Tensor Contraction for Parsimonious Deep Nets

AMAZON AI

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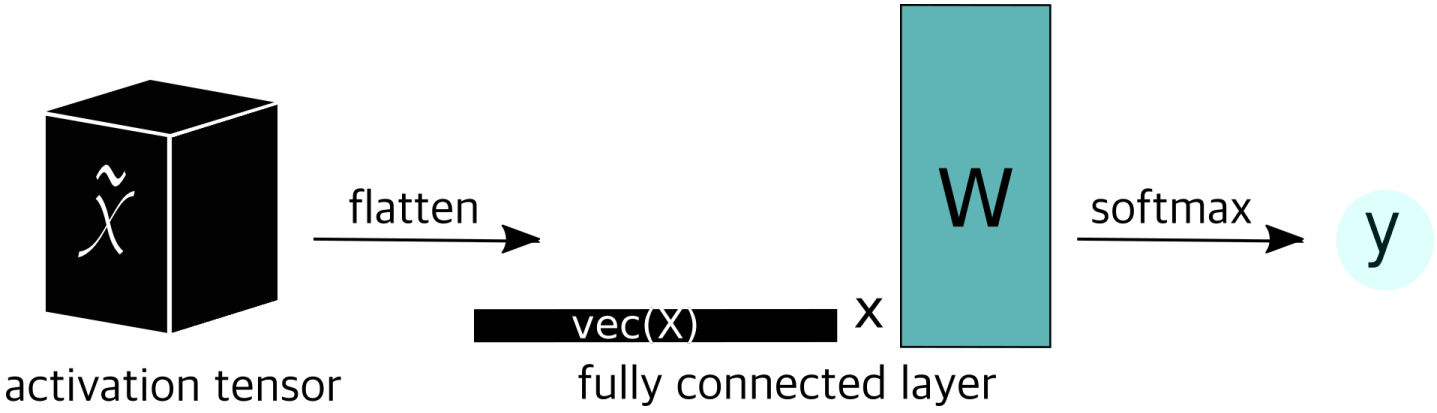
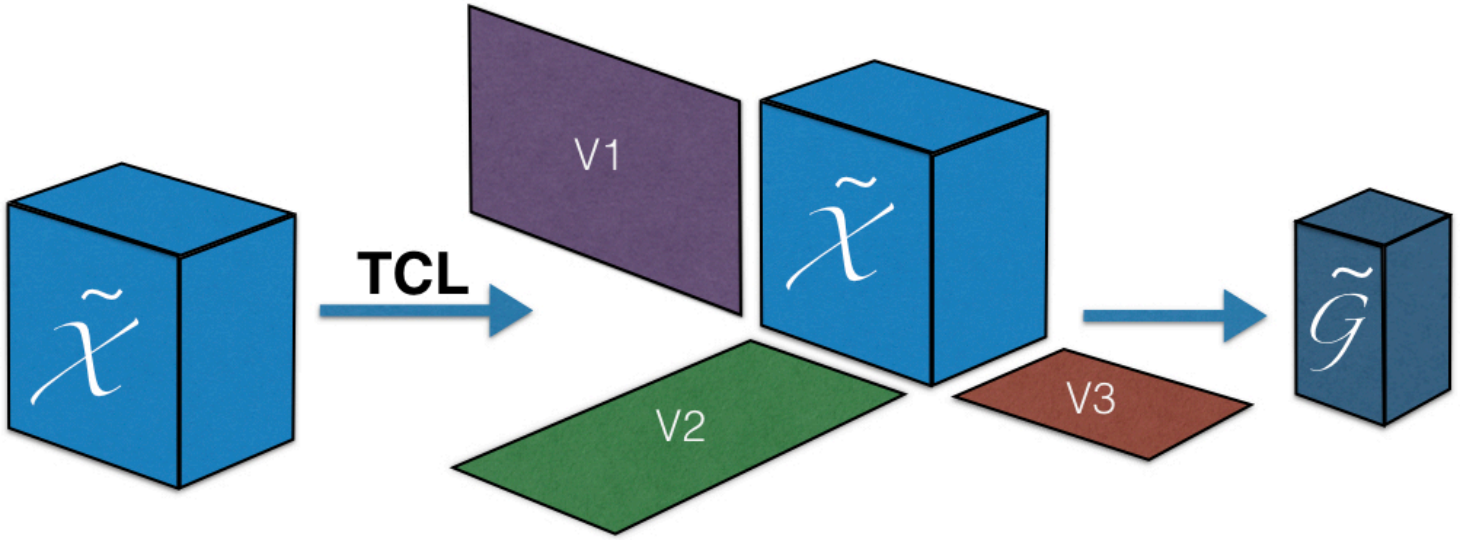
Traditional approaches



