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CATX

A JAX implementation of the *"Efficient Contextual Bandits with Continuous Actions"* paper

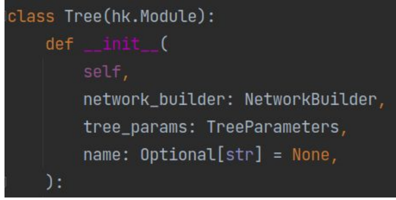
Tree

Tree

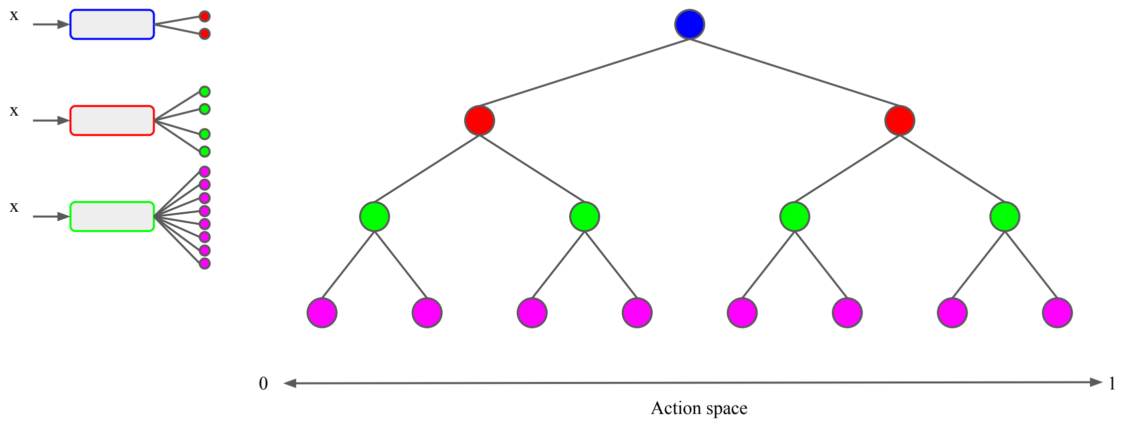
This example uses a tree of depth 3

At each depth there is neural network (depth 0: blue, depth 1: red, and depth 2: green)

Each neural network output layer dimension is 2^(depth+1)



```
class Tree(hk.Module):
    def __init__(
        self,
        network_builder: NetworkBuilder,
        tree_params: TreeParameters,
        name: Optional[str] = None,
    ):
```



Tree parameters

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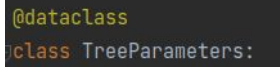
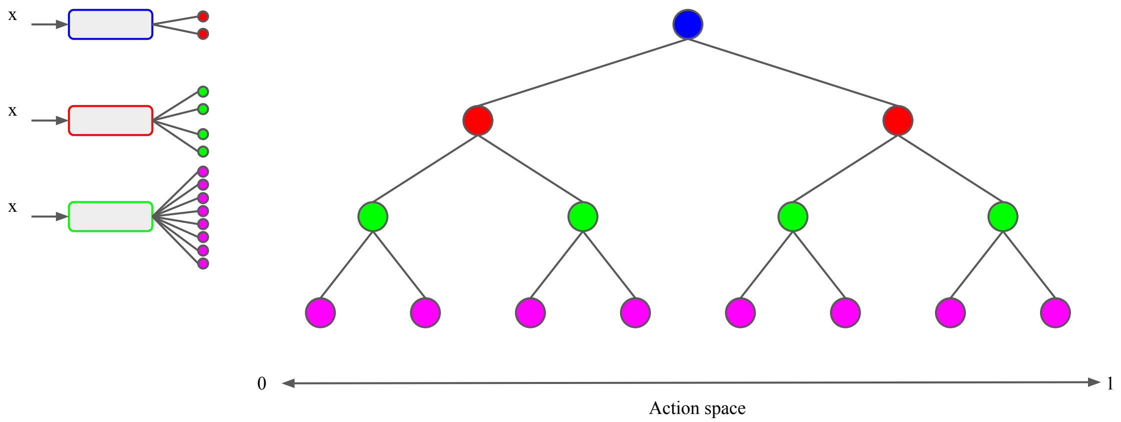
Tree parameters

action space



```
@dataclass
class TreeParameters:
```



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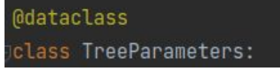
Tree parameters

action spaces: each discretized action centroid covers 2*bandwidth of the action space



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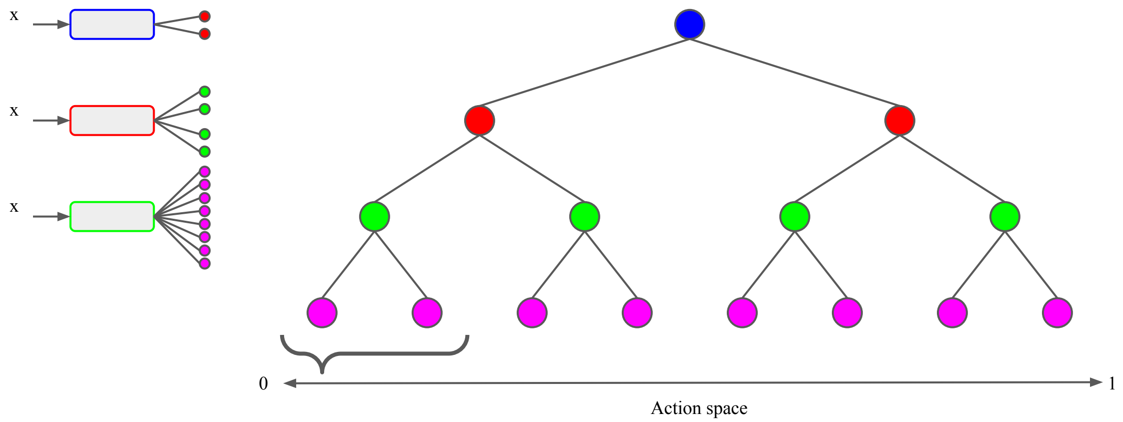
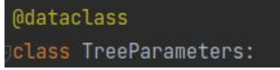


Tree parameters



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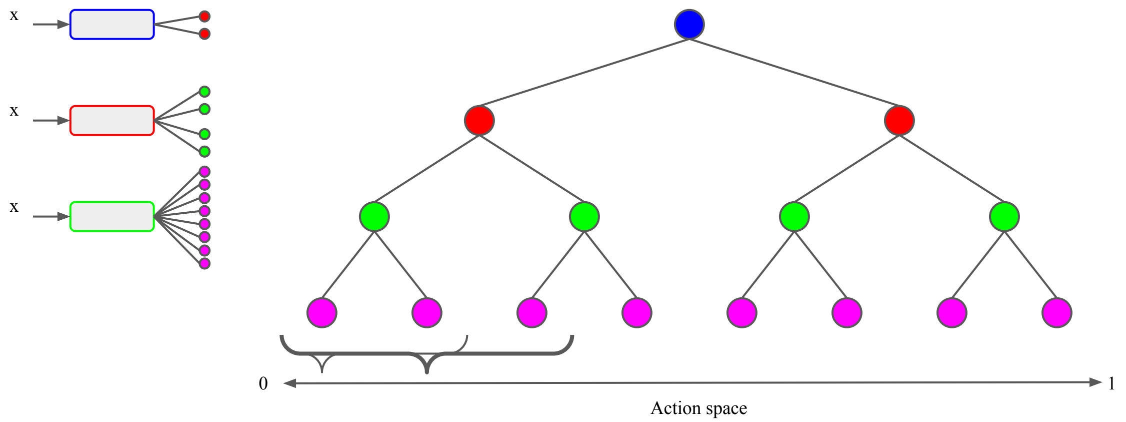

