

Biologically Plausible Deep Learning: A Critical Review

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¹<https://github.com/RobertTLange/Bio-Plausible-DeepLearning>

Motivation

Literature Review

| | Backprop (Rummelhart et al., 1986) | Feedback Alignment (Lillicrap et al., 2016) | Target Propagation (LeCun, 1986) | Difference TP (Lee et al., 2015) | Simplified DTP (Bartunov et al., 2018) | Segregated Compartments (Guergiev et al., 2017) | Microcircuits (Sacramento et al., 2018) |
|-------------------------------|---------------------------------------|--|-------------------------------------|-------------------------------------|---|--|--|
| Exact Gradients | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ (In Limit) |
| No Weight Transport | ✗ | ✓ | ✓/✗ (Final Layer) | ✓/✗ (Final Layer) | ✓ | ✓ | ✓ |
| No Separate Pathways | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ |
| Dendritic Integration | - | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ |
| Separate Weights Learned | - | ✗ | ✓ | ✓ | ✓ | ✗ | ✓/✗ |
| Linear Stabilization | - | - | ✗ | ✓ | ✓ | - | - |
| Explicit Error Representation | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ |

Guerguiev et al. (2017)

| | Backprop (Rummelhart et al., 1986) | Feedback Alignment (Lillicrap et al., 2016) | Target Propagation (LeCun, 1986) | Difference TP (Lee et al., 2015) | Simplified DTP (Bartunov et al., 2018) | Segregated Compartments (Guerguiev et al., 2017) | Microcircuits (Sacramento et al., 2018) |
|-------------------------------|---------------------------------------|--|-------------------------------------|-------------------------------------|---|---|--|
| Exact Gradients | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ (In Limit) |
| No Weight Transport | ✗ | ✓ | ✓/✗ (Final Layer) | ✓/✗ (Final Layer) | ✓ | ✓ | ✓ |
| No Separate Pathways | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ |
| Dendritic Integration | - | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ |
| Separate Weights Learned | - | ✗ | ✓ | ✓ | ✓ | ✗ | ✓/✗ |
| Linear Stabilization | - | - | ✗ | ✓ | ✓ | - | - |
| Explicit Error Representation | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ |

What's next?

References I

Guerguiev, Jordan, Lillicrap, Timothy P, & Richards, Blake A. 2017. Towards deep learning with segregated dendrites. *ELife*, **6**, e22901.