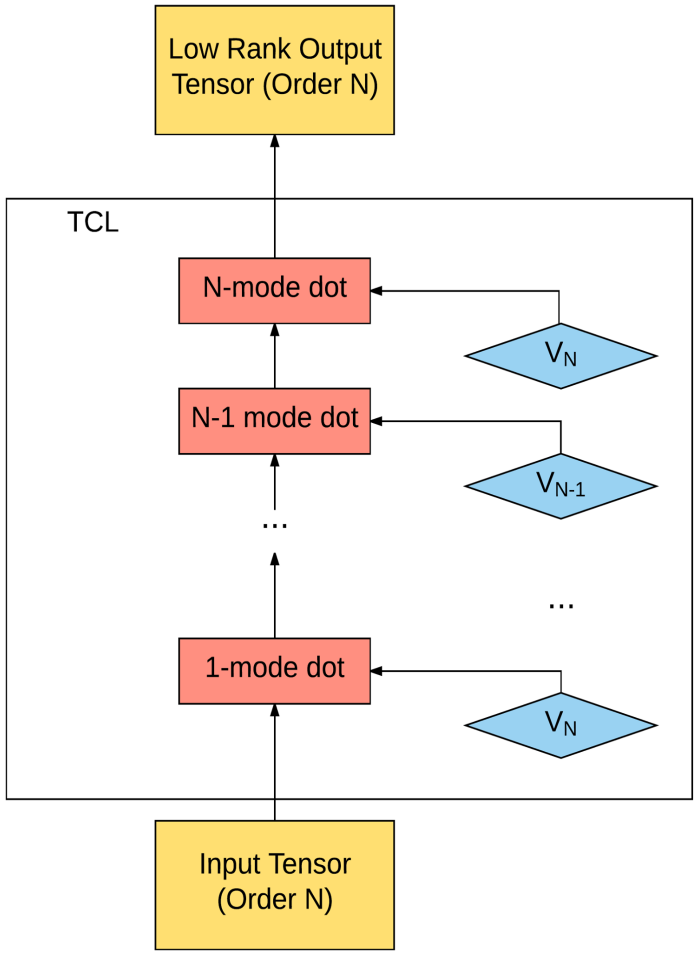
- DATA => CONV => RELU => POOL => Activation tensor
- Flattening looses information
- Can we leverage directly the activation tensor before the flattening?
  - Potential space savings
  - Performance improvement

Tensor Contraction

- Tensor contraction: contract along each mode to obtain a low rank, compact tensor

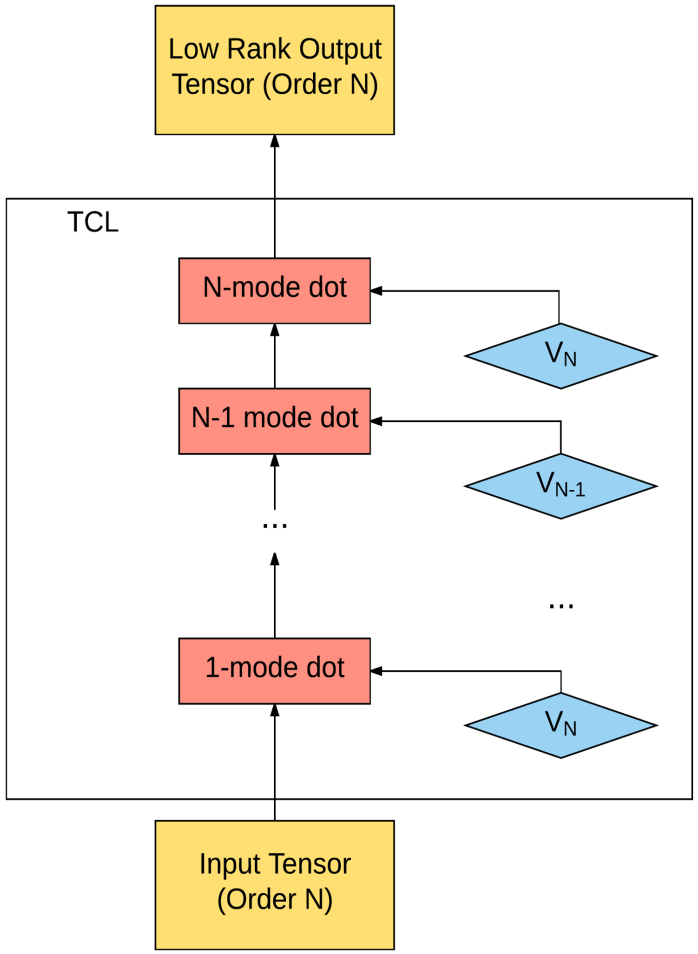


Tensor Contraction Layers (TCL)



- Take activation tensor as input
- Feed it through a TCL
- Output a low-rank activation tensor

