

finance

- quants : portfolio calculations
- trading: hold,sell,buy
(HFT)

hedge funds

A $120/100x * 5$

B $85/100y * 5$

long short : $120/100 x * 5 * 12$ long
 $85/100y * 5 * 3$ short

- BFSI - IBs (they account for market inflation, risks and exchange defaults), hedge funds (risky)

weight

- Timeseries (statistical /math modelling)
- * Model this trading (RL environment)

IPO s - going public - listed in stock exchange
demand of the shares

RL : (What will we see today?? Train a DQN for trading on S&P ??)

Env : can be anything (States)

Agent : is ass. following actions and remembering (DL)

Rewards : functions

Actions: based on a set of environmental conditions bot will take actions

reward +=100

stop episode

- crash

if car.pos >u_thresh Camera mounted on car pos > both (Agent) obs.pos:

reward -=50

RL is simulation of a robot to maximise rewards

playground lot of obstacles (posts,signals) (Env)

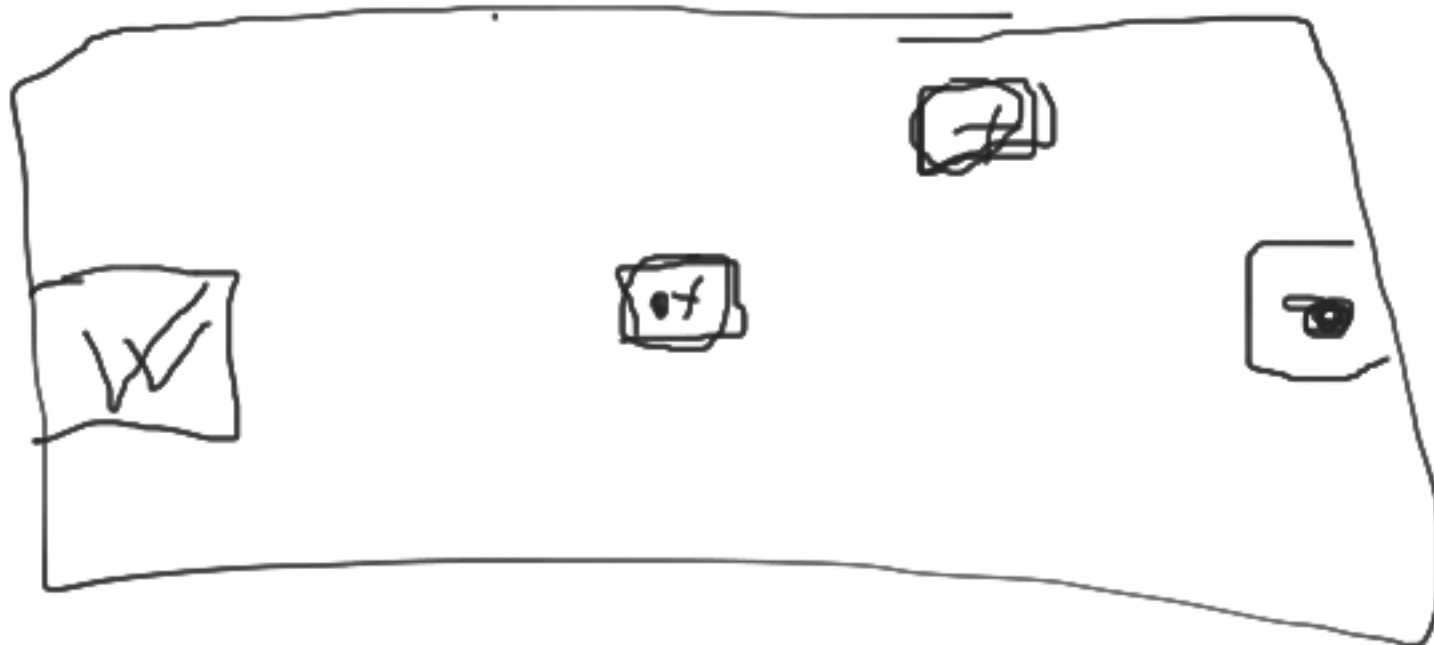
Reward->??? Action

reward functions -> actions

- go in opposite direction

pseudocode

if car.x >= location.x && car.y >=location.y



```
//reach the end  
if car.pos < u_thresh.pos && car.pos>l_thresh.pos  
    reward +=100  
    stop episode
```

