Karlsruhe Institute of Technology

HiWi Notes: Minimize Code Constraint Polynomial using Adam

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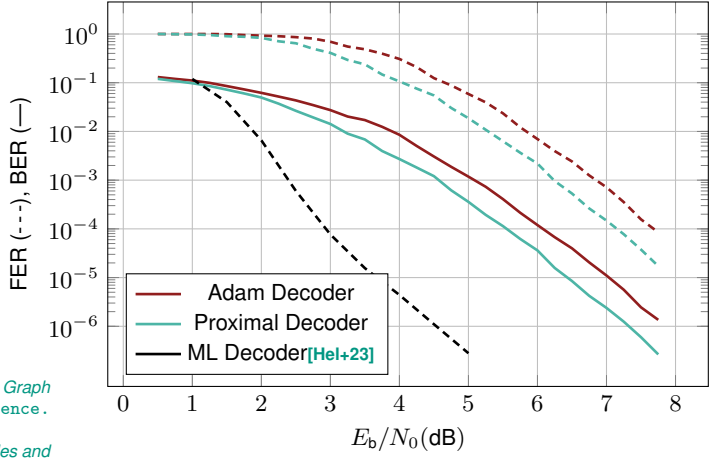
Implementation

```
def decode(self, y: torch.Tensor) -> torch.Tensor:
    optimizer = torch.optim.Adam([y], lr=self._learning_rate)

    c_hat = (y < 0).int()

    for _ in range(self._K):
        optimizer.zero_grad()
        loss = self._code_constraint_polynomial(y)
        loss.backward()
        optimizer.step()

        c_hat = (y < 0).int()

        if not torch.any(torch.matmul(self._H, c_hat) % 2):
            break

    return c_hat
```

Performance

- Code: 204.33.484[Mac24]: (3,6) regular LDPC code
- Decoder parameters
  - Learning Rate: 0.05
  - Max. Number of Adam optimizer iterations: 150

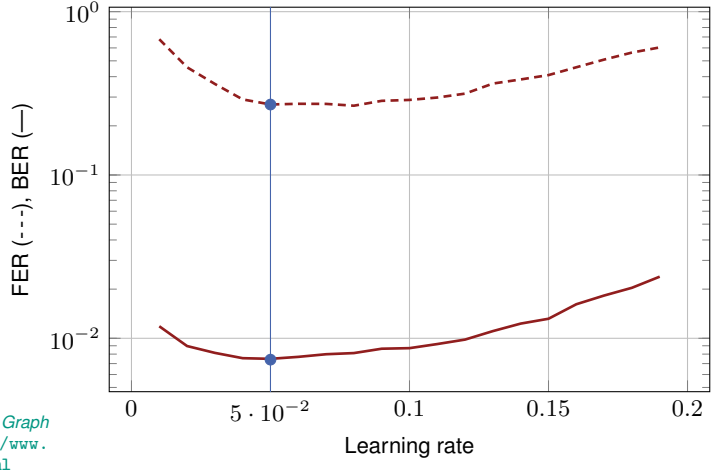


[Mac24] David J.C. MacKay: *Encyclopedia of Sparse Graph Codes*. Dec. 2024. url: http://www.inference.org.uk/mackay/codes/data.html

[Hel+23] Michael Helmling et al. *Database of Channel Codes and ML Simulation Results*. Apr. 2023. url: https://www.uni-kl.de/channel-codes.

Parameter Choice: Learning Rate

- Code: 204.33.484[Mac24]: (3,6) regular LDPC code
- Decoder parameters
  - $E_b/N_0 = 4$dB
  - Max. Number of Adam optimizer iterations: 150
- Chosen learning rate: 0.05



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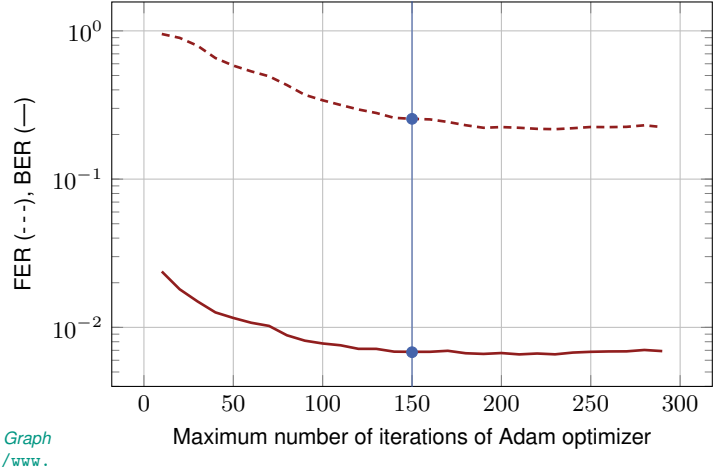

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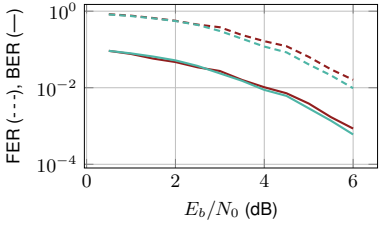
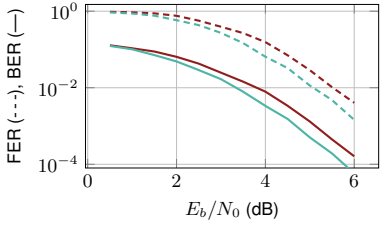
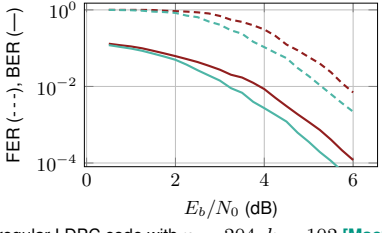
Comparison of Performance for Different Codes



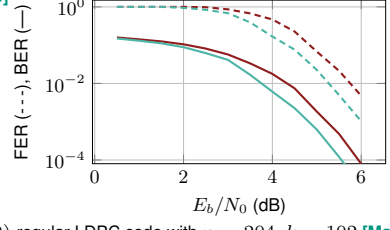
(a) BCH code with $n = 31, k = 26$



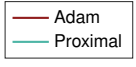
(b) $(3, 6)$-regular LDPC code with $n = 96, k = 48$ **[Mac24, 96.33.965]**



(c) $(3, 6)$-regular LDPC code with $n = 204, k = 102$ **[Mac24, 204.33.484]**



(d) $(5, 10)$-regular LDPC code with $n = 204, k = 102$ **[Mac24, 204.55.187]**



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