Tensor Contraction Layers (TCL)



- Compact representation
  less parameters

- Measured in terms of percentage of space savings in the fully connected layers:

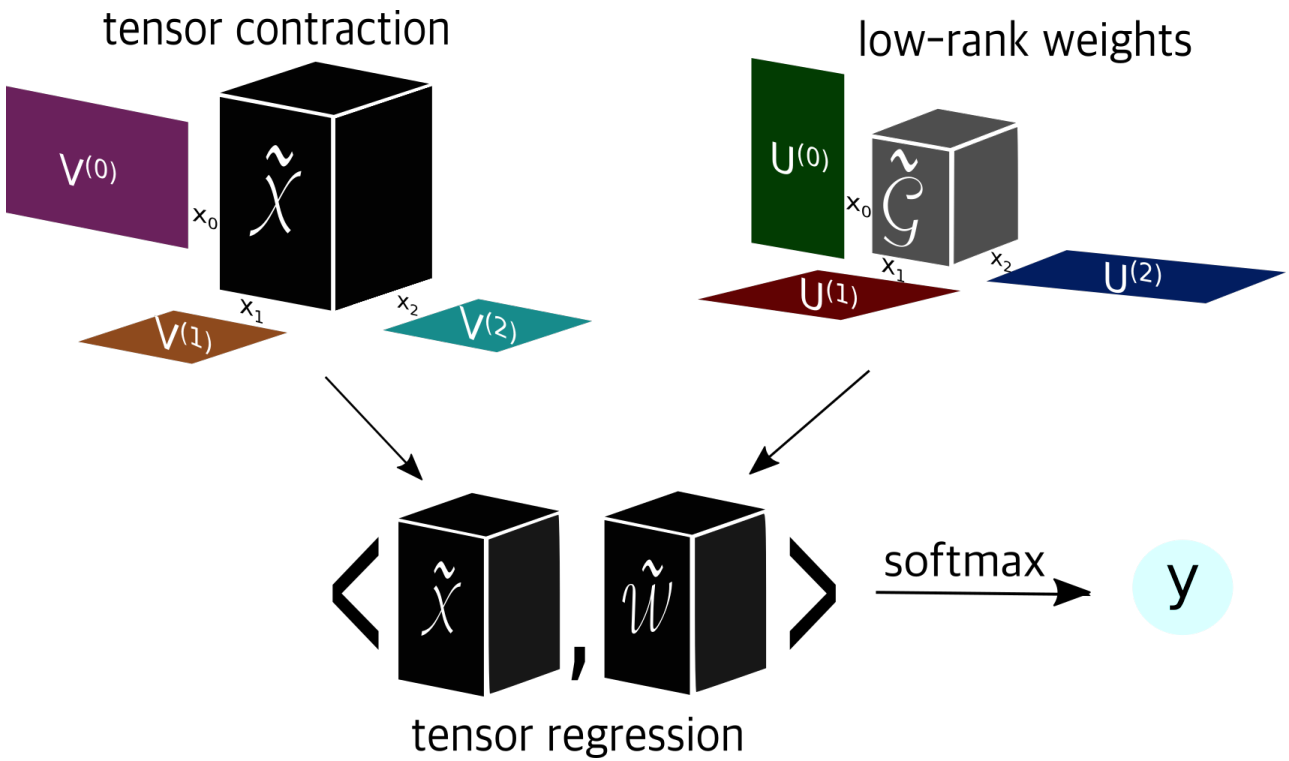
$$1 - \frac{n_{TCL}}{n_{original}}$$

- Similar and sometimes better performance

Performance of the TCL

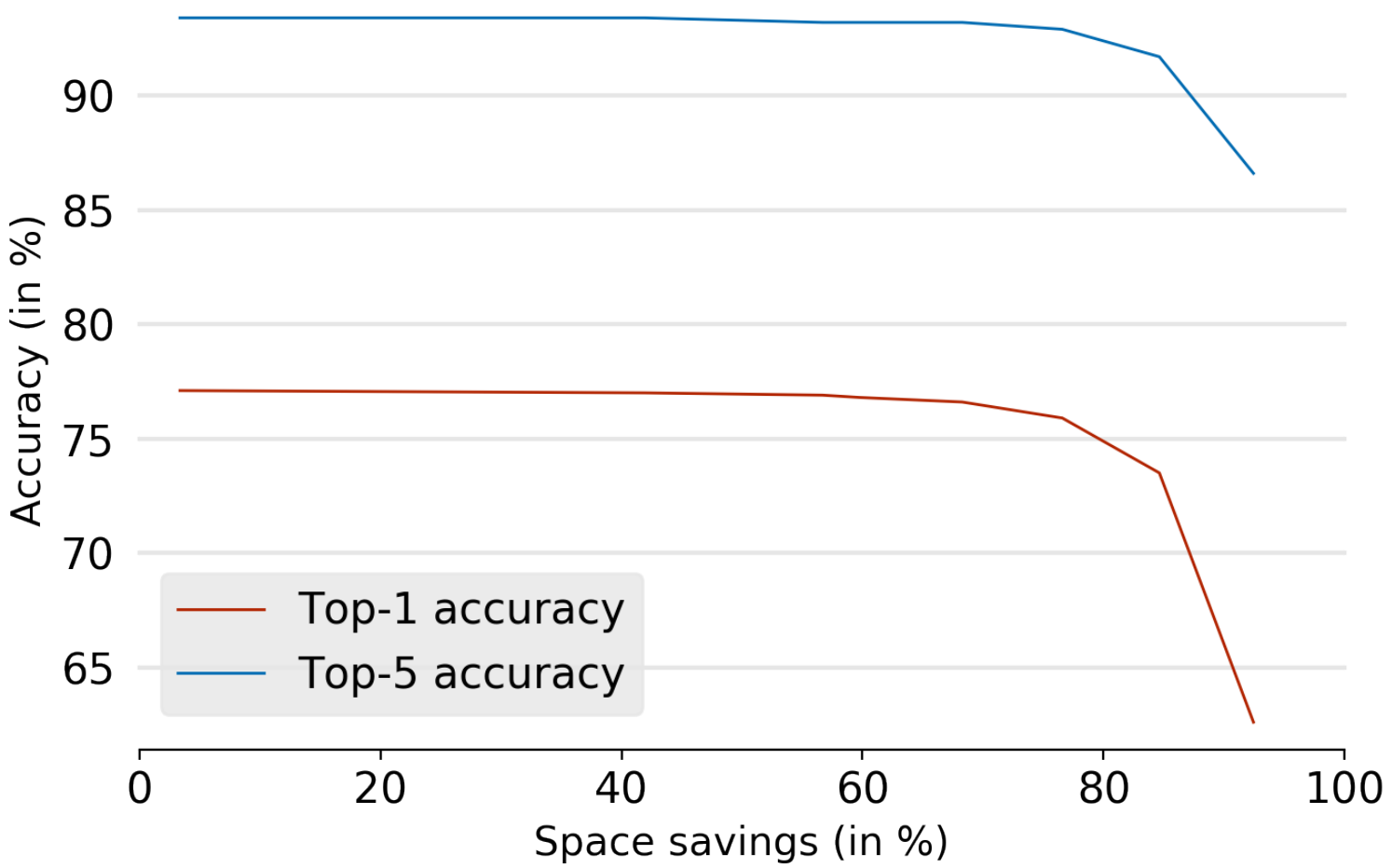
- Trained end-to-end
- On ImageNet with VGG:
  - 65.9% space savings
  - performance drop of 0.6% only
- On ImageNet with AlexNet:
  - 56.6% space savings
  - Performance improvement of 0.5%

Low-rank tensor regression



Tensor Regression Networks, *J. Kossaifi, Z.C.Lipton, A.Khanna, T.Furlanello and A.Anandkumar*, ArXiv pre-publication

Performance and rank



Performance of the TRL

- 92.4% space savings, 4% decrease in Top-1 accuracy
- 68.2% space savings, no decrease in Top-1 accuracy