- crash

```
if car.pos <u_thresh_obs.pos && car.pos > l_thresh_obs.pos:  
    reward -=50
```

- do not go out of field

```
if car.pos >u_thresh_field.pos && car.pos < l_thresh_field.pos:  
    reward +=25
```

- go in opposite direction

distance measure

```
if(car.pos- u_thresh.pos)<thresh  
    reward+=40  
else:  
    reward-=20
```

- give a small reward for moving car.pos in direction of thresh_final.pos



minimise
the
directional
difference

acost, asint

acost1, asint1

- reward
stay
- penalty
make your
direction
correct!!

$$acost - acost1, asint - asint1$$

$$= a(cost - cost1)$$

```
if car.post.x - car.post1.x  
<thresh_radians:  
    reward+=15  
else:  
    reward-=15
```

```
(car.post.x = cost(tan-1(pos.y/pos.x)))
```

DRL:

(Model free RL)

- On policy
- Off policy

(Model Based RL) ~~~

2 functions:

Q V

Either you maximise the value function V - off policy (be quick)
or you maximise the policy Q to maximise the V - on policy (actor critics)

discrete or continuous - off policy in cont spaces is inefficient

Q Learning (Sutton & Bellman equations), SARSA

Temporal Difference Learning

Off policy - DQN

Also note: In RL we take expectations of rewards rather than only rewards
 $E[f(x)]$ not $f(x)$



$$f(x) = |x|$$

3 signals - B,H,S

Agent: Sequential Dense prediction of 3 softmax logits

memory: a container for previous observations

cache memory: 30 % of previous observations recent (buffer)

actions: predict probabilities

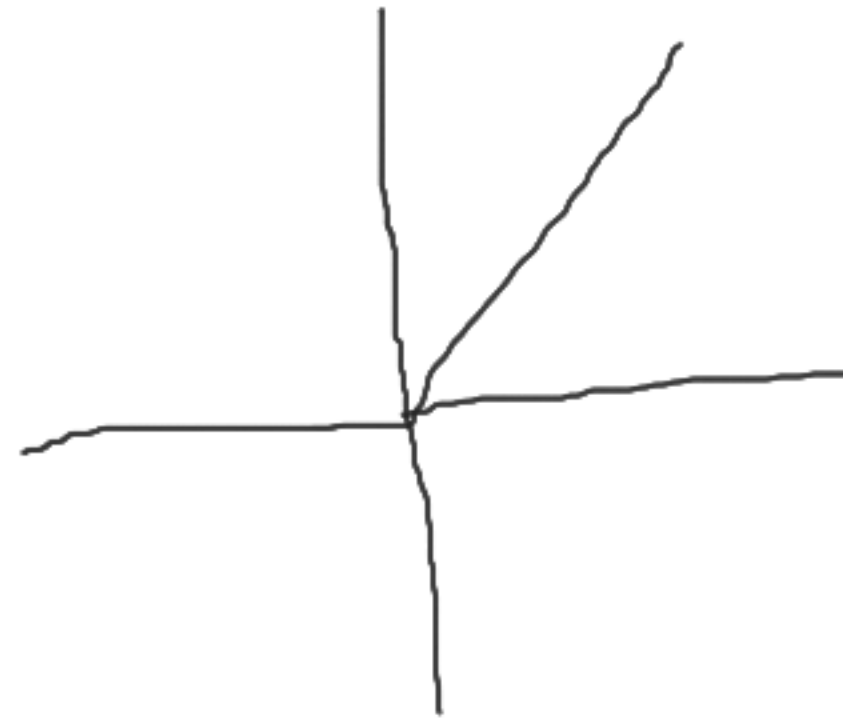
learn: update agents memory ,states

(update your capital) $f(x) = x$ for all $x > 0$

$f(x) = 0$ otherwise

relu

Can we do derivatives??????



Memory: states, actions, past rewards, next steps , met my goal

For off policy there is always an experience replay ????