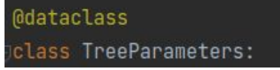

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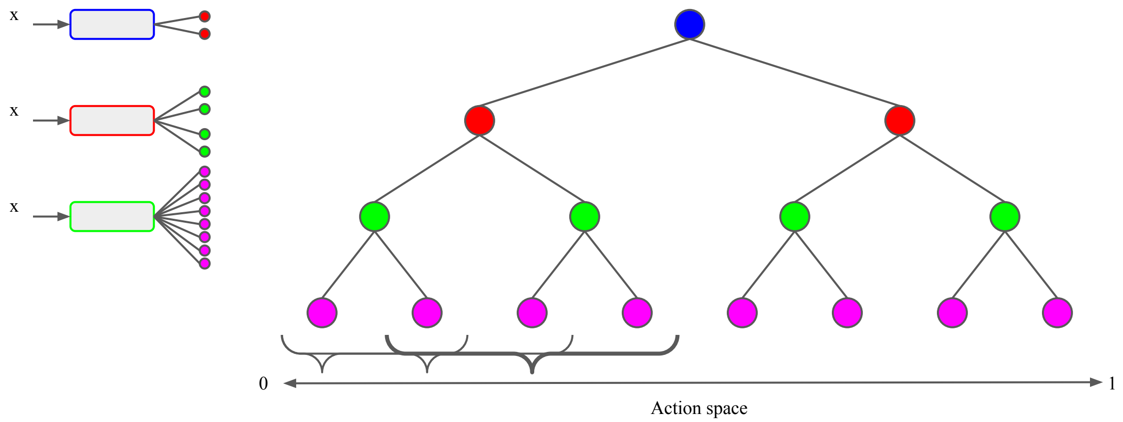

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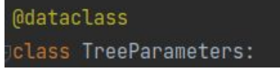
Tree parameters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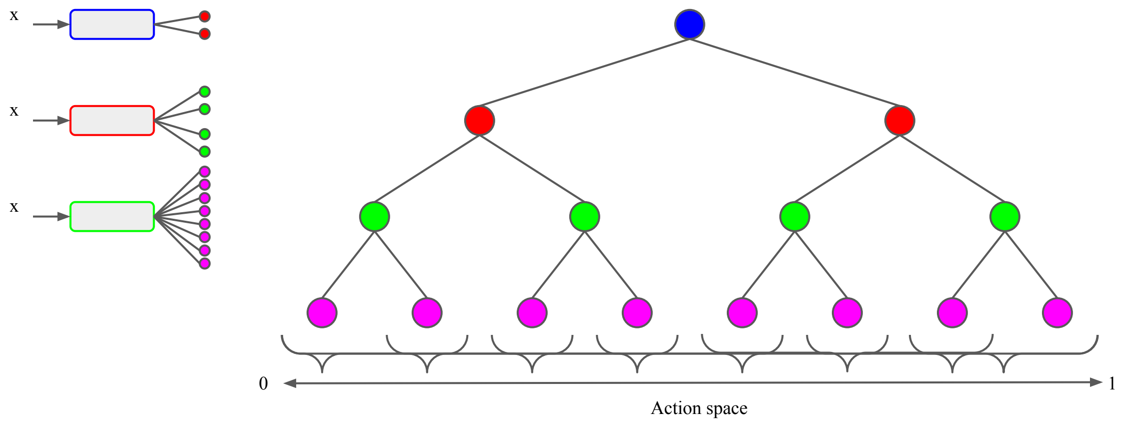

Action query

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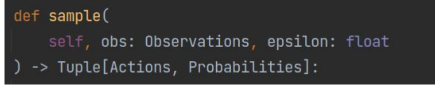
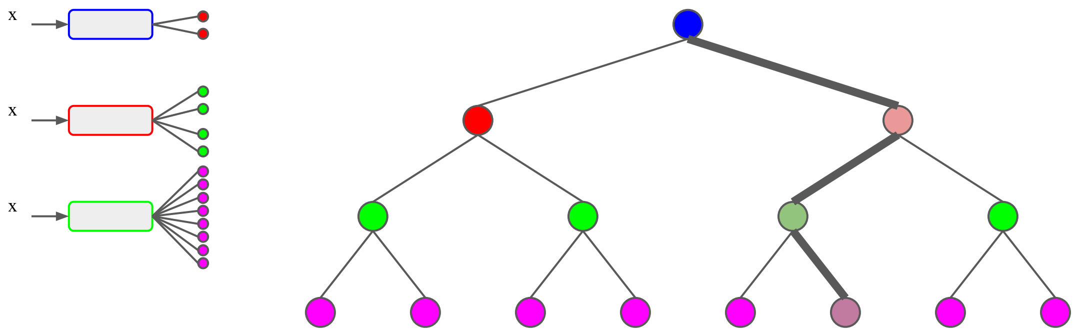
Action query

forward pass of the tree by following the max of the logits



```
def sample(
    self, obs: Observations, epsilon: float
) -> Tuple[Actions, Probabilities]:
```



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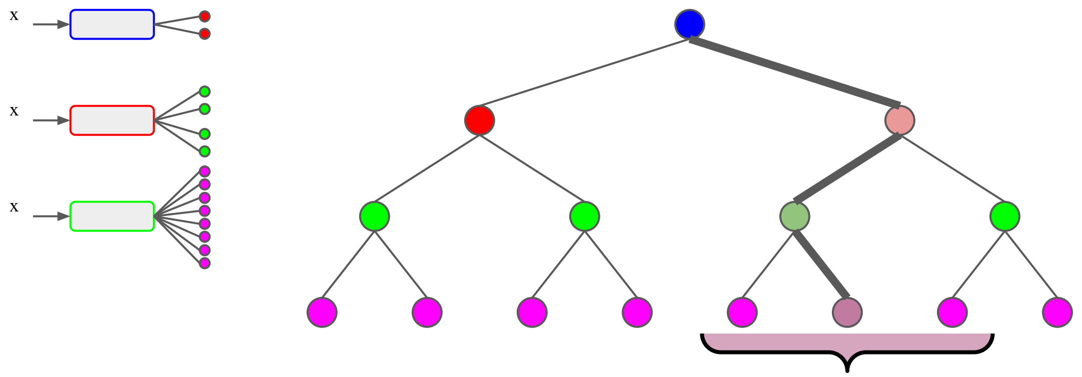
Action query

sample an action with eps-greedy

```
def sample(
    self, obs: Observations, epsilon: float
) -> Tuple[Actions, Probabilities]:
```



