

-----Mandatory Information to fill-----  
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**Group ID: 13**

**Group Members Name with Student ID:**

Name	BITS ID
Ramlal Singh	2023AC05814
Harish Kumar	2023AD05136
Cherukupally Sarika	2023AC05780
Penta Srujana	2023AC05788

-----Write your remarks (if any) that you want should get  
consider at the time of evaluation-----

Remarks: ##Add here

## Background

In the world of online streaming, user satisfaction and engagement are critical metrics for the success of a movie recommendation system. A well-designed recommendation algorithm can significantly enhance user experience by suggesting movies that align with their preferences, leading to higher platform retention and usage. Recommendation systems face the challenge of balancing exploration (discovering new movies) with exploitation (recommending known favourites) to maximize user satisfaction over time.

## Scenario

Imagine a leading online movie streaming platform, TrendMovie Inc., that aims to become the go-to destination for personalized movie recommendations. The platform features a vast collection of movies catering to diverse audiences. TrendMovie Inc. wants to optimize its recommendation strategy to deliver maximum user satisfaction while maintaining a high level of engagement. Each movie recommendation is treated as an interaction with the user, and their feedback is used to refine the recommendation strategy dynamically.

## Objective

Your objective is to design and implement a recommendation system using Multi-Armed Bandit (MAB) algorithms to maximize cumulative user satisfaction. The system should dynamically allocate recommendations by learning user preferences in real-time, striking the right balance between exploration and exploitation.

## Dataset

The dataset contains user ratings for a variety of movies. Key columns in the dataset include:

- **User ID:** A unique identifier for each user.
- **Movie ID:** A unique identifier for each.
- **Rating:** A score provided by the user for a movie (on a scale of 1 to 5).
- **Timestamp:** The time when the rating was given (optional for this assignment).

**\*Link for accessing dataset:\***

[https://drive.google.com/file/d/1gfobhqlVCw8Oo52JCiYpEBGhG5k7cWBr/view?usp=drive\\_link](https://drive.google.com/file/d/1gfobhqlVCw8Oo52JCiYpEBGhG5k7cWBr/view?usp=drive_link)

## Environment Details

**Arms:** Each movie represents an "arm" in the MAB framework. The probability of a movie being liked by a user is initially unknown and will be estimated based on user feedback during the interactions. For example:

Arm 1: Movie A

Arm 2: Movie B

Arm 3: Movie C

... and so on, for all movies in the dataset.

**Reward Function:** The reward function is defined based on user ratings:

**\*Reward = 1:\*** The user rates the movie high star (e.g., 4 or 5 stars).

**\*Reward = 0:\*** The user rates the movie low star (e.g., 1, 2, or 3 stars).

**Assumptions:**

Run simulations for 1000 iterations for each policy

## Requirements and Deliverables:

Implement the Multi-Arm Bandit Problem for the given above scenario for all the below mentioned policy methods.

1. Load the movie ratings dataset and preprocess it as needed.
2. Define the environment and compute rewards.
3. Implement a random policy for movie recommendations and print each iteration.
4. Implement a greedy policy that always recommends the movie with the highest estimated reward and print each iteration.
5. Implement the epsilon-greedy policy, where with probability  $\epsilon$  you explore (recommend a random movie) and with probability  $(1-\epsilon)$  you exploit (recommend the best-known movie). Try with  $\epsilon = 0.1, 0.2, 0.5$ , and print each iteration. What value of  $\epsilon$  yields the best performance?
6. Implement the UCB algorithm for movie recommendations and print each iteration.
7. Plot the cumulative rewards for all policies on a single graph to compare their performance.
8. Determine which policy performs the best based on cumulative reward. Provide a concise conclusion summarizing the decision-making process and the trade-offs between exploration and exploitation.

## Initialize constants

```
In [1]: #Constants

#Initialize value function and policy
```

## Load Dataset (0.5M)

```
In [19]: # Code for Dataset Loading and print dataset statistics
#-----write your code below this line-----

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

# 1. Load the movie ratings dataset and preprocess it as needed.

# Step 1: Load and preprocess the dataset
file_path = 'TrendMovie.csv'
df = pd.read_csv(file_path)
print('Whole Datasets: \n')
print(df)

# Convert ratings into rewards
# Reward = 1 if Rating >= 4, else Reward = 0
df['Reward'] = (df['rating'] >= 4).astype(int)
```

```
print(" \n Dataset greator than 4 rating: \n")
print(df.head())
```

Whole Datasets:

	userId	movieId	rating	timestamp
0	1	1	4.0	964982703
1	1	3	4.0	964981247
2	1	6	4.0	964982224
3	1	47	5.0	964983815
4	1	50	5.0	964982931
...	...	...	...	...
100831	610	166534	4.0	1493848402
100832	610	168248	5.0	1493850091
100833	610	168250	5.0	1494273047
100834	610	168252	5.0	1493846352
100835	610	170875	3.0	1493846415

[100836 rows x 4 columns]

Dataset greator than 4 rating:

	userId	movieId	rating	timestamp	Reward
0	1	1	4.0	964982703	1
1	1	3	4.0	964981247	1
2	1	6	4.0	964982224	1
3	1	47	5.0	964983815	1
4	1	50	5.0	964982931	1

## Design a Movie Environment (0.5M)

In [20]: *# Code for Dataset Loading and print dataset statistics along with reward function*  
*#-----write your code below this line-----*

```
class MovieEnvironment:
    def __init__(self, dataframe):
        self.dataframe = dataframe
        self.movie_rewards = self._calculate_movie_rewards()

    def _calculate_movie_rewards(self):
        return self.dataframe.groupby('movieId')['Reward'].mean().to_dict()

    def get_reward(self, movie_id):
        rewards = self.dataframe[self.dataframe['movieId'] == movie_id]['Reward']
        return np.random.choice(rewards)

# Initialize the environment
environment = MovieEnvironment(df)
movie_rewards = environment.movie_rewards
print("\nAverage reward per movie:")
print(movie_rewards)

# Initialize cumulative rewards for policies
```

```
cumulative_rewards_random = []  
cumulative_rewards_greedy = []  
cumulative_rewards_epsilon = {0.1: [], 0.2: [], 0.5: []}  
cumulative_rewards_ucb = []  
  
# Track total rewards for comparisons  
total_rewards_random = 0  
total_rewards_greedy = 0  
total_rewards_epsilon = {0.1: 0, 0.2: 0, 0.5: 0}  
total_rewards_ucb = 0
```

Average reward per movie:

{1: 0.6837209302325581, 2: 0.45454545454545453, 3: 0.34615384615384615, 4: 0.0, 5: 0.24489795918367346, 6: 0.6764705882352942, 7: 0.37037037037037035, 8: 0.125, 9: 0.25, 10: 0.44696969696969696, 11: 0.6142857142857143, 12: 0.15789473684210525, 13: 0.25, 14: 0.6666666666666666, 15: 0.38461538461538464, 16: 0.6951219512195121, 17: 0.5970149253731343, 18: 0.55, 19: 0.20454545454545456, 20: 0.06666666666666667, 21: 0.5056179775280899, 22: 0.2222222222222222, 23: 0.25, 24: 0.32142857142857145, 25: 0.5657894736842105, 26: 0.5384615384615384, 27: 0.3333333333333333, 28: 0.72727272727272727, 29: 0.7105263157894737, 30: 0.6666666666666666, 31: 0.34210526315789475, 32: 0.6666666666666666, 33: 0.5859375, 34: 0.6865671641791045, 35: 0.0, 36: 0.38461538461538464, 37: 0.5, 38: 0.6, 39: 0.2857142857142857, 40: 0.25, 41: 0.17391304347826086, 42: 0.3125, 43: 0.3333333333333333, 44: 0.6896551724137931, 45: 0.3235294117647059, 46: 0.0, 47: 0.7990196078431373, 48: 0.42857142857142855, 49: 1.0, 50: 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## Using Random Policy (0.5M)

Implement a random policy for movie recommendations and print each iteration.

