

Negative Transfer in Deep Multi-task Learning

Shengchao Liu
Yingyu Liang
Anthony Gitter



Multi-task Learning Roadmap

Transfer Learning:

Transfer knowledge from source tasks to target tasks

Multi-task Learning:

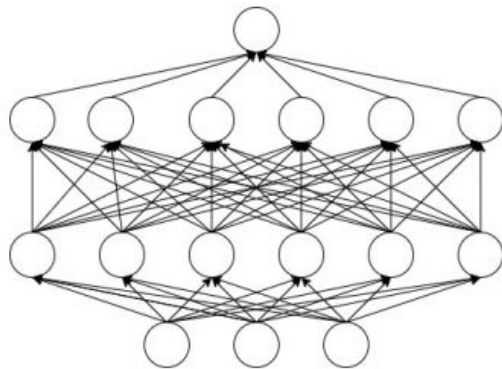
Model the task relatedness

Learn all tasks simultaneously

Learn shared representation

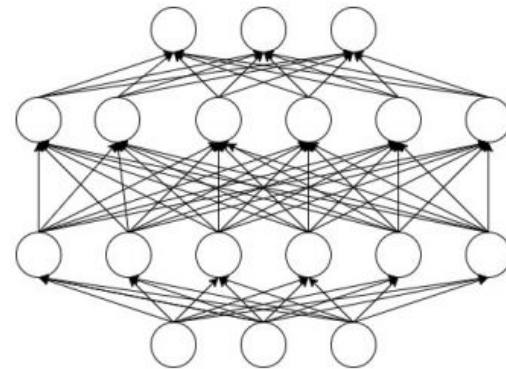
Deep Multi-task Learning

(Deep) Single-task learning



(a) Single-task NN

(Deep) Multi-task learning



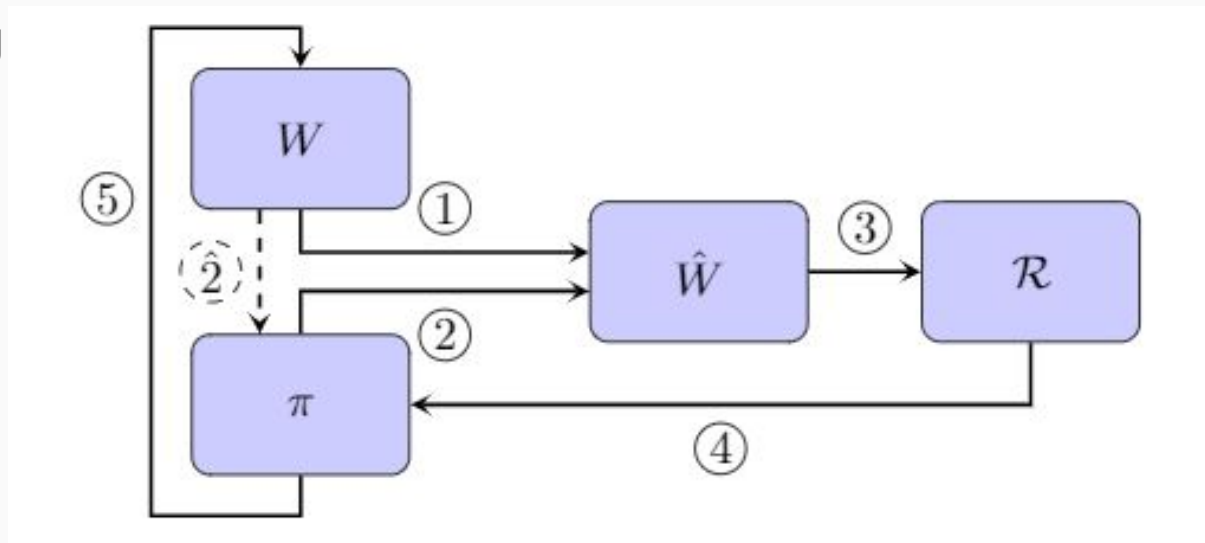
(b) Multi-task Hard NN

[Negative Transfer](#)

Reinforced Multi-task Learning (RMTL)

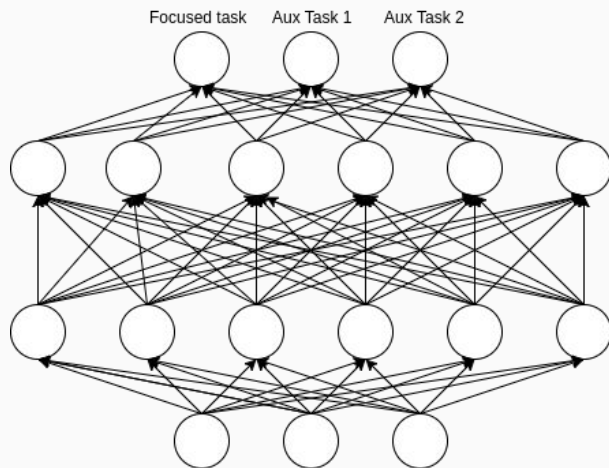
Reinforcement Learning

1. policy
2. reward function



RMTL on a Focused Task

Focused Learning



Algorithm 3: Reward Function

Given a focused task.

