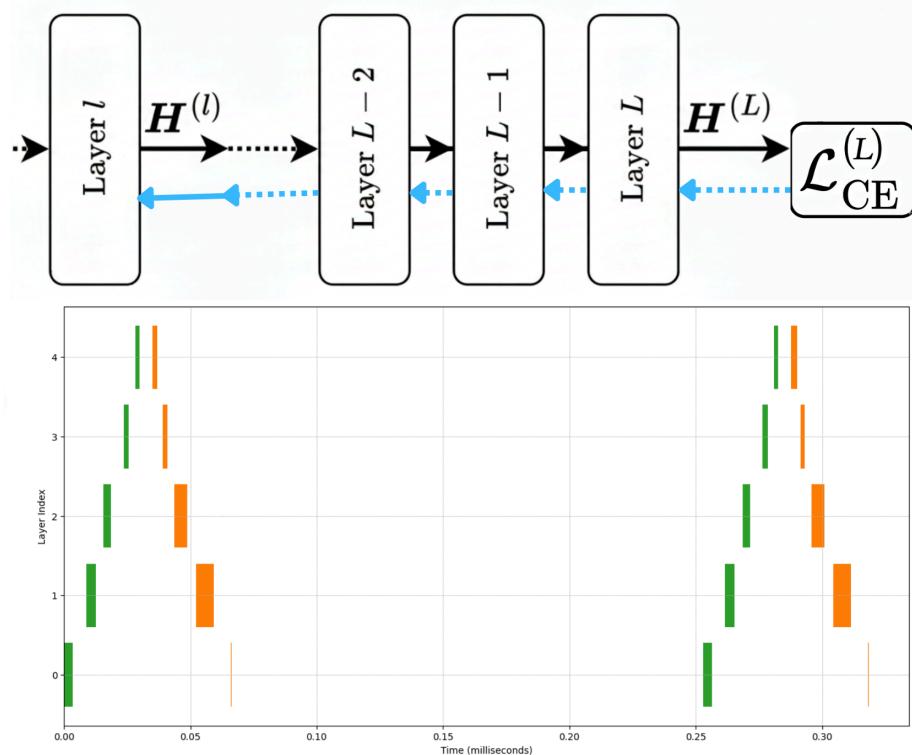
LLS in CNNs::

LLS: Local Learning Rule for Deep Neural Networks Inspired by Neural Activity Synchronisation
by Marco P. E., Apolinario, Arani Roy , Kaushik Roy

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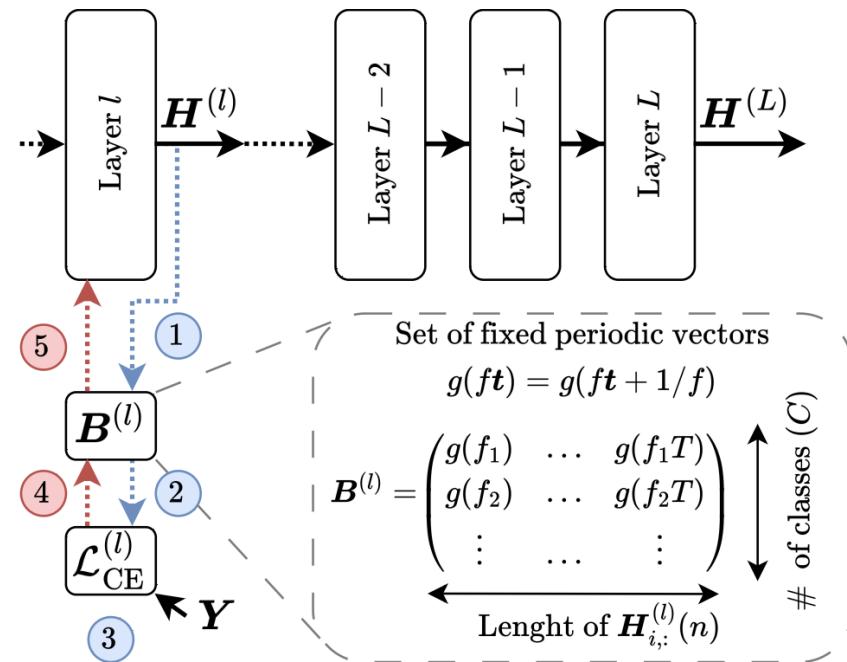
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In CNN's;
BP: non-locality and update-locking



