Experiment 1

March 12, 2018

Simulation Details

Considered $K = 3$, $T = 1001$, $N = 1200$. Report statistics at $t = 1000$
The Bandit priors that were considered:

- Uniform: Draw the mean rewards for the arms from [0.25, 0.75]
- "HeavyTail": We took the mean rewards to be randomly drawn from Beta($\alpha = 0.6, \beta = 0.6$). With this distribution it was likely to have arms that were at the extremes (close to 1 and close to 0) but also some of the arms with intermediate value means.
- Needle-in-haystack
    1. High - 2 arms with mean 0.50, 1 arm with mean 0.70 (+ 0.20)

Algorithms considered:

1. ThompsonSampling with priors of $Beta(1, 1)$ for every arm.
2. DynamicGreedy with priors of $Beta(1, 1)$ for every arm
3. Bayesian Dynamic ϵ-greedy with priors of $Beta(1, 1)$ for every arm and $\epsilon = 0.05$

Agent Algorithms considered:

1. HardMax
2. HardMaxWithRandom
3. SoftMax ($\alpha = 30$)

Memory Sizes

1. 100

Simulation Procedure

```
for Each prior p do
    Generate true distribution from p (except for needle-in-haystack, just use p itself)
    Generate T × K realizations for the arms
    for Each agent algorithm agentalg do
        for Each principal algorithm pair principalalg1, principalalg2 do
            for N simulations do
                Give the agents 5 observations from each principal
                Run simulation for T periods
            end for
        end for
    end for
end for
```

Results

All results are reported for memory size = 100.

The rows represent the agent algorithms (defined as above). The columns represent principal 1 vs principal 2 (e.g. TS vs DG means Thompson Sampling is principal 1 and Dynamic Greedy is principal 2).

Within each cell, the following data are presented:

1. The first row displays the sample mean market share for principal 1 as well as a 95% confidence band of the mean.
2. The second row displays the sample variance of the market share and in parentheses are 95 % confidence bands for the variance.
3. The third row displays the % of simulations that resulted in "extreme" market shares. Extreme market shares are defined as being simulations were one of the principals (either principal 1 or 2) ended up with 90% or more of the market.

Results for t= 1000 Needle In Haystack High Memory= 100

	TS vs DEG	TS vs DG	DG vs DEG	TS vs TS	DEG vs DEG	DG vs DG
HM	**0.51** +/- 0.03 Var: 0.24 Share: 96 %	**0.53** +/- 0.03 Var: 0.23 Share: 93 %	**0.51** +/- 0.03 Var: 0.24 Share: 94 %	**0.48** +/- 0.03 Var: 0.24 Share: 96 %	**0.5** +/- 0.03 Var: 0.24 Share: 95 %	**0.49** +/- 0.03 Var: 0.23 Share: 90 %
HMR	**0.52** +/- 0.02 Var: 0.18 Share: 76 %	**0.54** +/- 0.02 Var: 0.17 Share: 72 %	**0.46** +/- 0.02 Var: 0.17 Share: 67 %	**0.5** +/- 0.02 Var: 0.19 Share: 79 %	**0.51** +/- 0.02 Var: 0.17 Share: 71 %	**0.49** +/- 0.02 Var: 0.16 Share: 63 %
SM	**0.52** +/- 0.02 Var: 0.073 Share: 4.5 %	**0.55** +/- 0.02 Var: 0.079 Share: 6.4 %	**0.47** +/- 0.02 Var: 0.077 Share: 6.9 %	**0.5** +/- 0.01 Var: 0.064 Share: 2.8 %	**0.5** +/- 0.02 Var: 0.079 Share: 7.1 %	**0.5** +/- 0.02 Var: 0.082 Share: 6.9 %

Results for t= 1000 Heavy Tail Memory= 100

	TS vs DEG	TS vs DG	DG vs DEG	TS vs TS	DEG vs DEG	DG vs DG
HM	**0.4** +/- 0.03 Var: 0.23 Share: 98 %	**0.42** +/- 0.03 Var: 0.23 Share: 95 %	**0.53** +/- 0.03 Var: 0.23 Share: 90 %	**0.5** +/- 0.03 Var: 0.24 Share: 98 %	**0.5** +/- 0.03 Var: 0.23 Share: 91 %	**0.5** +/- 0.03 Var: 0.22 Share: 88 %
HMR	**0.46** +/- 0.02 Var: 0.19 Share: 79 %	**0.44** +/- 0.02 Var: 0.19 Share: 80 %	**0.54** +/- 0.02 Var: 0.16 Share: 66 %	**0.49** +/- 0.03 Var: 0.2 Share: 88 %	**0.48** +/- 0.02 Var: 0.16 Share: 65 %	**0.5** +/- 0.02 Var: 0.15 Share: 60 %
SM	**0.53** +/- 0.01 Var: 0.048 Share: 2.8 %	**0.48** +/- 0.01 Var: 0.056 Share: 3.8 %	**0.53** +/- 0.01 Var: 0.049 Share: 3.2 %	**0.49** +/- 0.01 Var: 0.049 Share: 1.8 %	**0.49** +/- 0.01 Var: 0.046 Share: 3.5 %	**0.5** +/- 0.01 Var: 0.041 Share: 3.2 %

Results for t= 1000 Uniform Memory= 100

	TS vs DEG	TS vs DG	DG vs DEG	TS vs TS	DEG vs DEG	DG vs DG
HM	**0.48** +/- 0.03 Var: 0.23 Share: 93 %	**0.48** +/- 0.03 Var: 0.23 Share: 93 %	**0.5** +/- 0.03 Var: 0.22 Share: 89 %	**0.49** +/- 0.03 Var: 0.24 Share: 93 %	**0.51** +/- 0.03 Var: 0.23 Share: 92 %	**0.49** +/- 0.03 Var: 0.22 Share: 88 %
HMR	**0.47** +/- 0.02 Var: 0.16 Share: 65 %	**0.51** +/- 0.02 Var: 0.17 Share: 69 %	**0.49** +/- 0.02 Var: 0.15 Share: 58 %	**0.5** +/- 0.02 Var: 0.17 Share: 69 %	**0.51** +/- 0.02 Var: 0.16 Share: 64 %	**0.49** +/- 0.02 Var: 0.15 Share: 58 %
SM	**0.49** +/- 0.01 Var: 0.051 Share: 2.4 %	**0.51** +/- 0.01 Var: 0.059 Share: 3.2 %	**0.51** +/- 0.01 Var: 0.058 Share: 3.6 %	**0.51** +/- 0.01 Var: 0.054 Share: 2.2 %	**0.49** +/- 0.01 Var: 0.057 Share: 4.2 %	**0.5** +/- 0.01 Var: 0.057 Share: 3.9 %

Comments: Almost everything is just a 50-50 split!

1. Almost all of the same algorithms pitted against each other ended with getting a 50/50 market share. This seems to be a good sanity check.

2. Strange things: focus on TS vs DEG (Heavy Tail). DEG wins for HM and HMR, but TS wins for SM. This seems weird? TS also seems to lose on HMR with Uniform prior.

3. Why does DynamicGreedy do so well on the HeavyTail prior? Does this make sense?