(Mandatory)

```
In [21]: # run the environment with an agent that is guided by a random policy
#-----write your code below this line-----

print("\nRandom policy iterations:")
for i in range(1000):
    arm = np.random.choice(df['movieId'].unique())
    reward = np.random.choice(df[df['movieId'] == arm]['Reward'])
    total_rewards_random += reward
    cumulative_rewards_random.append(total_rewards_random)
    print(f"Iteration {i+1}: Movie {arm}, Reward: {reward}")
```

## Random policy iterations:

Iteration 1: Movie 5112, Reward: 0  
Iteration 2: Movie 4246, Reward: 0  
Iteration 3: Movie 91873, Reward: 0  
Iteration 4: Movie 1325, Reward: 0  
Iteration 5: Movie 114925, Reward: 0  
Iteration 6: Movie 2429, Reward: 1  
Iteration 7: Movie 87960, Reward: 0  
Iteration 8: Movie 2320, Reward: 0  
Iteration 9: Movie 4885, Reward: 0  
Iteration 10: Movie 710, Reward: 0  
Iteration 11: Movie 3475, Reward: 1  
Iteration 12: Movie 60303, Reward: 1  
Iteration 13: Movie 92243, Reward: 1  
Iteration 14: Movie 115667, Reward: 0  
Iteration 15: Movie 1387, Reward: 1  
Iteration 16: Movie 100553, Reward: 1  
Iteration 17: Movie 49824, Reward: 0  
Iteration 18: Movie 106839, Reward: 0  
Iteration 19: Movie 72489, Reward: 1  
Iteration 20: Movie 26059, Reward: 1  
Iteration 21: Movie 948, Reward: 0  
Iteration 22: Movie 57504, Reward: 1  
Iteration 23: Movie 1267, Reward: 1  
Iteration 24: Movie 37384, Reward: 1  
Iteration 25: Movie 6957, Reward: 1  
Iteration 26: Movie 73160, Reward: 0  
Iteration 27: Movie 7938, Reward: 0  
Iteration 28: Movie 4804, Reward: 0  
Iteration 29: Movie 58492, Reward: 0  
Iteration 30: Movie 9, Reward: 1  
Iteration 31: Movie 95307, Reward: 0  
Iteration 32: Movie 6898, Reward: 0  
Iteration 33: Movie 26409, Reward: 1  
Iteration 34: Movie 26236, Reward: 1  
Iteration 35: Movie 55282, Reward: 0  
Iteration 36: Movie 72224, Reward: 0  
Iteration 37: Movie 2090, Reward: 0  
Iteration 38: Movie 156783, Reward: 0  
Iteration 39: Movie 514, Reward: 1  
Iteration 40: Movie 32009, Reward: 0  
Iteration 41: Movie 2746, Reward: 0  
Iteration 42: Movie 8934, Reward: 0  
Iteration 43: Movie 82167, Reward: 0  
Iteration 44: Movie 140481, Reward: 1  
Iteration 45: Movie 1123, Reward: 0  
Iteration 46: Movie 74688, Reward: 0  
Iteration 47: Movie 34129, Reward: 0  
Iteration 48: Movie 6314, Reward: 0  
Iteration 49: Movie 4297, Reward: 1  
Iteration 50: Movie 7396, Reward: 1  
Iteration 51: Movie 65225, Reward: 1  
Iteration 52: Movie 109313, Reward: 1  
Iteration 53: Movie 2165, Reward: 0  
Iteration 54: Movie 2170, Reward: 0  
Iteration 55: Movie 149406, Reward: 0



Iteration 56: Movie 8968, Reward: 0  
Iteration 57: Movie 3707, Reward: 0  
Iteration 58: Movie 3962, Reward: 0  
Iteration 59: Movie 5771, Reward: 0  
Iteration 60: Movie 73488, Reward: 0  
Iteration 61: Movie 74727, Reward: 1  
Iteration 62: Movie 6782, Reward: 1  
Iteration 63: Movie 50356, Reward: 0  
Iteration 64: Movie 1984, Reward: 0  
Iteration 65: Movie 7924, Reward: 0  
Iteration 66: Movie 174053, Reward: 1  
Iteration 67: Movie 1107, Reward: 0  
Iteration 68: Movie 43912, Reward: 0  
Iteration 69: Movie 429, Reward: 0  
Iteration 70: Movie 627, Reward: 1  
Iteration 71: Movie 5919, Reward: 1  
Iteration 72: Movie 48696, Reward: 1  
Iteration 73: Movie 81191, Reward: 1  
Iteration 74: Movie 148652, Reward: 0  
Iteration 75: Movie 230, Reward: 0  
Iteration 76: Movie 3971, Reward: 0  
Iteration 77: Movie 31422, Reward: 0  
Iteration 78: Movie 7255, Reward: 0  
Iteration 79: Movie 1582, Reward: 0  
Iteration 80: Movie 141513, Reward: 1  
Iteration 81: Movie 2068, Reward: 1  
Iteration 82: Movie 2995, Reward: 0  
Iteration 83: Movie 6057, Reward: 0  
Iteration 84: Movie 4796, Reward: 0  
Iteration 85: Movie 6537, Reward: 1  
Iteration 86: Movie 209, Reward: 0  
Iteration 87: Movie 159077, Reward: 0  
Iteration 88: Movie 5218, Reward: 0  
Iteration 89: Movie 8955, Reward: 0  
Iteration 90: Movie 2465, Reward: 0  
Iteration 91: Movie 128852, Reward: 0  
Iteration 92: Movie 171011, Reward: 1  
Iteration 93: Movie 2477, Reward: 0  
Iteration 94: Movie 2571, Reward: 0  
Iteration 95: Movie 4846, Reward: 0  
Iteration 96: Movie 116413, Reward: 0  
Iteration 97: Movie 3668, Reward: 0  
Iteration 98: Movie 6104, Reward: 1  
Iteration 99: Movie 59129, Reward: 0  
Iteration 100: Movie 40966, Reward: 0  
Iteration 101: Movie 4529, Reward: 1  
Iteration 102: Movie 1704, Reward: 1  
Iteration 103: Movie 4946, Reward: 1  
Iteration 104: Movie 438, Reward: 0  
Iteration 105: Movie 2506, Reward: 1  
Iteration 106: Movie 69278, Reward: 0  
Iteration 107: Movie 1477, Reward: 1  
Iteration 108: Movie 8340, Reward: 1  
Iteration 109: Movie 3132, Reward: 0  
Iteration 110: Movie 169958, Reward: 0  
Iteration 111: Movie 2599, Reward: 0

Iteration 112: Movie 1643, Reward: 1  
Iteration 113: Movie 3640, Reward: 1  
Iteration 114: Movie 105250, Reward: 0  
Iteration 115: Movie 4128, Reward: 0  
Iteration 116: Movie 593, Reward: 0  
Iteration 117: Movie 1909, Reward: 1  
Iteration 118: Movie 44243, Reward: 0  
Iteration 119: Movie 122882, Reward: 0  
Iteration 120: Movie 6898, Reward: 0  
Iteration 121: Movie 96655, Reward: 0  
Iteration 122: Movie 1023, Reward: 0  
Iteration 123: Movie 2096, Reward: 1  
Iteration 124: Movie 51037, Reward: 0  
Iteration 125: Movie 133712, Reward: 1  
Iteration 126: Movie 4748, Reward: 0  
Iteration 127: Movie 6379, Reward: 0  
Iteration 128: Movie 748, Reward: 1  
Iteration 129: Movie 7013, Reward: 1  
Iteration 130: Movie 128542, Reward: 0  
Iteration 131: Movie 4200, Reward: 1  
Iteration 132: Movie 89090, Reward: 1  
Iteration 133: Movie 51357, Reward: 1  
Iteration 134: Movie 37741, Reward: 1  
Iteration 135: Movie 48744, Reward: 0  
Iteration 136: Movie 1357, Reward: 1  
Iteration 137: Movie 5951, Reward: 0  
Iteration 138: Movie 130634, Reward: 1  
Iteration 139: Movie 30850, Reward: 1  
Iteration 140: Movie 8014, Reward: 0  
Iteration 141: Movie 189043, Reward: 0  
Iteration 142: Movie 84844, Reward: 1  
Iteration 143: Movie 6367, Reward: 0  
Iteration 144: Movie 173255, Reward: 0  
Iteration 145: Movie 2707, Reward: 0  
Iteration 146: Movie 8784, Reward: 1  
Iteration 147: Movie 164226, Reward: 1  
Iteration 148: Movie 6558, Reward: 0  
Iteration 149: Movie 5303, Reward: 1  
Iteration 150: Movie 234, Reward: 0  
Iteration 151: Movie 3728, Reward: 1  
Iteration 152: Movie 81512, Reward: 1  
Iteration 153: Movie 4852, Reward: 0  
Iteration 154: Movie 6954, Reward: 0  
Iteration 155: Movie 703, Reward: 0  
Iteration 156: Movie 1257, Reward: 0  
Iteration 157: Movie 7058, Reward: 0  
Iteration 158: Movie 517, Reward: 1  
Iteration 159: Movie 1032, Reward: 1  
Iteration 160: Movie 170777, Reward: 1  
Iteration 161: Movie 144262, Reward: 0  
Iteration 162: Movie 8189, Reward: 0  
Iteration 163: Movie 151763, Reward: 1  
Iteration 164: Movie 215, Reward: 0  
Iteration 165: Movie 3514, Reward: 0  
Iteration 166: Movie 5476, Reward: 0  
Iteration 167: Movie 2117, Reward: 0