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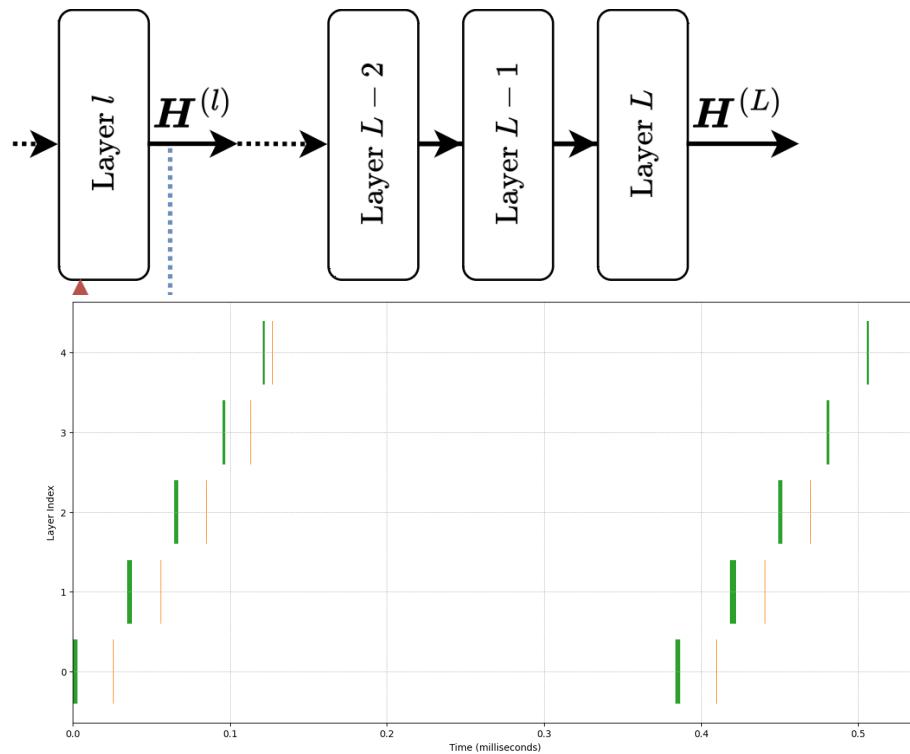
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In CNN's;
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- Solution::
Synchronise at layer-level to features
BP: non-locality and update-locking



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In CNN's;
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Synchronise at layer-level to features
~~BP: non-locality and update locking~~