Bcs in DQN we need to Agent to perform everything

states -> actions (3) -> rewards (+/-R) -> next_steps(3) ->done(T/F)

DQN is very optimistic

does not account for margins of errors

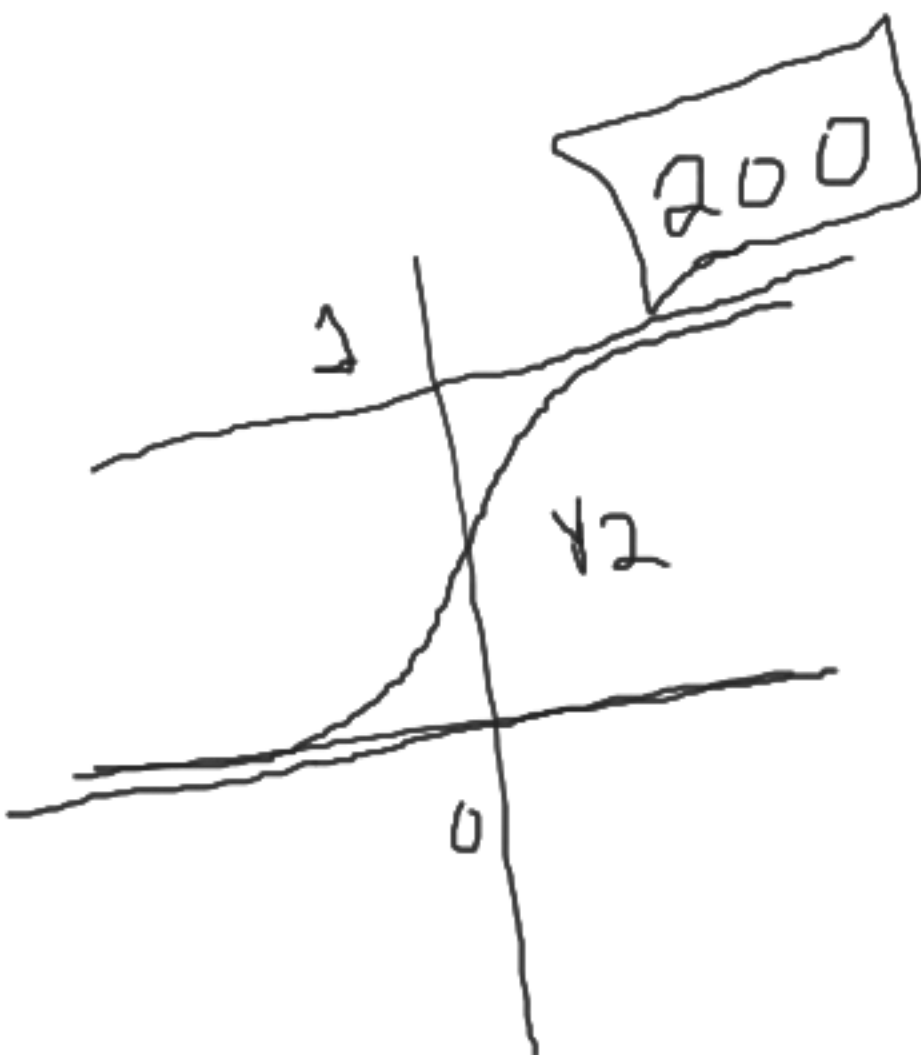
Agent will have 2 brains

updating the weights from second brain to the first brain -> ??? margin of error found by the second brain is now updated in the first brain . Now the first brain knows the errors which might have come had he bought at 7 and sold at 10

brain->model() DQNs

second brain->target model() DQNs

DDQN -> they are not competing against each other



Environment -? Portfolio
 Capital
 Stock (1)
 Quantity
 previous stock prices (upto certain timesteps)
 -> dates
 previous rewards

Operations:
 env update operations
 reset_portfolio ?????? -> on completion of episode (agent reaches the target)

generate price
 related to reward differences between the Agent and the env/portfolio ??
 NN -> bias , forgetting

$\lim_{x \rightarrow \infty} n^x / x^n$

$E[f(x)] = E[x(t) + \gamma (x(t-1)) * \text{scalar values}]$
 policy gradients -> starting point of on policy