Iteration 168: Movie 2147, Reward: 0  
Iteration 169: Movie 95, Reward: 0  
Iteration 170: Movie 2735, Reward: 1  
Iteration 171: Movie 112421, Reward: 1  
Iteration 172: Movie 2731, Reward: 1  
Iteration 173: Movie 47629, Reward: 1  
Iteration 174: Movie 7137, Reward: 0  
Iteration 175: Movie 1458, Reward: 1  
Iteration 176: Movie 34405, Reward: 1  
Iteration 177: Movie 8873, Reward: 1  
Iteration 178: Movie 53129, Reward: 1  
Iteration 179: Movie 159690, Reward: 0  
Iteration 180: Movie 1014, Reward: 0  
Iteration 181: Movie 6850, Reward: 0  
Iteration 182: Movie 37240, Reward: 1  
Iteration 183: Movie 4865, Reward: 0  
Iteration 184: Movie 94864, Reward: 1  
Iteration 185: Movie 5094, Reward: 0  
Iteration 186: Movie 4811, Reward: 0  
Iteration 187: Movie 6299, Reward: 1  
Iteration 188: Movie 51167, Reward: 1  
Iteration 189: Movie 4562, Reward: 1  
Iteration 190: Movie 2624, Reward: 0  
Iteration 191: Movie 2286, Reward: 0  
Iteration 192: Movie 77266, Reward: 0  
Iteration 193: Movie 131739, Reward: 0  
Iteration 194: Movie 103606, Reward: 1  
Iteration 195: Movie 454, Reward: 0  
Iteration 196: Movie 53355, Reward: 1  
Iteration 197: Movie 5109, Reward: 1  
Iteration 198: Movie 1663, Reward: 0  
Iteration 199: Movie 5540, Reward: 0  
Iteration 200: Movie 1059, Reward: 0  
Iteration 201: Movie 71205, Reward: 0  
Iteration 202: Movie 130482, Reward: 1  
Iteration 203: Movie 184245, Reward: 1  
Iteration 204: Movie 3035, Reward: 0  
Iteration 205: Movie 1753, Reward: 0  
Iteration 206: Movie 2571, Reward: 1  
Iteration 207: Movie 42556, Reward: 1  
Iteration 208: Movie 4113, Reward: 0  
Iteration 209: Movie 1290, Reward: 1  
Iteration 210: Movie 78499, Reward: 1  
Iteration 211: Movie 112070, Reward: 0  
Iteration 212: Movie 5609, Reward: 0  
Iteration 213: Movie 27105, Reward: 0  
Iteration 214: Movie 3357, Reward: 1  
Iteration 215: Movie 84950, Reward: 0  
Iteration 216: Movie 43744, Reward: 0  
Iteration 217: Movie 5875, Reward: 0  
Iteration 218: Movie 149590, Reward: 0  
Iteration 219: Movie 30816, Reward: 0  
Iteration 220: Movie 55555, Reward: 0  
Iteration 221: Movie 632, Reward: 1  
Iteration 222: Movie 26183, Reward: 0  
Iteration 223: Movie 4323, Reward: 1

Iteration 224: Movie 170, Reward: 0  
Iteration 225: Movie 113394, Reward: 1  
Iteration 226: Movie 27155, Reward: 0  
Iteration 227: Movie 6663, Reward: 0  
Iteration 228: Movie 63179, Reward: 0  
Iteration 229: Movie 3569, Reward: 1  
Iteration 230: Movie 8487, Reward: 0  
Iteration 231: Movie 44193, Reward: 0  
Iteration 232: Movie 2078, Reward: 0  
Iteration 233: Movie 83827, Reward: 1  
Iteration 234: Movie 78349, Reward: 0  
Iteration 235: Movie 168174, Reward: 0  
Iteration 236: Movie 3652, Reward: 0  
Iteration 237: Movie 5524, Reward: 0  
Iteration 238: Movie 4276, Reward: 1  
Iteration 239: Movie 107408, Reward: 1  
Iteration 240: Movie 56869, Reward: 1  
Iteration 241: Movie 64839, Reward: 0  
Iteration 242: Movie 35957, Reward: 1  
Iteration 243: Movie 93980, Reward: 0  
Iteration 244: Movie 3555, Reward: 1  
Iteration 245: Movie 282, Reward: 0  
Iteration 246: Movie 74946, Reward: 1  
Iteration 247: Movie 250, Reward: 0  
Iteration 248: Movie 34048, Reward: 1  
Iteration 249: Movie 1030, Reward: 0  
Iteration 250: Movie 6022, Reward: 0  
Iteration 251: Movie 136664, Reward: 0  
Iteration 252: Movie 68486, Reward: 1  
Iteration 253: Movie 172253, Reward: 0  
Iteration 254: Movie 2094, Reward: 0  
Iteration 255: Movie 179119, Reward: 1  
Iteration 256: Movie 1251, Reward: 1  
Iteration 257: Movie 4229, Reward: 0  
Iteration 258: Movie 5347, Reward: 0  
Iteration 259: Movie 47999, Reward: 1  
Iteration 260: Movie 135803, Reward: 0  
Iteration 261: Movie 96007, Reward: 0  
Iteration 262: Movie 357, Reward: 1  
Iteration 263: Movie 51698, Reward: 0  
Iteration 264: Movie 6251, Reward: 0  
Iteration 265: Movie 6036, Reward: 0  
Iteration 266: Movie 3384, Reward: 1  
Iteration 267: Movie 87298, Reward: 0  
Iteration 268: Movie 50, Reward: 1  
Iteration 269: Movie 61406, Reward: 1  
Iteration 270: Movie 4564, Reward: 0  
Iteration 271: Movie 142056, Reward: 0  
Iteration 272: Movie 90600, Reward: 1  
Iteration 273: Movie 1895, Reward: 0  
Iteration 274: Movie 3357, Reward: 1  
Iteration 275: Movie 4615, Reward: 1  
Iteration 276: Movie 94780, Reward: 0  
Iteration 277: Movie 2644, Reward: 0  
Iteration 278: Movie 56801, Reward: 0  
Iteration 279: Movie 94266, Reward: 0