Initialize neural network W , with depth d .

for batch of data B **do**

for all candidate policy π . **do**

 Get gradient w.r.t. batch of data on the last shared layer $\nabla_{d-1}B$.

 Compute cosine-similarity v w.r.t. the focused task based on $\nabla_{d-1}B$.

 Fetch reward, $r = \max(v, 0)$.

end for

 Select best π according to r .

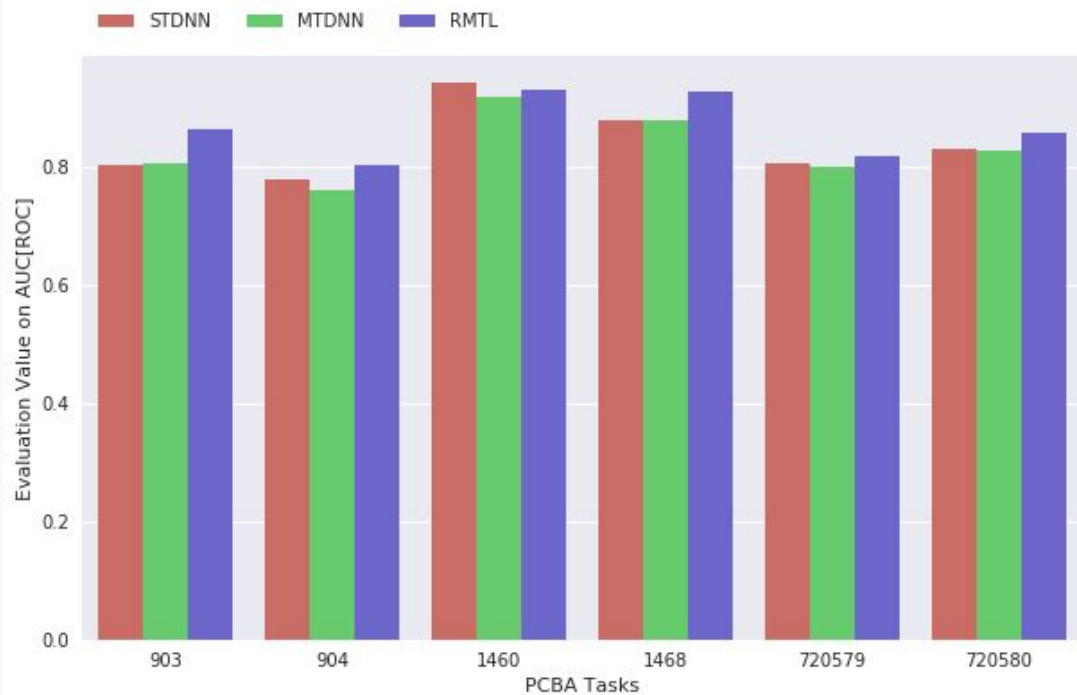
 Multiply gradients ∇B by $\pi \cdot r$.

 Update W by backpropagation.

end for

Experiments: PCBA

3 similar pairs from 128 tasks



Appendix

1. [More Focused Learning \(RM TL\) results, randomly sampled pairs](#)
2. [Negative transfer in 128 PCBA tasks](#)
3. GradNorm: [GradNorm: Gradient Normalization for Adaptive Loss Balancing in Deep Multitask Networks](#)
4. Pre-training and Fine-tuning
5. [Plottings: STL, MTL, GradNorm, Focused \(RM TL\), FineTuning](#)

Transfer Learning Settings	Related Areas	Source Domain Labels	Target Domain Labels	Tasks
<i>Inductive Transfer Learning</i>	Multi-task Learning	Available	Available	Regression, Classification
	Self-taught Learning	Unavailable	Available	Regression, Classification
<i>Transductive Transfer Learning</i>	Domain Adaptation, Sample Selection Bias, Co-variate Shift	Available	Unavailable	Regression, Classification
<i>Unsupervised Transfer Learning</i>		Unavailable	Unavailable	Clustering, Dimensionality Reduction