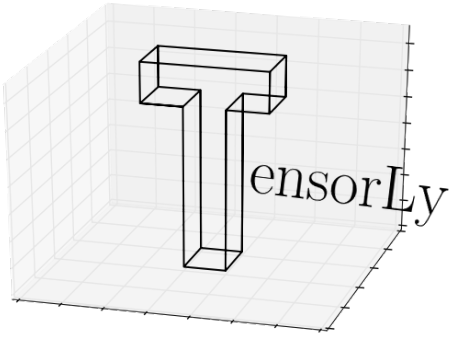
TRL rank	Performance (in %)		
	Top-1	Top-1	Space savings
baseline	77.1	93.4	0
(200, 1, 1, 200)	77.1	93.2	68.2
(150, 1, 1, 150)	76	92.9	76.6
(100, 1, 100)	74.6	91.7	84.6
(50, 1, 1, 50)	73.6	91	92.4

Results on ImageNet with a ResNet-101

Implementation

- MXNet as a Deep Learning framework
  http://mxnet.io/

- TensorLy for tensor operations
  https://tensorly.github.io



- Coming soon: mxnet backend for TensorLy
  tensor operation on GPU and CPU

Conclusion and future work

- Tensor contraction and tensor regression for Deep Neural Nets
- Add as an additional layer or replace one
- Less parameters
- Similar or even better performance

Future work

- Faster tensor operations
- Explore more tensor operations / networks architectures

Mahalo!

Any question?

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