Iteration 280: Movie 25947, Reward: 1  
Iteration 281: Movie 5867, Reward: 1  
Iteration 282: Movie 130518, Reward: 1  
Iteration 283: Movie 1960, Reward: 0  
Iteration 284: Movie 85510, Reward: 0  
Iteration 285: Movie 8879, Reward: 0  
Iteration 286: Movie 5604, Reward: 0  
Iteration 287: Movie 32515, Reward: 0  
Iteration 288: Movie 1574, Reward: 0  
Iteration 289: Movie 3797, Reward: 1  
Iteration 290: Movie 118166, Reward: 0  
Iteration 291: Movie 140715, Reward: 0  
Iteration 292: Movie 4292, Reward: 1  
Iteration 293: Movie 8580, Reward: 1  
Iteration 294: Movie 6547, Reward: 0  
Iteration 295: Movie 71867, Reward: 0  
Iteration 296: Movie 47044, Reward: 0  
Iteration 297: Movie 27539, Reward: 0  
Iteration 298: Movie 574, Reward: 0  
Iteration 299: Movie 4537, Reward: 1  
Iteration 300: Movie 26078, Reward: 1  
Iteration 301: Movie 8461, Reward: 0  
Iteration 302: Movie 43930, Reward: 0  
Iteration 303: Movie 55577, Reward: 0  
Iteration 304: Movie 8369, Reward: 0  
Iteration 305: Movie 210, Reward: 0  
Iteration 306: Movie 7083, Reward: 0  
Iteration 307: Movie 6748, Reward: 0  
Iteration 308: Movie 101525, Reward: 1  
Iteration 309: Movie 31617, Reward: 0  
Iteration 310: Movie 87867, Reward: 0  
Iteration 311: Movie 1824, Reward: 0  
Iteration 312: Movie 27689, Reward: 0  
Iteration 313: Movie 93297, Reward: 0  
Iteration 314: Movie 118512, Reward: 0  
Iteration 315: Movie 52867, Reward: 1  
Iteration 316: Movie 65631, Reward: 1  
Iteration 317: Movie 108949, Reward: 1  
Iteration 318: Movie 3922, Reward: 0  
Iteration 319: Movie 6422, Reward: 1  
Iteration 320: Movie 157110, Reward: 1  
Iteration 321: Movie 1663, Reward: 1  
Iteration 322: Movie 2563, Reward: 1  
Iteration 323: Movie 1081, Reward: 1  
Iteration 324: Movie 7743, Reward: 0  
Iteration 325: Movie 84847, Reward: 1  
Iteration 326: Movie 18, Reward: 0  
Iteration 327: Movie 109483, Reward: 0  
Iteration 328: Movie 8142, Reward: 1  
Iteration 329: Movie 3812, Reward: 1  
Iteration 330: Movie 34321, Reward: 0  
Iteration 331: Movie 4394, Reward: 0  
Iteration 332: Movie 120130, Reward: 1  
Iteration 333: Movie 111659, Reward: 0  
Iteration 334: Movie 61248, Reward: 0  
Iteration 335: Movie 31692, Reward: 0

Iteration 336: Movie 173, Reward: 1  
Iteration 337: Movie 8012, Reward: 0  
Iteration 338: Movie 51884, Reward: 1  
Iteration 339: Movie 3862, Reward: 1  
Iteration 340: Movie 7713, Reward: 1  
Iteration 341: Movie 159161, Reward: 1  
Iteration 342: Movie 130970, Reward: 1  
Iteration 343: Movie 26614, Reward: 0  
Iteration 344: Movie 71248, Reward: 0  
Iteration 345: Movie 2059, Reward: 0  
Iteration 346: Movie 3678, Reward: 1  
Iteration 347: Movie 5949, Reward: 1  
Iteration 348: Movie 133798, Reward: 0  
Iteration 349: Movie 58309, Reward: 1  
Iteration 350: Movie 30803, Reward: 1  
Iteration 351: Movie 5899, Reward: 0  
Iteration 352: Movie 86721, Reward: 1  
Iteration 353: Movie 176419, Reward: 0  
Iteration 354: Movie 70599, Reward: 1  
Iteration 355: Movie 26285, Reward: 0  
Iteration 356: Movie 49274, Reward: 1  
Iteration 357: Movie 26542, Reward: 0  
Iteration 358: Movie 6769, Reward: 0  
Iteration 359: Movie 2482, Reward: 0  
Iteration 360: Movie 52245, Reward: 0  
Iteration 361: Movie 169992, Reward: 0  
Iteration 362: Movie 101612, Reward: 0  
Iteration 363: Movie 7064, Reward: 0  
Iteration 364: Movie 182299, Reward: 1  
Iteration 365: Movie 55444, Reward: 1  
Iteration 366: Movie 6962, Reward: 0  
Iteration 367: Movie 2493, Reward: 1  
Iteration 368: Movie 472, Reward: 0  
Iteration 369: Movie 619, Reward: 0  
Iteration 370: Movie 33499, Reward: 0  
Iteration 371: Movie 27904, Reward: 0  
Iteration 372: Movie 167772, Reward: 0  
Iteration 373: Movie 5049, Reward: 1  
Iteration 374: Movie 3484, Reward: 0  
Iteration 375: Movie 27523, Reward: 1  
Iteration 376: Movie 120625, Reward: 1  
Iteration 377: Movie 142372, Reward: 0  
Iteration 378: Movie 3127, Reward: 0  
Iteration 379: Movie 996, Reward: 0  
Iteration 380: Movie 67168, Reward: 0  
Iteration 381: Movie 43936, Reward: 1  
Iteration 382: Movie 160289, Reward: 1  
Iteration 383: Movie 5165, Reward: 1  
Iteration 384: Movie 6750, Reward: 0  
Iteration 385: Movie 134775, Reward: 0  
Iteration 386: Movie 4355, Reward: 0  
Iteration 387: Movie 1059, Reward: 0  
Iteration 388: Movie 88272, Reward: 0  
Iteration 389: Movie 46572, Reward: 0  
Iteration 390: Movie 121129, Reward: 0  
Iteration 391: Movie 52319, Reward: 1

Iteration 392: Movie 178323, Reward: 0  
Iteration 393: Movie 7085, Reward: 0  
Iteration 394: Movie 71902, Reward: 0  
Iteration 395: Movie 86817, Reward: 1  
Iteration 396: Movie 26401, Reward: 1  
Iteration 397: Movie 3211, Reward: 1  
Iteration 398: Movie 97950, Reward: 0  
Iteration 399: Movie 117444, Reward: 0  
Iteration 400: Movie 5348, Reward: 1  
Iteration 401: Movie 96488, Reward: 1  
Iteration 402: Movie 6466, Reward: 1  
Iteration 403: Movie 4349, Reward: 1  
Iteration 404: Movie 25750, Reward: 0  
Iteration 405: Movie 56274, Reward: 0  
Iteration 406: Movie 6658, Reward: 0  
Iteration 407: Movie 981, Reward: 0  
Iteration 408: Movie 167538, Reward: 0  
Iteration 409: Movie 7104, Reward: 0  
Iteration 410: Movie 3770, Reward: 0  
Iteration 411: Movie 142115, Reward: 1  
Iteration 412: Movie 107348, Reward: 0  
Iteration 413: Movie 26183, Reward: 1  
Iteration 414: Movie 178111, Reward: 0  
Iteration 415: Movie 2905, Reward: 1  
Iteration 416: Movie 4386, Reward: 0  
Iteration 417: Movie 4728, Reward: 0  
Iteration 418: Movie 96815, Reward: 0  
Iteration 419: Movie 3802, Reward: 0  
Iteration 420: Movie 42725, Reward: 0  
Iteration 421: Movie 1779, Reward: 0  
Iteration 422: Movie 78034, Reward: 0  
Iteration 423: Movie 1554, Reward: 0  
Iteration 424: Movie 775, Reward: 0  
Iteration 425: Movie 146662, Reward: 1  
Iteration 426: Movie 109483, Reward: 0  
Iteration 427: Movie 7167, Reward: 0  
Iteration 428: Movie 5102, Reward: 0  
Iteration 429: Movie 71327, Reward: 0  
Iteration 430: Movie 22, Reward: 0  
Iteration 431: Movie 4520, Reward: 0  
Iteration 432: Movie 62293, Reward: 0  
Iteration 433: Movie 1292, Reward: 0  
Iteration 434: Movie 2563, Reward: 0  
Iteration 435: Movie 37857, Reward: 1  
Iteration 436: Movie 102735, Reward: 0  
Iteration 437: Movie 6554, Reward: 0  
Iteration 438: Movie 2492, Reward: 1  
Iteration 439: Movie 109487, Reward: 1  
Iteration 440: Movie 3543, Reward: 1  
Iteration 441: Movie 141844, Reward: 1  
Iteration 442: Movie 140541, Reward: 1  
Iteration 443: Movie 7127, Reward: 0  
Iteration 444: Movie 115111, Reward: 0  
Iteration 445: Movie 8138, Reward: 1  
Iteration 446: Movie 27618, Reward: 0  
Iteration 447: Movie 77846, Reward: 1