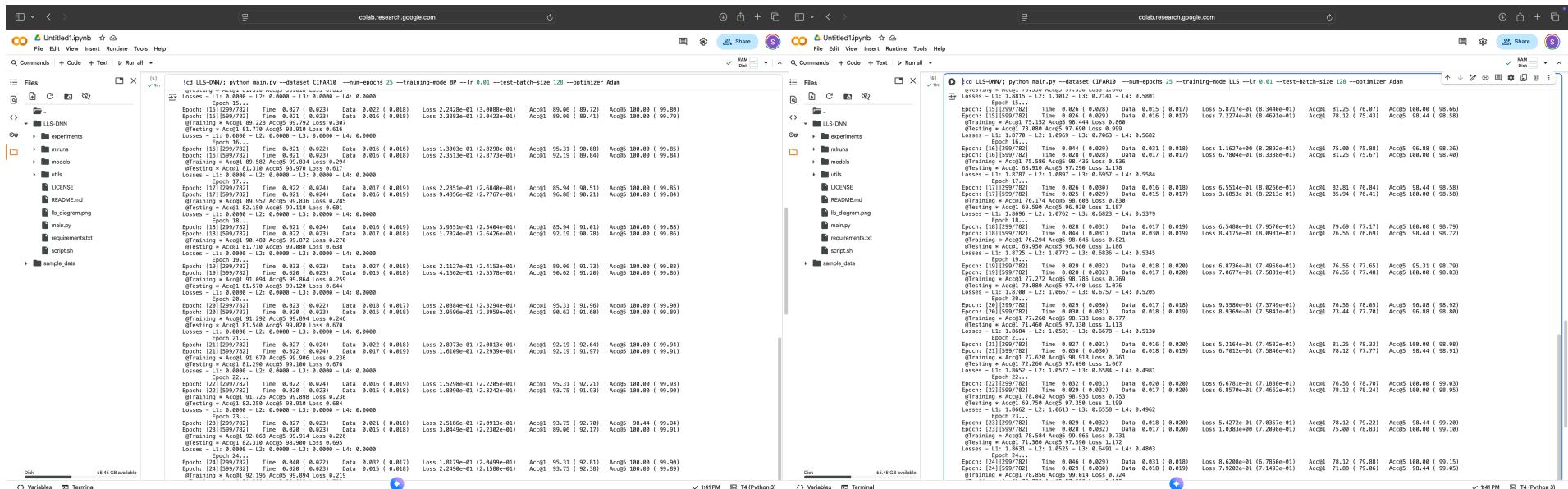


Evaluation::

On training:

- $T = 9\text{mins}$;
 - dataset CIFAR10 —num-epochs 25
 - training-mode BP ...