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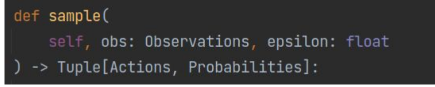
Action query

sample an action with eps-greedy



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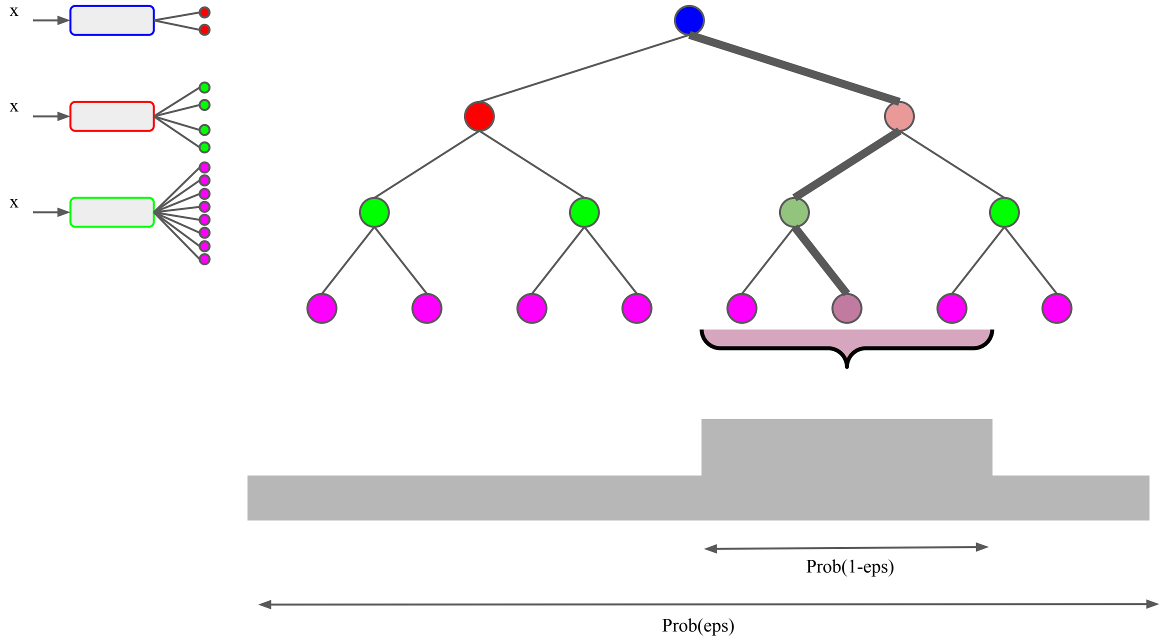

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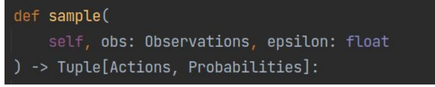
Action query

sample an action with eps-greedy



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    self, obs: Observations, epsilon: float
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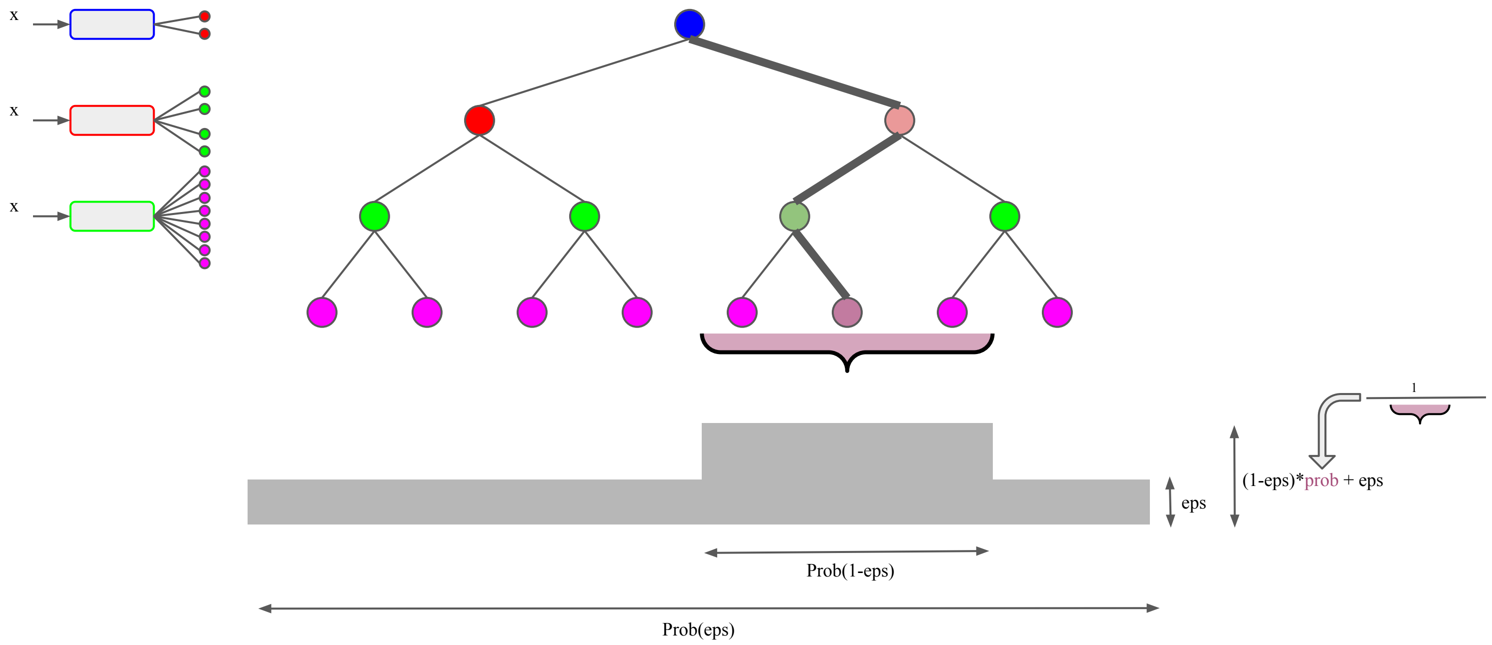

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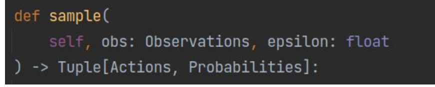
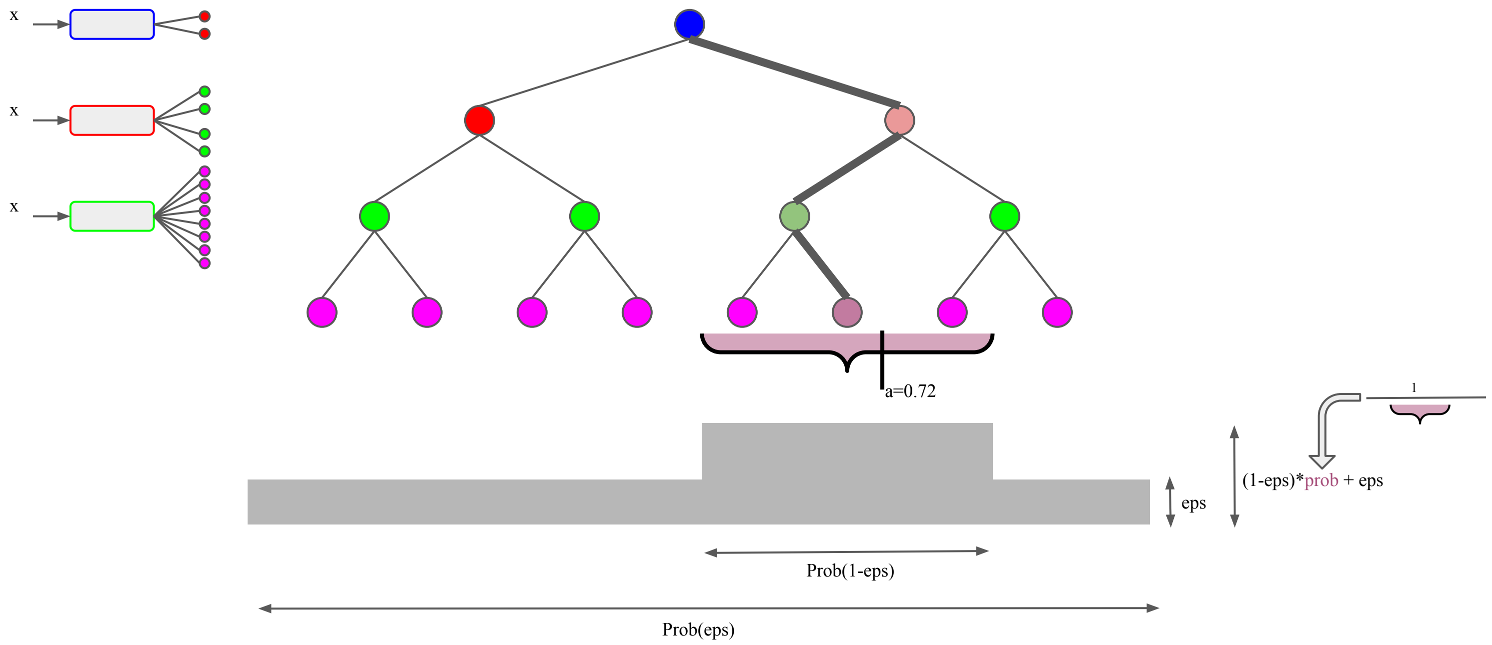
Action query

sample an action with eps-greedy (example: a=0.72)



```
def sample(
    self, obs: Observations, epsilon: float
) -> Tuple[Actions, Probabilities]:
```