Iteration 448: Movie 1224, Reward: 1  
Iteration 449: Movie 32302, Reward: 1  
Iteration 450: Movie 4810, Reward: 0  
Iteration 451: Movie 158022, Reward: 0  
Iteration 452: Movie 69712, Reward: 1  
Iteration 453: Movie 95690, Reward: 1  
Iteration 454: Movie 6169, Reward: 0  
Iteration 455: Movie 1598, Reward: 0  
Iteration 456: Movie 3653, Reward: 0  
Iteration 457: Movie 7925, Reward: 1  
Iteration 458: Movie 539, Reward: 1  
Iteration 459: Movie 3198, Reward: 0  
Iteration 460: Movie 48982, Reward: 0  
Iteration 461: Movie 3764, Reward: 0  
Iteration 462: Movie 172591, Reward: 1  
Iteration 463: Movie 7107, Reward: 0  
Iteration 464: Movie 171011, Reward: 1  
Iteration 465: Movie 3433, Reward: 0  
Iteration 466: Movie 7019, Reward: 0  
Iteration 467: Movie 640, Reward: 0  
Iteration 468: Movie 8502, Reward: 0  
Iteration 469: Movie 4723, Reward: 0  
Iteration 470: Movie 92730, Reward: 0  
Iteration 471: Movie 118894, Reward: 1  
Iteration 472: Movie 158027, Reward: 1  
Iteration 473: Movie 3007, Reward: 0  
Iteration 474: Movie 59995, Reward: 1  
Iteration 475: Movie 80586, Reward: 0  
Iteration 476: Movie 33615, Reward: 0  
Iteration 477: Movie 4574, Reward: 0  
Iteration 478: Movie 2381, Reward: 0  
Iteration 479: Movie 413, Reward: 0  
Iteration 480: Movie 6773, Reward: 0  
Iteration 481: Movie 50147, Reward: 0  
Iteration 482: Movie 160730, Reward: 0  
Iteration 483: Movie 60904, Reward: 1  
Iteration 484: Movie 1099, Reward: 1  
Iteration 485: Movie 122926, Reward: 1  
Iteration 486: Movie 8378, Reward: 1  
Iteration 487: Movie 61210, Reward: 0  
Iteration 488: Movie 80166, Reward: 0  
Iteration 489: Movie 2488, Reward: 0  
Iteration 490: Movie 50685, Reward: 0  
Iteration 491: Movie 905, Reward: 1  
Iteration 492: Movie 167380, Reward: 1  
Iteration 493: Movie 6982, Reward: 0  
Iteration 494: Movie 114028, Reward: 1  
Iteration 495: Movie 986, Reward: 1  
Iteration 496: Movie 41997, Reward: 0  
Iteration 497: Movie 59995, Reward: 1  
Iteration 498: Movie 4965, Reward: 1  
Iteration 499: Movie 2037, Reward: 1  
Iteration 500: Movie 6336, Reward: 0  
Iteration 501: Movie 4785, Reward: 1  
Iteration 502: Movie 3410, Reward: 1  
Iteration 503: Movie 84950, Reward: 0



Iteration 504: Movie 161966, Reward: 1  
Iteration 505: Movie 3247, Reward: 0  
Iteration 506: Movie 4672, Reward: 0  
Iteration 507: Movie 159193, Reward: 0  
Iteration 508: Movie 785, Reward: 0  
Iteration 509: Movie 2972, Reward: 1  
Iteration 510: Movie 8894, Reward: 0  
Iteration 511: Movie 1643, Reward: 0  
Iteration 512: Movie 116797, Reward: 1  
Iteration 513: Movie 663, Reward: 0  
Iteration 514: Movie 3941, Reward: 1  
Iteration 515: Movie 5736, Reward: 0  
Iteration 516: Movie 199, Reward: 1  
Iteration 517: Movie 44204, Reward: 0  
Iteration 518: Movie 3003, Reward: 1  
Iteration 519: Movie 1006, Reward: 0  
Iteration 520: Movie 1461, Reward: 0  
Iteration 521: Movie 5254, Reward: 0  
Iteration 522: Movie 159193, Reward: 0  
Iteration 523: Movie 39715, Reward: 0  
Iteration 524: Movie 34520, Reward: 0  
Iteration 525: Movie 4282, Reward: 0  
Iteration 526: Movie 111844, Reward: 0  
Iteration 527: Movie 63436, Reward: 0  
Iteration 528: Movie 1542, Reward: 0  
Iteration 529: Movie 5048, Reward: 0  
Iteration 530: Movie 76091, Reward: 1  
Iteration 531: Movie 4439, Reward: 0  
Iteration 532: Movie 8724, Reward: 1  
Iteration 533: Movie 31221, Reward: 1  
Iteration 534: Movie 2292, Reward: 0  
Iteration 535: Movie 595, Reward: 0  
Iteration 536: Movie 31685, Reward: 0  
Iteration 537: Movie 6612, Reward: 1  
Iteration 538: Movie 3504, Reward: 0  
Iteration 539: Movie 8587, Reward: 0  
Iteration 540: Movie 140525, Reward: 0  
Iteration 541: Movie 2473, Reward: 0  
Iteration 542: Movie 46105, Reward: 1  
Iteration 543: Movie 61986, Reward: 0  
Iteration 544: Movie 176389, Reward: 0  
Iteration 545: Movie 354, Reward: 0  
Iteration 546: Movie 104863, Reward: 1  
Iteration 547: Movie 39231, Reward: 0  
Iteration 548: Movie 114818, Reward: 0  
Iteration 549: Movie 6316, Reward: 0  
Iteration 550: Movie 7147, Reward: 1  
Iteration 551: Movie 6517, Reward: 0  
Iteration 552: Movie 3622, Reward: 0  
Iteration 553: Movie 4037, Reward: 1  
Iteration 554: Movie 103245, Reward: 0  
Iteration 555: Movie 145491, Reward: 0  
Iteration 556: Movie 1610, Reward: 1  
Iteration 557: Movie 2987, Reward: 0  
Iteration 558: Movie 55190, Reward: 0  
Iteration 559: Movie 46723, Reward: 0

Iteration 560: Movie 2043, Reward: 0  
Iteration 561: Movie 173197, Reward: 1  
Iteration 562: Movie 140852, Reward: 0  
Iteration 563: Movie 2320, Reward: 0  
Iteration 564: Movie 79897, Reward: 1  
Iteration 565: Movie 31162, Reward: 0  
Iteration 566: Movie 99122, Reward: 0  
Iteration 567: Movie 176621, Reward: 0  
Iteration 568: Movie 3146, Reward: 0  
Iteration 569: Movie 2801, Reward: 1  
Iteration 570: Movie 70206, Reward: 0  
Iteration 571: Movie 57368, Reward: 1  
Iteration 572: Movie 46578, Reward: 1  
Iteration 573: Movie 2734, Reward: 0  
Iteration 574: Movie 73499, Reward: 0  
Iteration 575: Movie 1701, Reward: 0  
Iteration 576: Movie 2369, Reward: 0  
Iteration 577: Movie 95780, Reward: 1  
Iteration 578: Movie 4909, Reward: 0  
Iteration 579: Movie 65982, Reward: 0  
Iteration 580: Movie 101360, Reward: 0  
Iteration 581: Movie 71530, Reward: 1  
Iteration 582: Movie 26386, Reward: 0  
Iteration 583: Movie 6228, Reward: 1  
Iteration 584: Movie 7086, Reward: 0  
Iteration 585: Movie 31437, Reward: 1  
Iteration 586: Movie 42725, Reward: 0  
Iteration 587: Movie 113186, Reward: 0  
Iteration 588: Movie 69224, Reward: 1  
Iteration 589: Movie 107159, Reward: 1  
Iteration 590: Movie 70451, Reward: 1  
Iteration 591: Movie 184997, Reward: 1  
Iteration 592: Movie 145745, Reward: 0  
Iteration 593: Movie 5012, Reward: 1  
Iteration 594: Movie 2011, Reward: 1  
Iteration 595: Movie 848, Reward: 1  
Iteration 596: Movie 54617, Reward: 0  
Iteration 597: Movie 1180, Reward: 0  
Iteration 598: Movie 8477, Reward: 1  
Iteration 599: Movie 5787, Reward: 0  
Iteration 600: Movie 4329, Reward: 0  
Iteration 601: Movie 68358, Reward: 1  
Iteration 602: Movie 8609, Reward: 0  
Iteration 603: Movie 5238, Reward: 0  
Iteration 604: Movie 3429, Reward: 1  
Iteration 605: Movie 175401, Reward: 1  
Iteration 606: Movie 77893, Reward: 1  
Iteration 607: Movie 1332, Reward: 1  
Iteration 608: Movie 26225, Reward: 1  
Iteration 609: Movie 128695, Reward: 0  
Iteration 610: Movie 424, Reward: 0  
Iteration 611: Movie 2836, Reward: 0  
Iteration 612: Movie 781, Reward: 1  
Iteration 613: Movie 79798, Reward: 1  
Iteration 614: Movie 2724, Reward: 0  
Iteration 615: Movie 224, Reward: 1