- $T = 11\text{mins}$;
 - dataset CIFAR10 —num-epochs 25
 - training-mode LLS ...



```
cd LLS-DNN/; python main.py --dataset CIFAR10 --num-epochs 25 --training-mode BP --lr 0.01 --test-batch-size 128 --optimizer Adam
Epoch 15...:
Epoch: [15] [599/782] Time 0.821 ( 0.023) Data 0.022 ( 0.018) Loss 2.2428e-01 ( 3.4898e-03) Acc@1 89.06 ( 89.72) Acc@5 100.00 ( 99.98)
Epoch: [15] [599/782] Time 0.821 ( 0.023) Data 0.015 ( 0.018) Loss 2.1382e-01 ( 3.0422e-03) Acc@1 89.06 ( 89.41) Acc@5 100.00 ( 99.79)
@Training * Acc@1 89.228 Acc@5 99.792 Loss 0.387
@Testing * Acc@1 81.125 Acc@5 98.978 Loss 0.417
Losses - L1: 0.0000 - L2: 0.0000 - L3: 0.0000 - L4: 0.0000
Epoch 16...:
Epoch: [16] [599/782] Time 0.821 ( 0.022) Data 0.016 ( 0.016) Loss 1.8093e-01 ( 2.9298e-03) Acc@1 95.31 ( 98.88) Acc@5 100.00 ( 99.85)
Epoch: [16] [599/782] Time 0.821 ( 0.022) Data 0.016 ( 0.016) Loss 2.3513e-01 ( 2.8773e-03) Acc@1 92.13 ( 89.84) Acc@5 100.00 ( 99.84)
@Training * Acc@1 89.582 Acc@5 99.434 Loss 0.294
@Testing * Acc@1 81.125 Acc@5 98.978 Loss 0.417
Losses - L1: 0.0000 - L2: 0.0000 - L3: 0.0000 - L4: 0.0000
Epoch 17...:
Epoch: [17] [599/782] Time 0.821 ( 0.024) Data 0.017 ( 0.018) Loss 2.2055e-01 ( 2.5848e-03) Acc@1 85.04 ( 98.51) Acc@5 100.00 ( 99.85)
Epoch: [17] [599/782] Time 0.821 ( 0.024) Data 0.016 ( 0.018) Loss 9.4856e-02 ( 2.7776e-03) Acc@1 96.82 ( 98.21) Acc@5 100.00 ( 99.84)
@Training * Acc@1 82.158 Acc@5 98.978 Loss 0.265
@Testing * Acc@1 81.125 Acc@5 98.978 Loss 0.417
Losses - L1: 0.0000 - L2: 0.0000 - L3: 0.0000 - L4: 0.0000
Epoch 18...:
Epoch: [18] [599/782] Time 0.821 ( 0.024) Data 0.016 ( 0.018) Loss 3.9551e-01 ( 2.5484e-03) Acc@1 85.19 ( 91.81) Acc@5 100.00 ( 99.88)
Epoch: [18] [599/782] Time 0.821 ( 0.024) Data 0.015 ( 0.018) Loss 1.8734e-01 ( 2.6426e-03) Acc@1 81.19 ( 98.78) Acc@5 100.00 ( 99.86)
@Training * Acc@1 98.488 Acc@5 99.872 Loss 0.278
@Testing * Acc@1 81.125 Acc@5 98.978 Loss 0.417
Losses - L1: 0.0000 - L2: 0.0000 - L3: 0.0000 - L4: 0.0000
Epoch 19...:
Epoch: [19] [599/782] Time 0.822 ( 0.023) Data 0.027 ( 0.018) Loss 2.1127e-01 ( 2.4153e-03) Acc@1 89.06 ( 91.73) Acc@5 100.00 ( 99.88)
Epoch: [19] [599/782] Time 0.822 ( 0.023) Data 0.015 ( 0.018) Loss 4.1662e-01 ( 2.5578e-03) Acc@1 90.62 ( 91.28) Acc@5 100.00 ( 99.86)
@Training * Acc@1 81.578 Acc@5 99.128 Loss 0.444
@Testing * Acc@1 81.125 Acc@5 98.978 Loss 0.417
Losses - L1: 0.0000 - L2: 0.0000 - L3: 0.0000 - L4: 0.0000
Epoch 20...:
Epoch: [20] [599/782] Time 0.821 ( 0.024) Data 0.019 ( 0.018) Loss 2.3884e-01 ( 2.3298e-03) Acc@1 95.31 ( 91.96) Acc@5 100.00 ( 99.98)
Epoch: [20] [599/782] Time 0.821 ( 0.024) Data 0.015 ( 0.018) Loss 2.9696e-01 ( 2.3959e-03) Acc@1 98.62 ( 91.68) Acc@5 100.00 ( 99.89)
@Training * Acc@1 91.292 Acc@5 99.494 Loss 0.246
@Testing * Acc@1 81.125 Acc@5 98.978 Loss 0.417
Losses - L1: 0.0000 - L2: 0.0000 - L3: 0.0000 - L4: 0.0000
Epoch 21...:
Epoch: [21] [599/782] Time 0.821 ( 0.024) Data 0.012 ( 0.018) Loss 2.8973e-01 ( 2.0813e-03) Acc@1 92.19 ( 92.64) Acc@5 100.00 ( 99.94)