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Action cost

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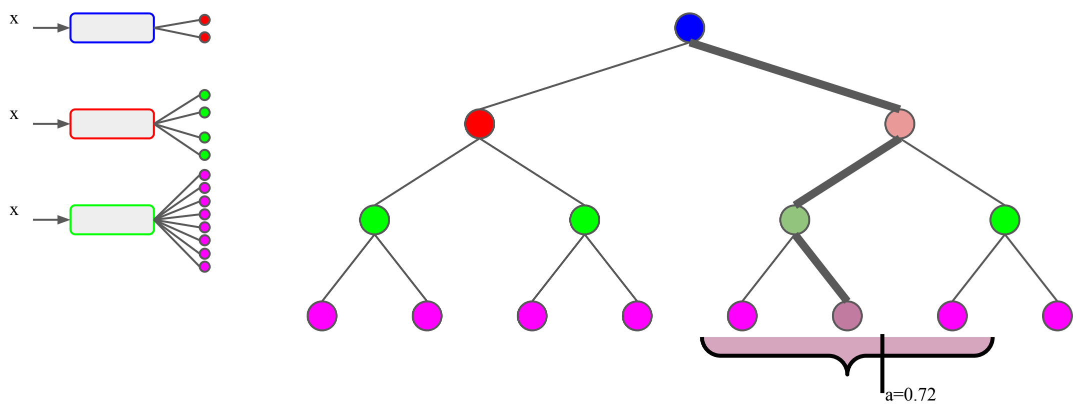
Action cost

apply action in the environment and receive cost feedback



Action cost

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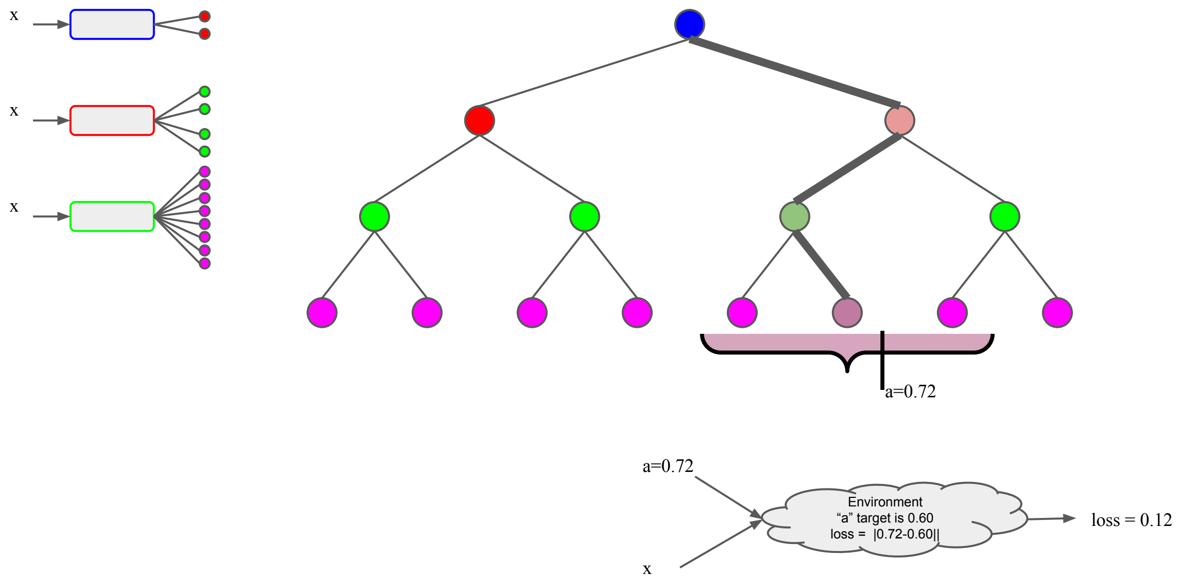

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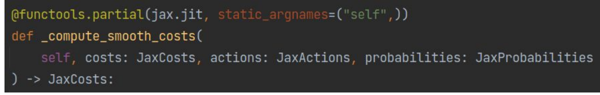
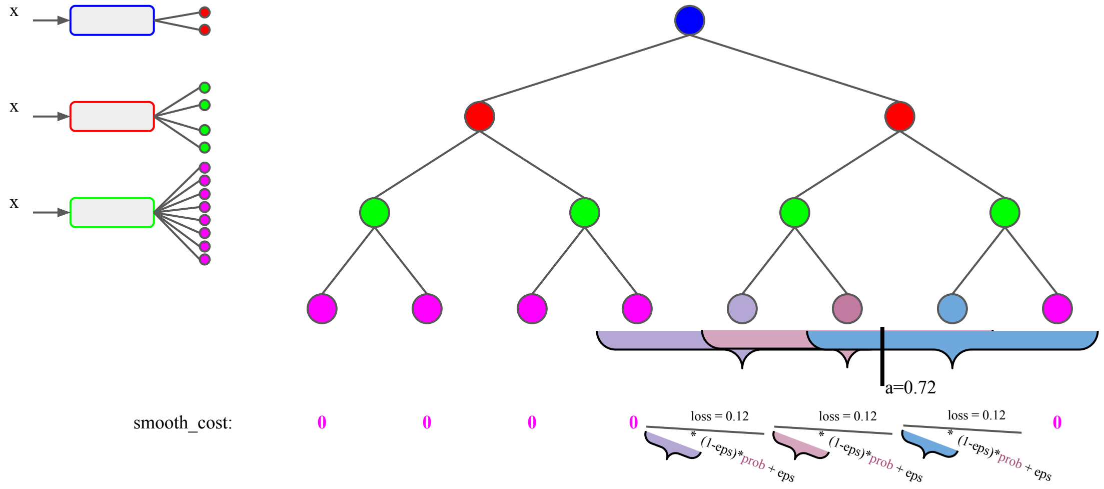
Action cost

smooth the cost across the discretized actions that could have generated the applied action



```
@functools.partial(jax.jit, static_argnames=("self",))
def _compute_smooth_costs(
    self, costs: JaxCosts, actions: JaxActions, probabilities: JaxProbabilities
) -> JaxCosts:
```