Iteration 616: Movie 74789, Reward: 0  
Iteration 617: Movie 2882, Reward: 0  
Iteration 618: Movie 3150, Reward: 1  
Iteration 619: Movie 97870, Reward: 1  
Iteration 620: Movie 988, Reward: 0  
Iteration 621: Movie 183911, Reward: 0  
Iteration 622: Movie 80549, Reward: 1  
Iteration 623: Movie 75947, Reward: 0  
Iteration 624: Movie 26151, Reward: 0  
Iteration 625: Movie 1191, Reward: 1  
Iteration 626: Movie 54259, Reward: 0  
Iteration 627: Movie 1091, Reward: 0  
Iteration 628: Movie 7373, Reward: 0  
Iteration 629: Movie 1082, Reward: 1  
Iteration 630: Movie 567, Reward: 0  
Iteration 631: Movie 85438, Reward: 0  
Iteration 632: Movie 6400, Reward: 0  
Iteration 633: Movie 57421, Reward: 1  
Iteration 634: Movie 2557, Reward: 1  
Iteration 635: Movie 2266, Reward: 0  
Iteration 636: Movie 7015, Reward: 0  
Iteration 637: Movie 6020, Reward: 0  
Iteration 638: Movie 2121, Reward: 0  
Iteration 639: Movie 3453, Reward: 0  
Iteration 640: Movie 74226, Reward: 1  
Iteration 641: Movie 175577, Reward: 0  
Iteration 642: Movie 3152, Reward: 1  
Iteration 643: Movie 55272, Reward: 1  
Iteration 644: Movie 8387, Reward: 0  
Iteration 645: Movie 46322, Reward: 1  
Iteration 646: Movie 81132, Reward: 1  
Iteration 647: Movie 159069, Reward: 1  
Iteration 648: Movie 53921, Reward: 0  
Iteration 649: Movie 2710, Reward: 0  
Iteration 650: Movie 27762, Reward: 0  
Iteration 651: Movie 40723, Reward: 0  
Iteration 652: Movie 102819, Reward: 0  
Iteration 653: Movie 4393, Reward: 1  
Iteration 654: Movie 185435, Reward: 0  
Iteration 655: Movie 6619, Reward: 1  
Iteration 656: Movie 100882, Reward: 1  
Iteration 657: Movie 3071, Reward: 1  
Iteration 658: Movie 116529, Reward: 0  
Iteration 659: Movie 117444, Reward: 0  
Iteration 660: Movie 5448, Reward: 0  
Iteration 661: Movie 5786, Reward: 1  
Iteration 662: Movie 160400, Reward: 0  
Iteration 663: Movie 6851, Reward: 0  
Iteration 664: Movie 121231, Reward: 1  
Iteration 665: Movie 72641, Reward: 1  
Iteration 666: Movie 151653, Reward: 0  
Iteration 667: Movie 135567, Reward: 0  
Iteration 668: Movie 1177, Reward: 1  
Iteration 669: Movie 156371, Reward: 1  
Iteration 670: Movie 3015, Reward: 1  
Iteration 671: Movie 1201, Reward: 1

Iteration 672: Movie 54272, Reward: 0  
Iteration 673: Movie 2528, Reward: 0  
Iteration 674: Movie 2565, Reward: 1  
Iteration 675: Movie 103027, Reward: 0  
Iteration 676: Movie 715, Reward: 1  
Iteration 677: Movie 109191, Reward: 0  
Iteration 678: Movie 2010, Reward: 1  
Iteration 679: Movie 2772, Reward: 1  
Iteration 680: Movie 585, Reward: 0  
Iteration 681: Movie 74868, Reward: 0  
Iteration 682: Movie 2334, Reward: 1  
Iteration 683: Movie 6436, Reward: 1  
Iteration 684: Movie 156675, Reward: 0  
Iteration 685: Movie 688, Reward: 0  
Iteration 686: Movie 149354, Reward: 0  
Iteration 687: Movie 1985, Reward: 0  
Iteration 688: Movie 158783, Reward: 0  
Iteration 689: Movie 96917, Reward: 1  
Iteration 690: Movie 90376, Reward: 0  
Iteration 691: Movie 93326, Reward: 0  
Iteration 692: Movie 5357, Reward: 1  
Iteration 693: Movie 106648, Reward: 0  
Iteration 694: Movie 2694, Reward: 1  
Iteration 695: Movie 85020, Reward: 1  
Iteration 696: Movie 69140, Reward: 1  
Iteration 697: Movie 8966, Reward: 0  
Iteration 698: Movie 2316, Reward: 1  
Iteration 699: Movie 56286, Reward: 1  
Iteration 700: Movie 89759, Reward: 1  
Iteration 701: Movie 4255, Reward: 0  
Iteration 702: Movie 4043, Reward: 1  
Iteration 703: Movie 1488, Reward: 0  
Iteration 704: Movie 44773, Reward: 0  
Iteration 705: Movie 5397, Reward: 0  
Iteration 706: Movie 3469, Reward: 1  
Iteration 707: Movie 599, Reward: 0  
Iteration 708: Movie 4125, Reward: 0  
Iteration 709: Movie 1916, Reward: 1  
Iteration 710: Movie 30812, Reward: 0  
Iteration 711: Movie 1984, Reward: 0  
Iteration 712: Movie 122898, Reward: 0  
Iteration 713: Movie 89837, Reward: 1  
Iteration 714: Movie 85885, Reward: 1  
Iteration 715: Movie 6773, Reward: 0  
Iteration 716: Movie 91784, Reward: 1  
Iteration 717: Movie 136840, Reward: 0  
Iteration 718: Movie 3824, Reward: 0  
Iteration 719: Movie 95519, Reward: 1  
Iteration 720: Movie 4032, Reward: 1  
Iteration 721: Movie 53894, Reward: 1  
Iteration 722: Movie 4092, Reward: 0  
Iteration 723: Movie 114847, Reward: 0  
Iteration 724: Movie 3801, Reward: 1  
Iteration 725: Movie 102880, Reward: 0  
Iteration 726: Movie 38798, Reward: 1  
Iteration 727: Movie 149566, Reward: 1

Iteration 728: Movie 5358, Reward: 0  
Iteration 729: Movie 52435, Reward: 0  
Iteration 730: Movie 4047, Reward: 0  
Iteration 731: Movie 2662, Reward: 0  
Iteration 732: Movie 3947, Reward: 0  
Iteration 733: Movie 1682, Reward: 0  
Iteration 734: Movie 478, Reward: 0  
Iteration 735: Movie 2118, Reward: 1  
Iteration 736: Movie 2070, Reward: 1  
Iteration 737: Movie 69606, Reward: 0  
Iteration 738: Movie 160422, Reward: 0  
Iteration 739: Movie 144, Reward: 0  
Iteration 740: Movie 2469, Reward: 0  
Iteration 741: Movie 1279, Reward: 0  
Iteration 742: Movie 611, Reward: 0  
Iteration 743: Movie 5379, Reward: 1  
Iteration 744: Movie 1932, Reward: 0  
Iteration 745: Movie 69306, Reward: 0  
Iteration 746: Movie 5929, Reward: 0  
Iteration 747: Movie 7361, Reward: 1  
Iteration 748: Movie 107780, Reward: 1  
Iteration 749: Movie 109850, Reward: 0  
Iteration 750: Movie 84844, Reward: 1  
Iteration 751: Movie 95149, Reward: 1  
Iteration 752: Movie 6629, Reward: 0  
Iteration 753: Movie 138210, Reward: 0  
Iteration 754: Movie 1030, Reward: 0  
Iteration 755: Movie 32009, Reward: 0  
Iteration 756: Movie 8743, Reward: 0  
Iteration 757: Movie 5893, Reward: 0  
Iteration 758: Movie 1289, Reward: 0  
Iteration 759: Movie 8831, Reward: 0  
Iteration 760: Movie 217, Reward: 0  
Iteration 761: Movie 111113, Reward: 0  
Iteration 762: Movie 94405, Reward: 0  
Iteration 763: Movie 32469, Reward: 1  
Iteration 764: Movie 1016, Reward: 0  
Iteration 765: Movie 140265, Reward: 1  
Iteration 766: Movie 94070, Reward: 1  
Iteration 767: Movie 27878, Reward: 1  
Iteration 768: Movie 167064, Reward: 1  
Iteration 769: Movie 6566, Reward: 0  
Iteration 770: Movie 2465, Reward: 0  
Iteration 771: Movie 53326, Reward: 0  
Iteration 772: Movie 96610, Reward: 1  
Iteration 773: Movie 173255, Reward: 0  
Iteration 774: Movie 1484, Reward: 1  
Iteration 775: Movie 2565, Reward: 1  
Iteration 776: Movie 46664, Reward: 0  
Iteration 777: Movie 55768, Reward: 0  
Iteration 778: Movie 700, Reward: 1  
Iteration 779: Movie 31297, Reward: 0  
Iteration 780: Movie 68554, Reward: 1  
Iteration 781: Movie 102407, Reward: 0  
Iteration 782: Movie 285, Reward: 1  
Iteration 783: Movie 993, Reward: 0