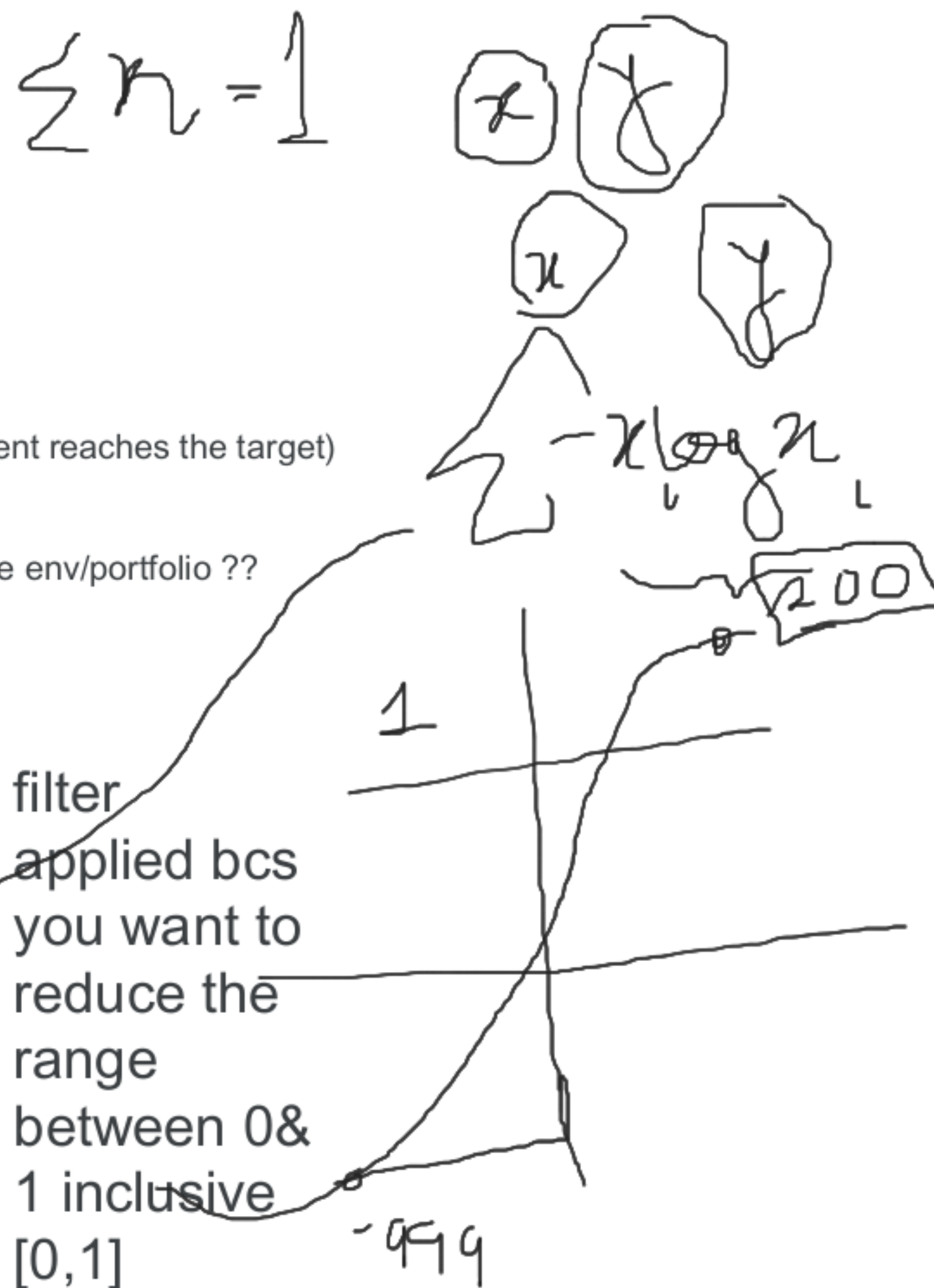
sigmoid: ???
 $1/(1+e^{(-x)}) = f(x)$
 $\lim_{x \rightarrow \infty} f(x) = 1$

$$\frac{e^{x_i}}{\sum e^{x_i}} = \text{softmax}$$

$$1 = 1 + e^{(-x)}$$

$$e^{(-x)} = 0$$

filter
 applied bcs
 you want to
 reduce the
 range
 between 0 &
 1 inclusive
 $[0, 1]$



Env :

Train script

pseudocode:

