

Deeplearning4j 实战（9）：强化学习 -- Cartpole任务的训练和效果测试

分享： 0 来源：wangongxi 阅读：19 时间：2017-07-12 16:48

在之前的博客中，我用Deeplearning4j构建深度神经网络来解决监督、无监督的机器学习问题。但除了这两类问题外，强化学习也是机器学习中一个重要的分支，并且Deeplearning4j的子项目--RL4j提供了对部分强化学习算法的支持。这里，就以强化学习中的经典任务--Cartpole问题作为学习RL4j的入门例子，讲解从环境搭建、模型训练再到最后的效果评估的结果。

Cartpole描述的问题可以认为是：在一辆小车上竖立一根杆子，然后给小车一个推或者拉的力，使得杆子尽量保持平衡不滑倒。更详细的描述可参见openai官网上关于Cartpole问题的解释：
<https://gym.openai.com/envs/CartPole-v0>

接着给出强化学习的一些概念：environment，action，reward

environment：描述强化学习问题中的外部环境，比如：Cartpole问题中杆子的角度，小车的位置、速度等。

action：在不同外部环境条件下采取的动作，比如：Cartpole问题中对于小车施加推或者拉的力。action可以是离散的集合，也可以是连续的。

reward：对于agent/network作出的action后获取的回报/评价。比如：Cartpole问题中如果施加的力可以继续让杆子保持平衡，那reward就+1。

在描述reward这个概念时，提到了agent这个概念，在实际应用中，agent可以用神经网络来实现。

对于强化学习训练后的agent来说，学习到的是如何在变化中的environment和reward选择action的能力。通常有两种学习策略可以选择：Policy-Based和Value-Based。Policy-Based直接学习action，通过Policy Gradient来更新模型参数，而相对的，Value-Based是最优化action所带来的reward（action-value function，Q-function）来间接选取action。一般认为如果action是离散的，那么Value-Based会优于Policy-Based，而连续的action则相反。在这里主要讨论Value-Based的学习策略，或者更具体的说Q-learning的问题。对于Policy-Based还有Model-Based不做讨论。

Q-learning的概念早在20多年前就已经提出，再与近年来流行的深度神经网络结合产生了DQN的概念。Q-learning的目标是最大化Q值从而学习到选取action的策略。Q-learning学习的策略公式：

$$Q(s_t, a_t) \leftarrow Q(s_t, a_t) + \alpha[r_{t+1} + \lambda \max_a Q(s_{t+1}, a) - Q(s_t, a_t)]$$

对于这里主要讨论的Cartpole问题，我们也采用Q-learning来实现。

可以看到，与监督学习相比，强化学习多了action，environment等概念。虽然可以将reward类比为监督学习中的label（或者反过来，label也可以认为是强化学习中最终的reward），但通过action与environment不断的交互甚至改变environment这一特点，是监督学习中所没有的。在构建应用的时候，监督学习的学习的目标：label，灌入的数据都是一个定值。比如，图像的分类的问题，在用CNN训练的时候，图片本身不发生变化，label也不会发生变化，唯一变化的是神经网络中的权重值。但强化学习在训练的时候，除了神经网络中的权重会发生变化（如果用NN建模的话），environment、reward等都会发生动态的变化。这样构建合适正确的训练数据会比较麻烦，

👤 (<http://weibo.com/u/3933853639>)



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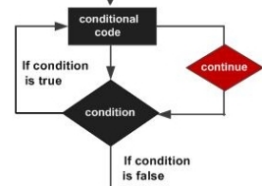


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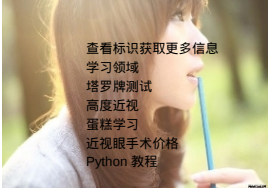
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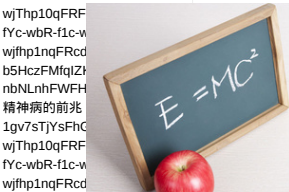


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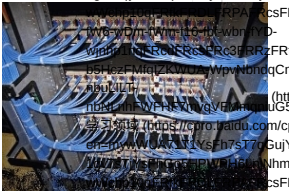
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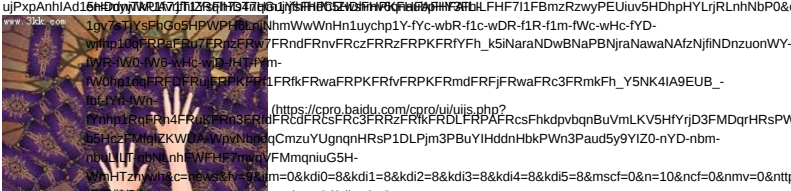


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