Iteration 784: Movie 92535, Reward: 1  
Iteration 785: Movie 5120, Reward: 1  
Iteration 786: Movie 7840, Reward: 1  
Iteration 787: Movie 102602, Reward: 1  
Iteration 788: Movie 8861, Reward: 0  
Iteration 789: Movie 34162, Reward: 0  
Iteration 790: Movie 89281, Reward: 0  
Iteration 791: Movie 879, Reward: 1  
Iteration 792: Movie 180985, Reward: 0  
Iteration 793: Movie 6696, Reward: 0  
Iteration 794: Movie 3328, Reward: 1  
Iteration 795: Movie 95449, Reward: 0  
Iteration 796: Movie 62336, Reward: 1  
Iteration 797: Movie 142602, Reward: 0  
Iteration 798: Movie 8685, Reward: 0  
Iteration 799: Movie 1330, Reward: 0  
Iteration 800: Movie 109723, Reward: 0  
Iteration 801: Movie 112868, Reward: 1  
Iteration 802: Movie 85, Reward: 1  
Iteration 803: Movie 118997, Reward: 0  
Iteration 804: Movie 41716, Reward: 1  
Iteration 805: Movie 27829, Reward: 0  
Iteration 806: Movie 2009, Reward: 1  
Iteration 807: Movie 1425, Reward: 0  
Iteration 808: Movie 2294, Reward: 0  
Iteration 809: Movie 3951, Reward: 1  
Iteration 810: Movie 46850, Reward: 1  
Iteration 811: Movie 959, Reward: 0  
Iteration 812: Movie 1, Reward: 1  
Iteration 813: Movie 778, Reward: 1  
Iteration 814: Movie 1016, Reward: 0  
Iteration 815: Movie 1696, Reward: 0  
Iteration 816: Movie 640, Reward: 0  
Iteration 817: Movie 86815, Reward: 0  
Iteration 818: Movie 3368, Reward: 0  
Iteration 819: Movie 58783, Reward: 0  
Iteration 820: Movie 173253, Reward: 0  
Iteration 821: Movie 6994, Reward: 0  
Iteration 822: Movie 1824, Reward: 0  
Iteration 823: Movie 1191, Reward: 0  
Iteration 824: Movie 4613, Reward: 0  
Iteration 825: Movie 968, Reward: 1  
Iteration 826: Movie 1966, Reward: 1  
Iteration 827: Movie 48780, Reward: 1  
Iteration 828: Movie 2145, Reward: 1  
Iteration 829: Movie 131714, Reward: 0  
Iteration 830: Movie 152091, Reward: 0  
Iteration 831: Movie 1958, Reward: 0  
Iteration 832: Movie 71379, Reward: 1  
Iteration 833: Movie 180031, Reward: 0  
Iteration 834: Movie 6817, Reward: 0  
Iteration 835: Movie 5896, Reward: 1  
Iteration 836: Movie 5932, Reward: 0  
Iteration 837: Movie 110102, Reward: 0  
Iteration 838: Movie 2352, Reward: 1  
Iteration 839: Movie 130490, Reward: 0

Iteration 840: Movie 105835, Reward: 1  
Iteration 841: Movie 85788, Reward: 0  
Iteration 842: Movie 3879, Reward: 0  
Iteration 843: Movie 4443, Reward: 0  
Iteration 844: Movie 8131, Reward: 0  
Iteration 845: Movie 38061, Reward: 1  
Iteration 846: Movie 2253, Reward: 0  
Iteration 847: Movie 4754, Reward: 1  
Iteration 848: Movie 8375, Reward: 0  
Iteration 849: Movie 52, Reward: 1  
Iteration 850: Movie 2490, Reward: 0  
Iteration 851: Movie 51540, Reward: 1  
Iteration 852: Movie 5818, Reward: 1  
Iteration 853: Movie 1180, Reward: 0  
Iteration 854: Movie 4052, Reward: 0  
Iteration 855: Movie 8464, Reward: 0  
Iteration 856: Movie 7085, Reward: 0  
Iteration 857: Movie 118702, Reward: 0  
Iteration 858: Movie 109723, Reward: 0  
Iteration 859: Movie 74530, Reward: 0  
Iteration 860: Movie 4573, Reward: 0  
Iteration 861: Movie 74089, Reward: 0  
Iteration 862: Movie 74089, Reward: 0  
Iteration 863: Movie 1064, Reward: 0  
Iteration 864: Movie 1124, Reward: 0  
Iteration 865: Movie 70206, Reward: 0  
Iteration 866: Movie 27778, Reward: 0  
Iteration 867: Movie 103210, Reward: 0  
Iteration 868: Movie 4883, Reward: 1  
Iteration 869: Movie 7833, Reward: 0  
Iteration 870: Movie 761, Reward: 0  
Iteration 871: Movie 2698, Reward: 0  
Iteration 872: Movie 3197, Reward: 0  
Iteration 873: Movie 73854, Reward: 1  
Iteration 874: Movie 3827, Reward: 0  
Iteration 875: Movie 5021, Reward: 0  
Iteration 876: Movie 86028, Reward: 0  
Iteration 877: Movie 33188, Reward: 0  
Iteration 878: Movie 98361, Reward: 1  
Iteration 879: Movie 2818, Reward: 0  
Iteration 880: Movie 7991, Reward: 0  
Iteration 881: Movie 8947, Reward: 0  
Iteration 882: Movie 142074, Reward: 0  
Iteration 883: Movie 6560, Reward: 0  
Iteration 884: Movie 5, Reward: 0  
Iteration 885: Movie 4259, Reward: 1  
Iteration 886: Movie 8879, Reward: 0  
Iteration 887: Movie 122920, Reward: 0  
Iteration 888: Movie 69685, Reward: 0  
Iteration 889: Movie 1208, Reward: 0  
Iteration 890: Movie 127152, Reward: 1  
Iteration 891: Movie 3248, Reward: 0  
Iteration 892: Movie 8720, Reward: 0  
Iteration 893: Movie 168846, Reward: 1  
Iteration 894: Movie 7165, Reward: 0  
Iteration 895: Movie 27904, Reward: 1