Update neural network weights

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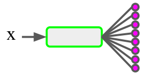
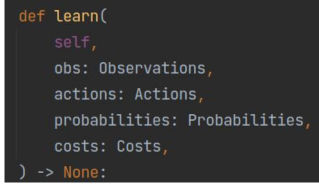
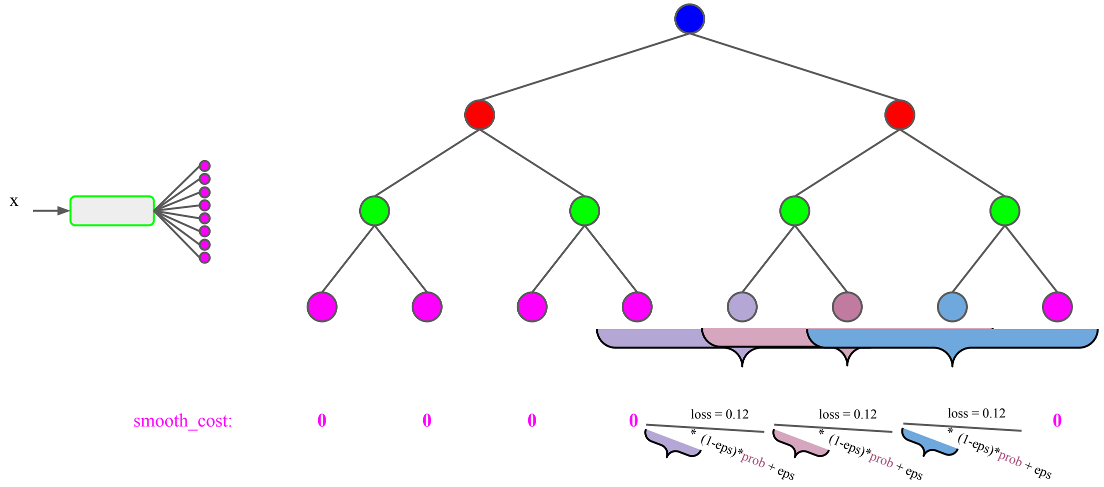
Update:





```
def learn(
    self,
    obs: Observations,
    actions: Actions,
    probabilities: Probabilities,
    costs: Costs,
) -> None:
```

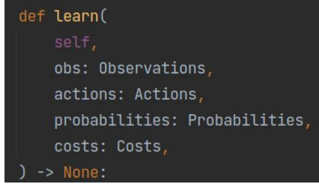


loss ft = sum(softmax(●●●●●●●●) * smooth cost)

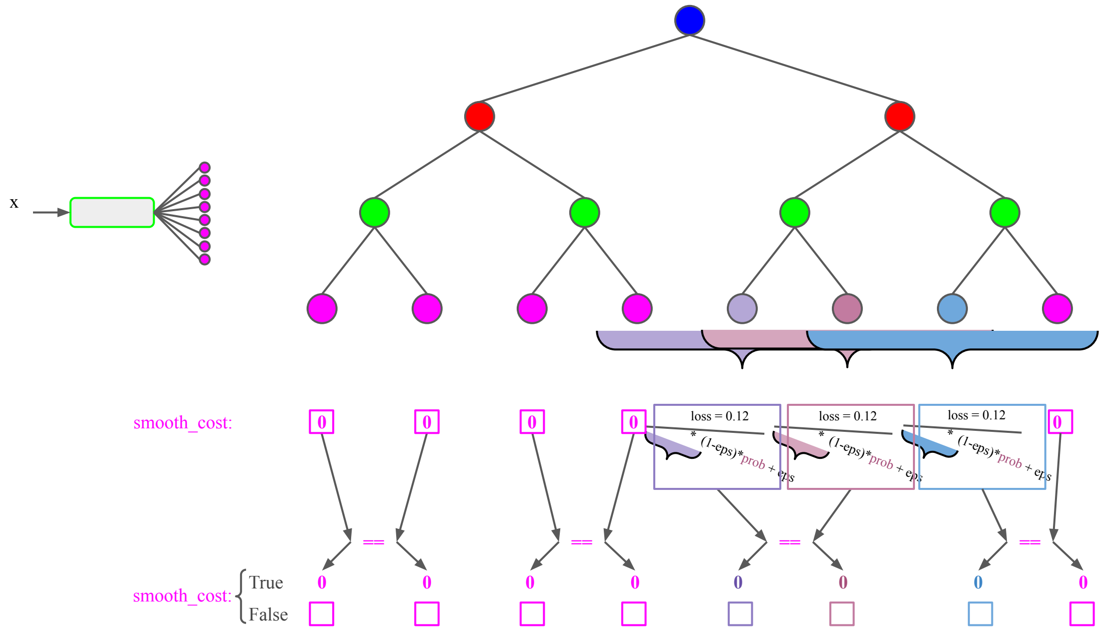
min(loss ft)

Update:

Only update nodes whose pair childs have different cost.



```
def learn(
    self,
    obs: Observations,
    actions: Actions,
    probabilities: Probabilities,
    costs: Costs,
) -> None:
```



loss ft = sum(softmax(●●●●●●●●) * smooth cost)

min(loss ft)

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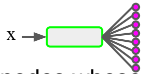
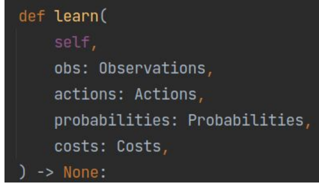
Update:



Only update nodes whose pair childs have different cost.
In this example:



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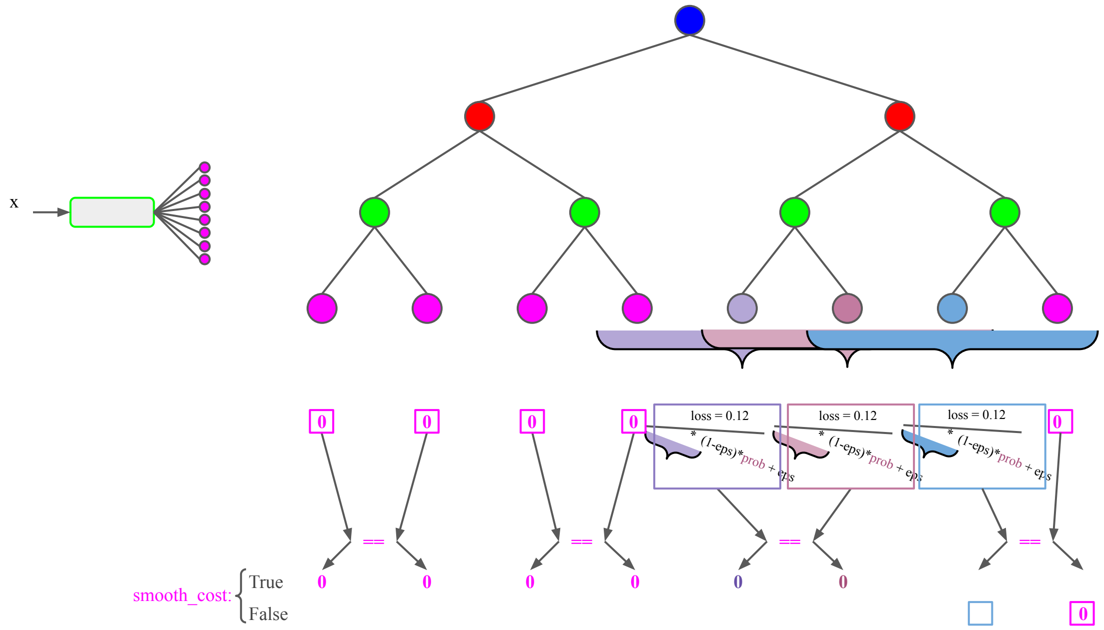

smooth_cost: $\begin{cases}\text{True} \\ \text{False}\end{cases}$

loss ft = sum(softmax(●●●●●●●●) * smooth cost)

min(loss ft)

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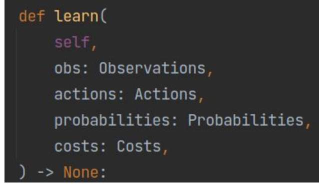
Update:

Only update nodes whose pair childs have different cost.
In this example:
Note: the softmax is performed pairwise