Epoch: [21] [599/782] Time 0.821 ( 0.024) Data 0.015 ( 0.018) Loss 1.6109e-01 ( 2.2939e-03) Acc@1 92.19 ( 91.97) Acc@5 100.00 ( 99.91)
@Training * Acc@1 82.258 Acc@5 99.133 Loss 0.236
@Testing * Acc@1 81.125 Acc@5 99.138 Loss 0.476
Losses - L1: 0.0000 - L2: 0.0000 - L3: 0.0000 - L4: 0.0000
Epoch 22...:
Epoch: [22] [599/782] Time 0.821 ( 0.024) Data 0.016 ( 0.018) Loss 1.5379e-01 ( 2.2935e-03) Acc@1 95.23 ( 92.21) Acc@5 100.00 ( 99.93)
Epoch: [22] [599/782] Time 0.821 ( 0.024) Data 0.015 ( 0.018) Loss 1.8899e-01 ( 2.3242e-03) Acc@1 93.75 ( 91.93) Acc@5 100.00 ( 99.91)
@Training * Acc@1 92.868 Acc@5 99.014 Loss 0.226
@Testing * Acc@1 81.125 Acc@5 98.978 Loss 0.417
Losses - L1: 0.0000 - L2: 0.0000 - L3: 0.0000 - L4: 0.0000
Epoch 23...:
Epoch: [23] [599/782] Time 0.821 ( 0.023) Data 0.021 ( 0.018) Loss 2.5186e-01 ( 2.0913e-03) Acc@1 93.75 ( 92.78) Acc@5 98.44 ( 99.94)
Epoch: [23] [599/782] Time 0.821 ( 0.023) Data 0.015 ( 0.018) Loss 3.6449e-01 ( 2.2382e-03) Acc@1 99.46 ( 92.17) Acc@5 100.00 ( 99.91)
@Training * Acc@1 92.868 Acc@5 99.014 Loss 0.226
@Testing * Acc@1 81.125 Acc@5 98.978 Loss 0.417
Losses - L1: 0.0000 - L2: 0.0000 - L3: 0.0000 - L4: 0.0000
Epoch 24...:
Epoch: [24] [599/782] Time 0.848 ( 0.022) Data 0.032 ( 0.017) Loss 1.8179e-01 ( 2.0499e-03) Acc@1 95.31 ( 92.38) Acc@5 100.00 ( 99.98)
Epoch: [24] [599/782] Time 0.828 ( 0.023) Data 0.015 ( 0.018) Loss 2.2498e-01 ( 2.1508e-03) Acc@1 93.75 ( 92.38) Acc@5 100.00 ( 99.89)
@Training * Acc@1 92.159 Acc@5 99.294 Loss 0.219
@Testing * Acc@1 81.125 Acc@5 98.978 Loss 0.417
Losses - L1: 0.0000 - L2: 0.0000 - L3: 0.0000 - L4: 0.0000
Epoch 25...:
Epoch: [25] [599/782] Time 0.821 ( 0.023) Data 0.021 ( 0.018) Loss 5.4727e-01 ( 7.4357e-03) Acc@1 78.12 ( 79.22) Acc@5 98.44 ( 99.28)
Epoch: [25] [599/782] Time 0.821 ( 0.023) Data 0.018 ( 0.018) Loss 1.8339e-01 ( 7.2098e-03) Acc@1 75.99 ( 78.83) Acc@5 100.00 ( 99.18)
@Training * Acc@1 78.584 Acc@5 99.868 Loss 0.731
@Testing * Acc@1 77.728 Acc@5 97.608 Loss 1.132
Losses - L1: 1.8831 - L2: 1.8525 - L3: 0.6409 - L4: 0.4080
Epoch 26...:
Epoch: [26] [599/782] Time 0.846 ( 0.029) Data 0.031 ( 0.018) Loss 8.6286e-01 ( 6.7658e-03) Acc@1 79.12 ( 79.88) Acc@5 100.00 ( 99.15)
Epoch: [26] [599/782] Time 0.829 ( 0.030) Data 0.018 ( 0.019) Loss 7.9282e-01 ( 7.1493e-03) Acc@1 71.88 ( 79.86) Acc@5 98.44 ( 99.05)
@Training * Acc@1 78.829 Acc@5 99.104 Loss 0.724
```

Goals::

Hierarchy

- CUDA implementation for the SmallConv (5-layer) LLS;
- CUDA implementation for the SmallConv (5-layer) LLS-M; LLS-MxM
- (CUDA implementation for the VGG8, MobileNet-V1 LLS;...)

- Generalising this approach to provide Parallel Local Learning Support using more generic framework via Triton for LLS; LLS-M; LLS-MxM; future-variants

Feedback:
Check feasibility of purple goal thoroughly to deliver that.

“Gratitude is not only the greatest of virtues, but the parent of all others”

MARCUS TULLIUS CICERO

“Thank you”,
TAs Ayush, Rahul:
timely help, believing in me.
Teachers Gopal, Karthik:
for this opportunity and teachings :)