Agent should be able to buy and sell
agent should be able to predict (agent.act())
agent should be able to update the weights
agent.experience _replay()
agent needs to update its history/memory
agent.remember()

Env:

stock[buydate] ,stock[enddate]

based on the rewards Agent is getting

env.reset()

env.generate_()

inherit parameters from portfolio -> scalars like balance etc

- there should be a training loop iterating upto the number of episodes provided

for i in training_iter:

do

agent.reset()

states=env.generate_()

while(j<trading_days):

do

set reward to 0

state=env.generate_()

get prev_portfolio_value()

Agent.forward() -> agent.act(state)

agent.buy() | agent.sell() | agent.hold()

if agent.missed_opportunity():

agent.penalize()

agent.get_rewards()

if agent.rewards()==threshold:

j++

#other functions for plotting.tb what not

sum of any three non recurring
real numbers where all are equal $\neq 1$ $[0,1]$

(True)

$3x=1$

$x = 1/3 \text{ R}$

$$1/3 =$$

[illegible]

at any time atleast one value $>$ greater than other 2

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states=env.generate_()

for j in trading_days:

do

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Training script as it is ...

When 2 brains are competing against each other

$$Q=v+A$$

uptil D2QNs , $Q=v$
advantage A

$$A=Q-v$$

Dueling DDQN

for some simulations D3QN > D2QN (more rewards)

Never ending dueling creates stagnation

D3QN

$$Q=V+ \max(A- 1/|A|<A>)$$

$A \rightarrow$ policy based methods (on policy)

On policy methods

policy person(brains??) + Agent (brains ???)

A

$$Q=V+A$$

actor critics

policy gradients -> minimise the advantage loss

$$A=Q-V =$$

increase the $E[A]$

- gradient descent
- gradient ascent

Q up and V down

A up

policy guy -> his eestimated returns are quite higher than the Agents returns --T/
F??

(Agent becomes the Actor)

When you have -rewards

A -> negative

Q down -V up ??

(policy guy becomes Actor)

$$r(t) + \gamma(r(t-1)) = R(t) = \text{discrete}$$

Bellman eq: $Q = V(t) + R(t)$

$$r(t) + \gamma(V(t-1)) = Q(t)_{\text{updated}}$$

$$A(t) = Q(t) - V(t)$$

$$= r(t) + \gamma(v(t-1)) - v(t)$$

$$= E[()]$$

(optima curve)

$$\max(A(t)) : ???$$

$$- d(v(t))/d(t)$$

- continuously differentiable within the same range

- curl should exist

$$J(t) = E[Q(t) \cdot \pi(t)] \rightarrow \text{gradient ascent}$$

$$\text{param update} = s(t+1) = s(t) + \text{scalar} * J(t)$$

Actor Critic Model

3 actions : B,H,S

Ingredients:

(Env and all are static)

- Actor Network (GD)
- Critic Network (GA)
- Synchronizing Module

pseudocode

- Actor pseudocode
 - def network():
Dense()
mse loss with adam
model
 - def weight_update():
return gradients([action,states])
- Critic psuedocode
 - def network():
return model
 - def weight_update():
return gradients([actions,states]) (added up ?????)
- def weight_transfer():
weight_update(actor)
weight_update(critic)

Combined ACAgent()

- Actor class
- Critic Class

AcAgent.actor
Acagent.critic

- there should be a training loop iterating upto the number of episodes provided

```
for i in training_iter:
```

```
do
```

```
    AcAgent.actor.reset()
```

```
    AcAgent.critic.reset()
```

```
    states=env.generate_()
```

```
    for j in trading_days:
```

```
        do
```

```
            set reward to 0
```

```
            state=env.generate_()
```

```
            get prev_portfolio_value()
```

```
            Agent.forward() -> agent.act(state)
```

```
            agent.buy() | agent.sell() | agent.hold()
```

```
            if agent.missed_opportunity():
```

```
                agent.penalize()
```

```
            env.update()
```

```
            if agent.rewards()==threshold
```

```
                do
```

```
                    agent.update()
```

```
                    end episode
```

ac -> you dont have memory?? no
cache memory ?

off policy:
C51
Rainbow

on policy:
AC
A3c, TRPO, P
PO, SAC

Timeseries
Arima, arima
x,
DQNs to
solve
timeseries