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    self,
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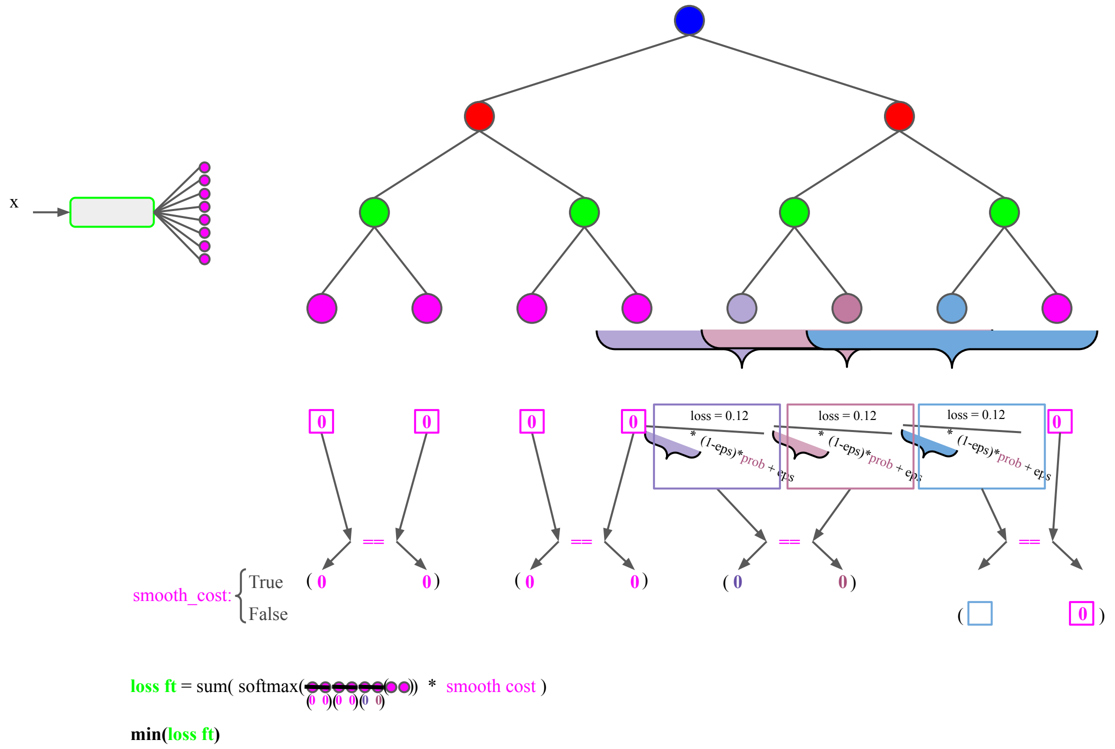
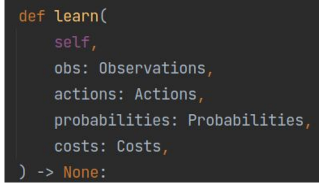


Update:



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def learn(
    self,
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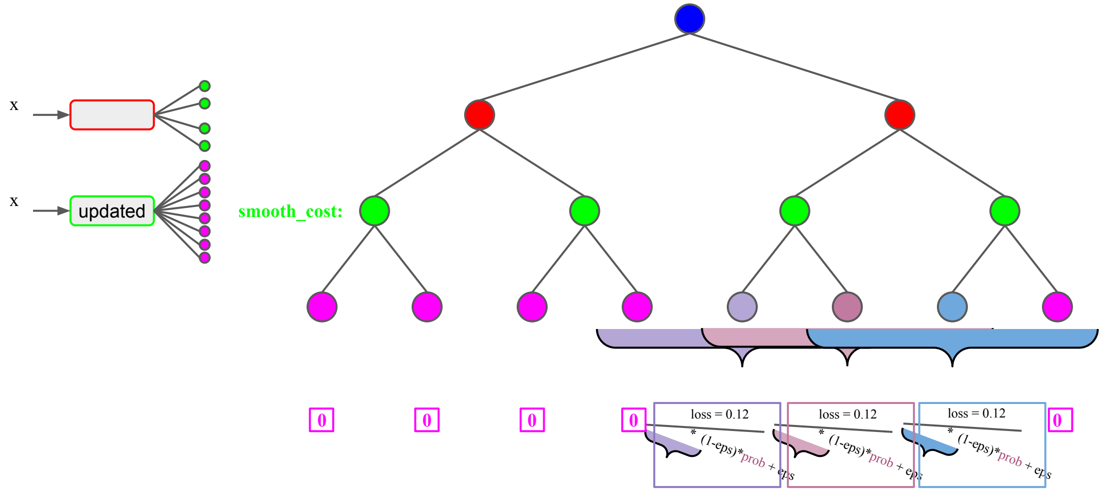
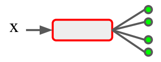
    actions: Actions,
    probabilities: Probabilities,
    costs: Costs,
) -> None:
```

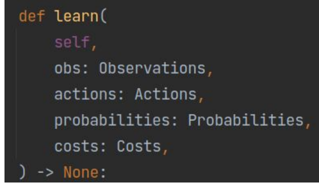


loss ft = sum(softmax((● ●) (● ●)) * smooth cost)

min(loss ft)

Update:





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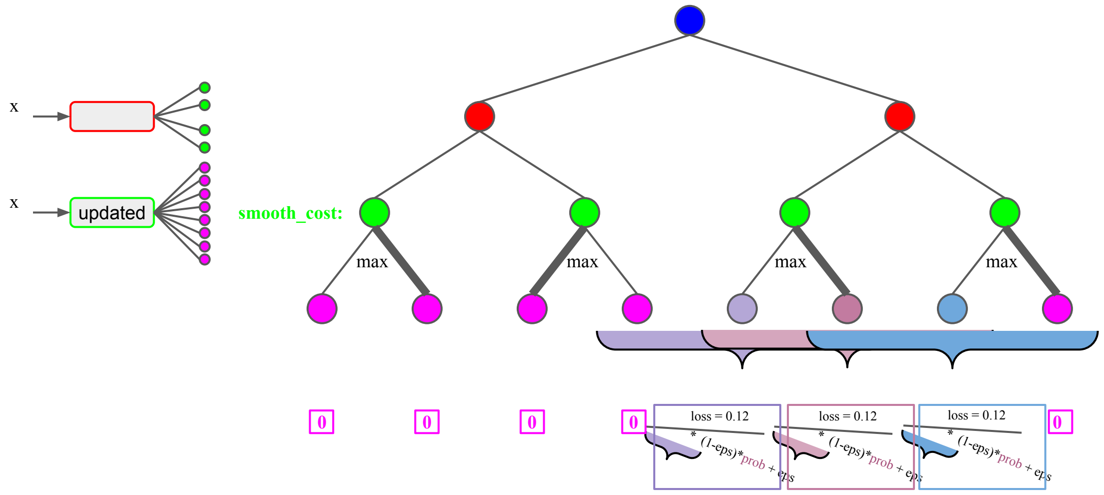
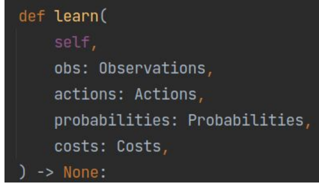


loss ft = sum(softmax((● ●) (● ●)) * **smooth cost**)

min(loss ft)

Update:



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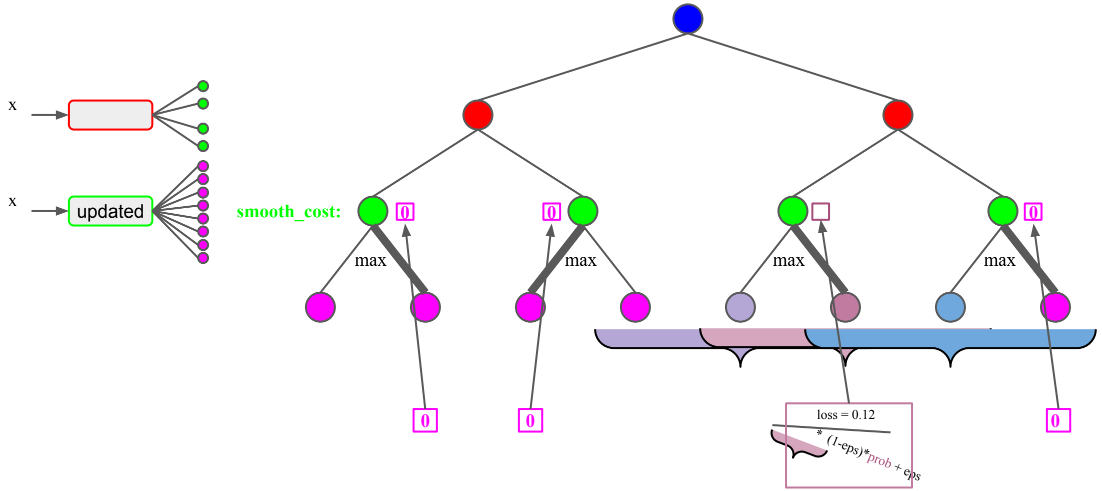

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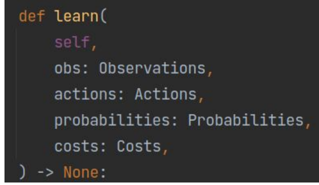
Update:



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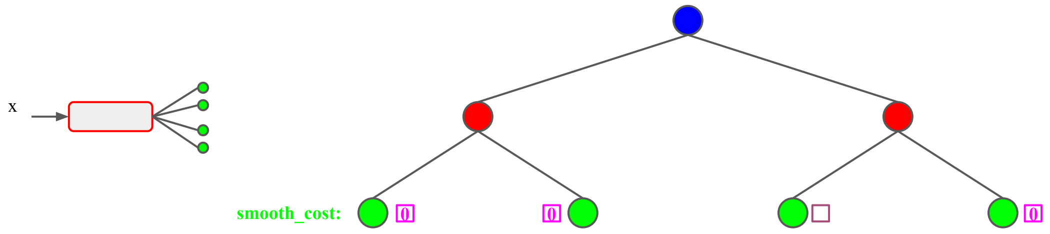

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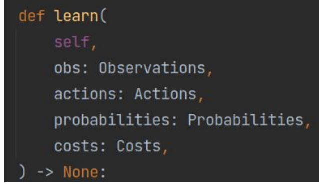

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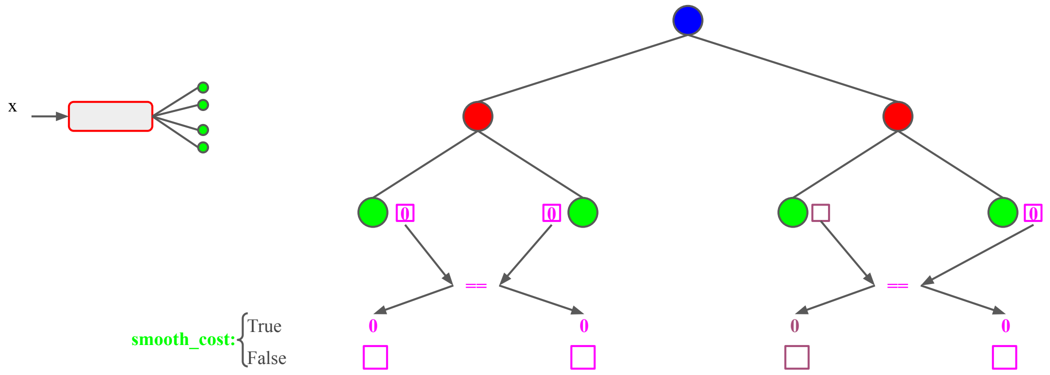

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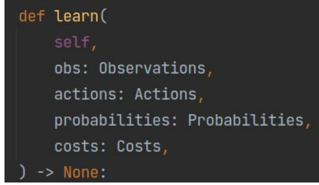

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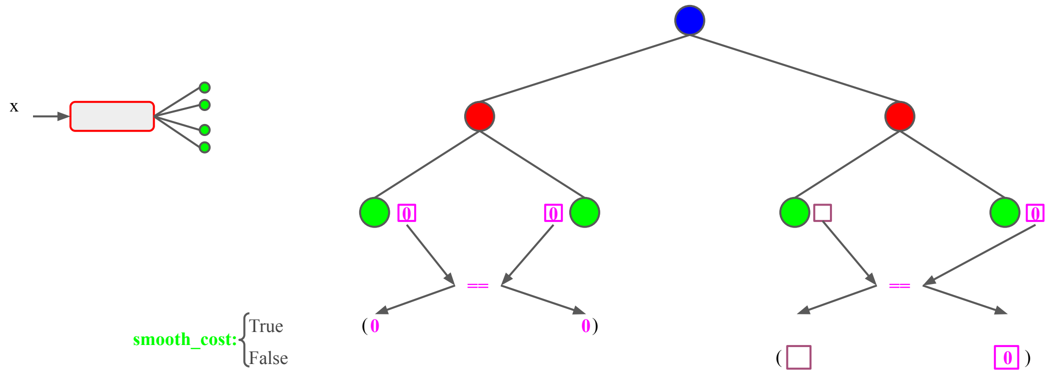

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min(loss ft)

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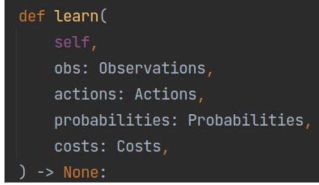

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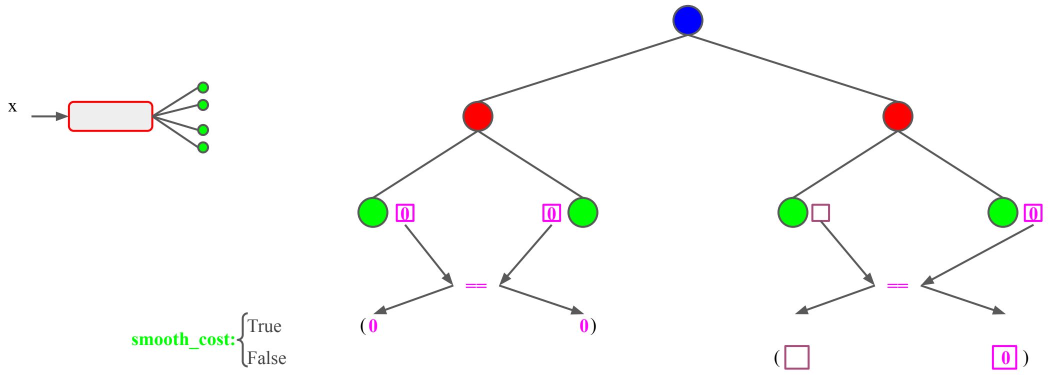

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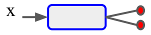

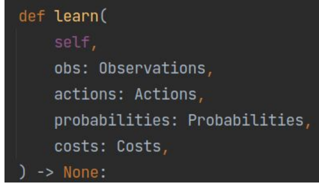

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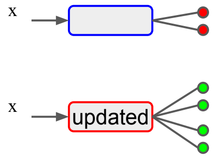

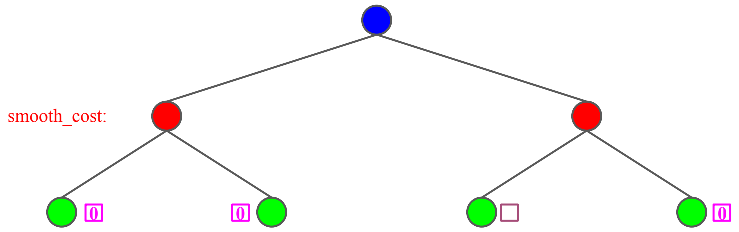

loss ft = sum(softmax(● ●) * smooth cost)

min(loss ft)

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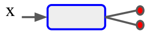
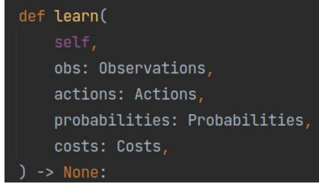
Update: 



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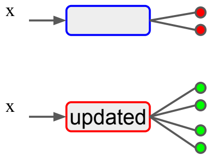

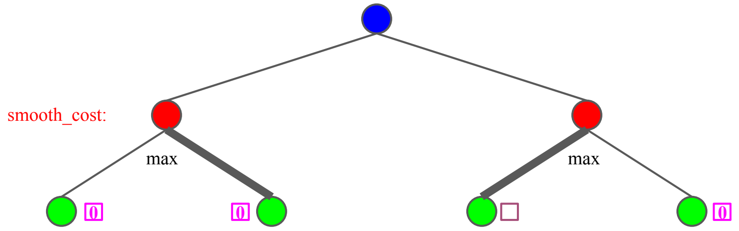

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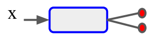
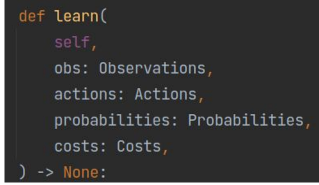
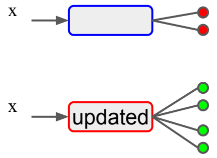
min(loss ft)

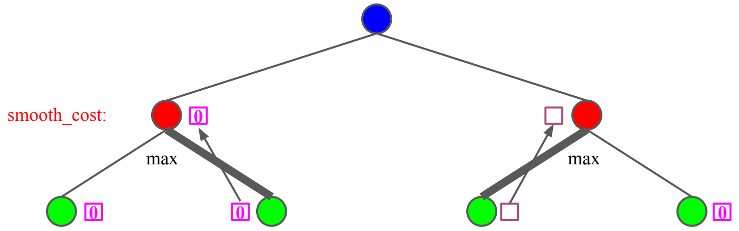
Update:





