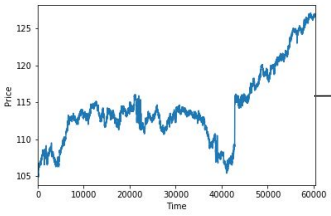
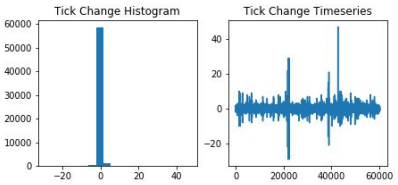
Market Making 3 Ways

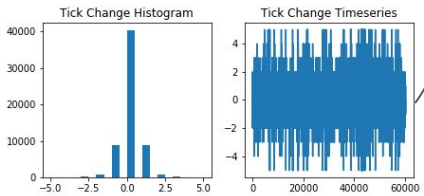
Real World Transaction Data!



Transform



Smooth



Simplify the Dynamics

	-4	-3	-2	-1	0	1	2	3	4
-4	0.00	0.00	4.21	7.37	35.79	14.74	7.37	12.63	17.89
-3	0.00	0.55	2.76	6.63	35.91	16.02	16.57	17.13	4.42
-2	0.11	0.33	1.54	4.63	40.02	29.99	20.73	1.54	1.10
-1	0.02	0.10	0.37	3.28	57.91	35.39	2.45	0.41	0.07
0	0.08	0.16	0.70	11.17	74.12	12.34	1.15	0.20	0.08
1	0.08	0.07	2.38	40.30	52.54	3.88	0.55	0.10	0.10
2	1.35	4.25	30.91	36.10	23.86	2.18	1.04	0.21	0.10
3	6.56	23.50	29.51	10.93	22.95	4.37	1.09	0.00	1.09
4	33.33	16.09	8.05	2.30	36.78	3.45	0.00	0.00	0.00

Dynamic Programming Object Specification

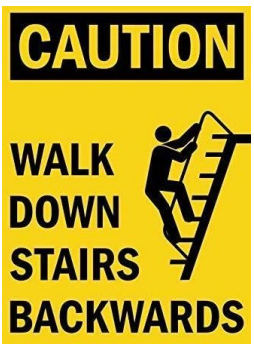
$$x_k = (x_{1,k}, x_{2,k}, x_{3,k})$$
$$u_k = (u_{1,k}, u_{2,k}, u_{3,k}, u_{4,k})$$

$$g_N(x_N) = x_{2,N} \qquad g_k(x_k, u_k, w_k) = \begin{cases} \frac{x_{2,k}}{|x_{1,k}|} + 0.05 & \text{if } w_k \le u_{1,k} \text{ and } x_{1,k} < 0 \\ \frac{x_{2,k}}{|x_{1,k}|} + 0.05 & \text{if } w_k \ge u_{3,k} \text{ and } x_{1,k} > 0 \\ -0.1x_{1,k}^2 & \text{if } x_{2,k} \ne 0 \\ 0 & \text{otherwise} \end{cases}$$

$$x_{1,k+1} = \begin{cases} x_{1,k} + 1 & \text{if } w_k \le u_{1,k} \\ x_{1,k} - 1 & \text{if } w_k \ge u_{3,k} \\ x_{1,k} & \text{otherwise} \end{cases} \qquad x_{2,k+1} = \begin{cases} \lfloor (1 - \frac{1}{|x_{1,k}|})(x_{2,k} + x_{1,k}w_k) \rfloor & \text{if } w_k \le u_{1,k} \text{ and } x_{1,k} < 0 \\ \lfloor (1 - \frac{1}{|x_{1,k}|})(x_{2,k} + x_{1,k}w_k) \rfloor & \text{if } w_k \ge u_{3,k} \text{ and } x_{1,k} > 0 \\ x_{2,k} + x_{1,k}w_k & \text{otherwise} \end{cases}$$

$$J_k(x_k) = \max_{u \in U_k} \mathbb{E}_w \{ g_k(x_k, u, w) + J_{k+1}(f_k(x_k, u, w)) \}$$

Back Recursion



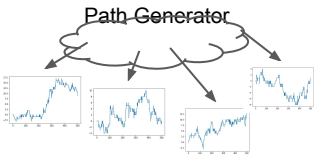
$J_N^*(\cdot)$

$J_{N-1}^*(\cdot)$

$J_{N-2}^*(\cdot)$

$J^*(\cdot)$

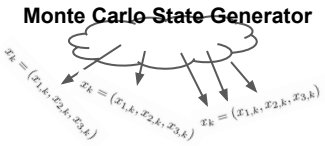
Rollout



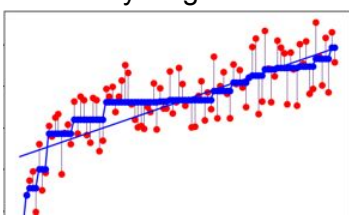
Algorithm 3: Monte Carlo Path Recursion - Function: deeper(x, totalcost, k)

```
if k == 2 then
    return totalcost
else
    U = subset(U_k(x))
    W = sample(p(·|x_3))
    for u in U do
        for w in W do
            x_{k+1} = f_k(x, u, w)
            cost_{+1} = g_k(x, u, w)
            deeper(x_{k+1}, totalcost + p(tick|x)cost_{+1}, k+1)
        end
    end
end
```

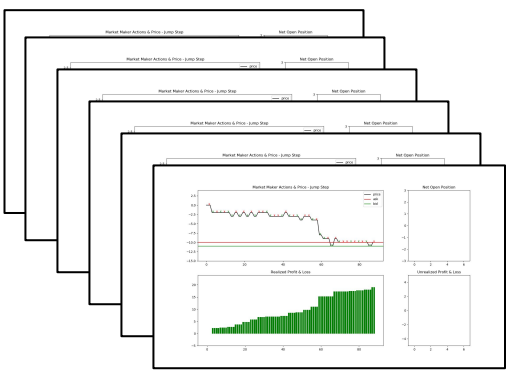
Parametric Approximation



Learn by Regression



Visualize



Compare

Path Name	uptrend	downtrend	no_change	high_vol	low_vol	avg_vol
Num. Trades	50.00	42.00	48.00	48.00	48.00	50.00
Closing Trades	50.00	40.00	48.00	47.00	48.00	50.00
Continuation Trades	0.00	2.00	0.00	1.00	0.00	0.00
Max Runup	0.00	0.00	0.00	0.00	0.00	0.00
Max Drawdown	0.00	-13.00	-1.00	-1.00	-1.00	0.00
Most Held Position	0.00	1.00	1.00	1.00	0.00	0.00
Most Held Position by %	50.98	52.94	49.02	47.06	50.98	50.98
Least Held Position	-1.00	2.00	-1.00	2.00	1.00	-1.00
Least Held Position by %	7.84	3.92	1.96	1.96	49.02	3.92
Total Revenue	16.25	-17.18	8.00	27.10	0.10	10.25
Avg Revenue per Period	0.32	-0.34	0.16	0.53	0.00	0.20

	Back Recursion	Rollout	Approximation
Num. Trades	100.00	7.00	78.00
Most Held Position	0.00	-1.00	1.00
Most Held Position by %	50.50	46.00	53.47
Total Revenue	22.50	-32.90	17.45
Avg Revenue per Period	0.22	-0.33	0.17