```
def learn(
    self,
    obs: Observations,
    actions: Actions,
    probabilities: Probabilities,
    costs: Costs,
) -> None:
```





loss ft = sum(softmax(● ●) * smooth cost)

min(loss ft)

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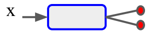
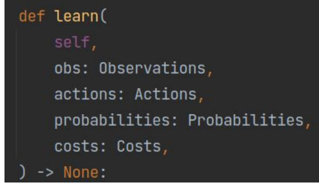
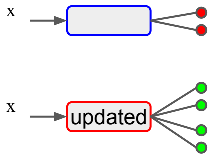
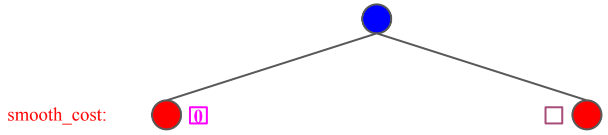
Update:





```
def learn(
    self,
    obs: Observations,
    actions: Actions,
    probabilities: Probabilities,
    costs: Costs,
) -> None:
```





loss ft = sum(softmax(● ●) * smooth cost)

min(loss ft)

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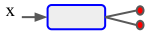
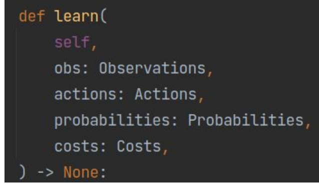
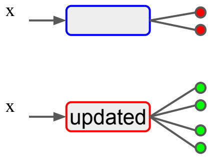
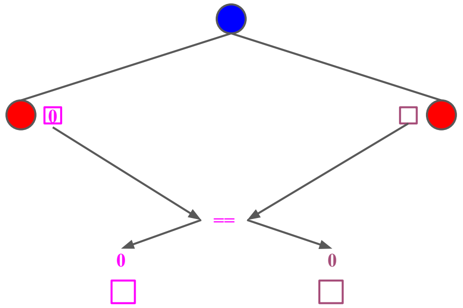
Update:





```
def learn(
    self,
    obs: Observations,
    actions: Actions,
    probabilities: Probabilities,
    costs: Costs,
) -> None:
```

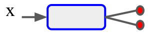


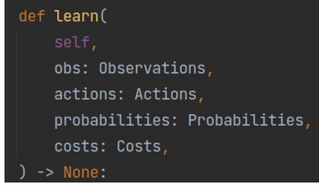


smooth_cost: {True, False}

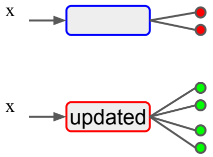
loss ft = sum(softmax(● ●) * smooth cost)

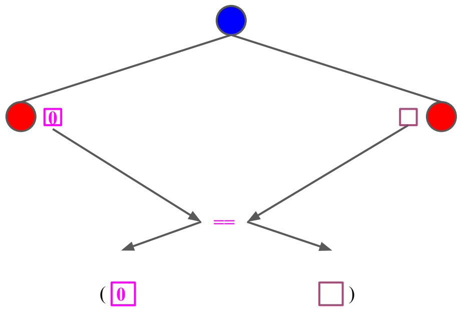
min(loss ft)

Update: 



```
def learn(
    self,
    obs: Observations,
    actions: Actions,
    probabilities: Probabilities,
    costs: Costs,
) -> None:
```



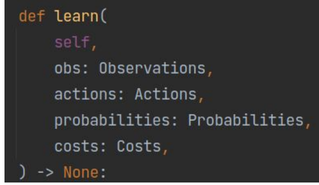


smooth_cost: $\begin{cases}\text{True}\\\text{False}\end{cases}$

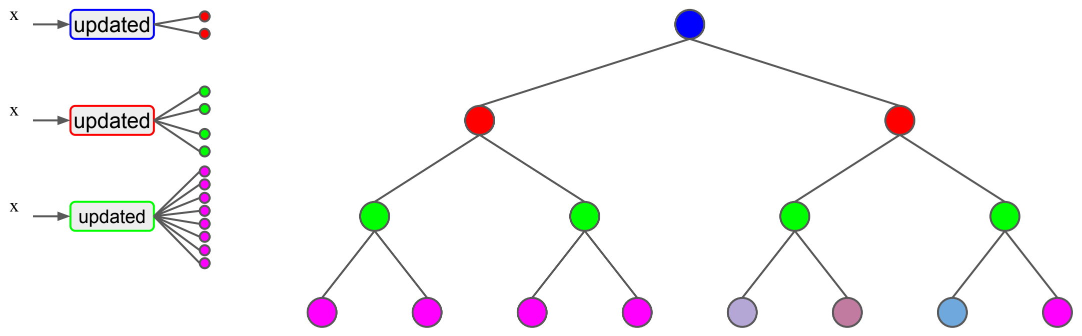
loss ft = sum(softmax((● ●)) * smooth cost)

min(loss ft)

Update:



```python
def learn(
    self,
    obs: Observations,
    actions: Actions,
    probabilities: Probabilities,
    costs: Costs,
) -> None:
```



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