Iteration 896: Movie 62644, Reward: 1  
Iteration 897: Movie 7449, Reward: 0  
Iteration 898: Movie 3401, Reward: 0  
Iteration 899: Movie 932, Reward: 1  
Iteration 900: Movie 8290, Reward: 0  
Iteration 901: Movie 43928, Reward: 0  
Iteration 902: Movie 3090, Reward: 0  
Iteration 903: Movie 141131, Reward: 0  
Iteration 904: Movie 3869, Reward: 1  
Iteration 905: Movie 130052, Reward: 0  
Iteration 906: Movie 136564, Reward: 0  
Iteration 907: Movie 37495, Reward: 0  
Iteration 908: Movie 3691, Reward: 0  
Iteration 909: Movie 26812, Reward: 0  
Iteration 910: Movie 2899, Reward: 0  
Iteration 911: Movie 8911, Reward: 1  
Iteration 912: Movie 4313, Reward: 0  
Iteration 913: Movie 4323, Reward: 1  
Iteration 914: Movie 102602, Reward: 1  
Iteration 915: Movie 69644, Reward: 0  
Iteration 916: Movie 26150, Reward: 1  
Iteration 917: Movie 26750, Reward: 0  
Iteration 918: Movie 6184, Reward: 0  
Iteration 919: Movie 2259, Reward: 0  
Iteration 920: Movie 7767, Reward: 1  
Iteration 921: Movie 179135, Reward: 1  
Iteration 922: Movie 137345, Reward: 0  
Iteration 923: Movie 55067, Reward: 0  
Iteration 924: Movie 27801, Reward: 0  
Iteration 925: Movie 144222, Reward: 0  
Iteration 926: Movie 7093, Reward: 1  
Iteration 927: Movie 49957, Reward: 0  
Iteration 928: Movie 1748, Reward: 0  
Iteration 929: Movie 6827, Reward: 0  
Iteration 930: Movie 990, Reward: 0  
Iteration 931: Movie 25963, Reward: 1  
Iteration 932: Movie 26695, Reward: 0  
Iteration 933: Movie 116823, Reward: 1  
Iteration 934: Movie 1339, Reward: 0  
Iteration 935: Movie 4708, Reward: 1  
Iteration 936: Movie 2102, Reward: 0  
Iteration 937: Movie 56156, Reward: 0  
Iteration 938: Movie 6902, Reward: 1  
Iteration 939: Movie 2870, Reward: 1  
Iteration 940: Movie 174055, Reward: 0  
Iteration 941: Movie 4802, Reward: 0  
Iteration 942: Movie 122896, Reward: 1  
Iteration 943: Movie 6545, Reward: 1  
Iteration 944: Movie 139747, Reward: 0  
Iteration 945: Movie 27866, Reward: 0  
Iteration 946: Movie 7700, Reward: 1  
Iteration 947: Movie 71520, Reward: 0  
Iteration 948: Movie 33639, Reward: 0  
Iteration 949: Movie 3948, Reward: 1  
Iteration 950: Movie 106916, Reward: 1  
Iteration 951: Movie 109848, Reward: 1



```
Iteration 952: Movie 57368, Reward: 0
Iteration 953: Movie 88810, Reward: 0
Iteration 954: Movie 5312, Reward: 0
Iteration 955: Movie 79224, Reward: 1
Iteration 956: Movie 5461, Reward: 0
Iteration 957: Movie 96, Reward: 0
Iteration 958: Movie 40614, Reward: 0
Iteration 959: Movie 48342, Reward: 0
Iteration 960: Movie 130686, Reward: 0
Iteration 961: Movie 42730, Reward: 0
Iteration 962: Movie 33679, Reward: 0
Iteration 963: Movie 173941, Reward: 0
Iteration 964: Movie 116823, Reward: 0
Iteration 965: Movie 5945, Reward: 1
Iteration 966: Movie 62644, Reward: 0
Iteration 967: Movie 8622, Reward: 0
Iteration 968: Movie 5353, Reward: 0
Iteration 969: Movie 1791, Reward: 0
Iteration 970: Movie 6156, Reward: 0
Iteration 971: Movie 5615, Reward: 0
Iteration 972: Movie 57502, Reward: 1
Iteration 973: Movie 130052, Reward: 0
Iteration 974: Movie 3689, Reward: 0
Iteration 975: Movie 3573, Reward: 0
Iteration 976: Movie 104272, Reward: 1
Iteration 977: Movie 3045, Reward: 0
Iteration 978: Movie 2371, Reward: 1
Iteration 979: Movie 173307, Reward: 0
Iteration 980: Movie 1945, Reward: 1
Iteration 981: Movie 1906, Reward: 0
Iteration 982: Movie 59814, Reward: 1
Iteration 983: Movie 4321, Reward: 1
Iteration 984: Movie 4720, Reward: 0
Iteration 985: Movie 2068, Reward: 1
Iteration 986: Movie 95949, Reward: 0
Iteration 987: Movie 50851, Reward: 1
Iteration 988: Movie 46337, Reward: 0
Iteration 989: Movie 1111, Reward: 0
Iteration 990: Movie 2065, Reward: 0
Iteration 991: Movie 2097, Reward: 0
Iteration 992: Movie 86593, Reward: 0
Iteration 993: Movie 32060, Reward: 0
Iteration 994: Movie 122922, Reward: 1
Iteration 995: Movie 100737, Reward: 0
Iteration 996: Movie 1631, Reward: 1
Iteration 997: Movie 5293, Reward: 0
Iteration 998: Movie 6239, Reward: 0
Iteration 999: Movie 2848, Reward: 1
Iteration 1000: Movie 4357, Reward: 1
```

## Using Greedy Policy (1M)

Implement a greedy policy that always recommends the movie with the highest estimated reward and print each iteration. (Mandatory)

```
In [22]: # run the environment with an agent that is guided by a greedy policy
#-----write your code below this line-----

print("\nGreedy policy iterations:")
movie_estimates = {movie: 0 for movie in df['movieId'].unique()}
movie_counts = {movie: 0 for movie in df['movieId'].unique()}

for i in range(1000):
    if i == 0 or max(movie_counts.values()) == 0:
        arm = np.random.choice(df['movieId'].unique()) # Random initial choice
    else:
        arm = max(movie_estimates, key=movie_estimates.get)

    reward = np.random.choice(df[df['movieId'] == arm]['Reward'])
    movie_counts[arm] += 1
    movie_estimates[arm] = ((movie_estimates[arm] * (movie_counts[arm] - 1)) + reward)

    total_rewards_greedy += reward
    cumulative_rewards_greedy.append(total_rewards_greedy)
    print(f"Iteration {i+1}: Movie {arm}, Reward: {reward}")
```

Greedy policy iterations:

Iteration 1: Movie 3693, Reward: 0  
Iteration 2: Movie 1, Reward: 1  
Iteration 3: Movie 1, Reward: 1  
Iteration 4: Movie 1, Reward: 1  
Iteration 5: Movie 1, Reward: 1  
Iteration 6: Movie 1, Reward: 1  
Iteration 7: Movie 1, Reward: 1  
Iteration 8: Movie 1, Reward: 1  
Iteration 9: Movie 1, Reward: 1  
Iteration 10: Movie 1, Reward: 0  
Iteration 11: Movie 1, Reward: 1  
Iteration 12: Movie 1, Reward: 1  
Iteration 13: Movie 1, Reward: 1  
Iteration 14: Movie 1, Reward: 1  
Iteration 15: Movie 1, Reward: 0  
Iteration 16: Movie 1, Reward: 1  
Iteration 17: Movie 1, Reward: 0  
Iteration 18: Movie 1, Reward: 1  
Iteration 19: Movie 1, Reward: 0  
Iteration 20: Movie 1, Reward: 1  
Iteration 21: Movie 1, Reward: 1  
Iteration 22: Movie 1, Reward: 1  
Iteration 23: Movie 1, Reward: 1  
Iteration 24: Movie 1, Reward: 1  
Iteration 25: Movie 1, Reward: 1  
Iteration 26: Movie 1, Reward: 0  
Iteration 27: Movie 1, Reward: 1  
Iteration 28: Movie 1, Reward: 1  
Iteration 29: Movie 1, Reward: 0  
Iteration 30: Movie 1, Reward: 1  
Iteration 31: Movie 1, Reward: 1  
Iteration 32: Movie 1, Reward: 0  
Iteration 33: Movie 1, Reward: 1  
Iteration 34: Movie 1, Reward: 1  
Iteration 35: Movie 1, Reward: 1  
Iteration 36: Movie 1, Reward: 1  
Iteration 37: Movie 1, Reward: 0  
Iteration 38: Movie 1, Reward: 1  
Iteration 39: Movie 1, Reward: 1  
Iteration 40: Movie 1, Reward: 1  
Iteration 41: Movie 1, Reward: 1  
Iteration 42: Movie 1, Reward: 1  
Iteration 43: Movie 1, Reward: 1  
Iteration 44: Movie 1, Reward: 1  
Iteration 45: Movie 1, Reward: 0  
Iteration 46: Movie 1, Reward: 1  
Iteration 47: Movie 1, Reward: 0  
Iteration 48: Movie 1, Reward: 1  
Iteration 49: Movie 1, Reward: 0  
Iteration 50: Movie 1, Reward: 0  
Iteration 51: Movie 1, Reward: 0  
Iteration 52: Movie 1, Reward: 1  
Iteration 53: Movie 1, Reward: 1  
Iteration 54: Movie 1, Reward: 1  
Iteration 55: Movie 1, Reward: 1

Iteration 56: Movie 1, Reward: 1  
Iteration 57: Movie 1, Reward: 0  
Iteration 58: Movie 1, Reward: 0  
Iteration 59: Movie 1, Reward: 1  
Iteration 60: Movie 1, Reward: 1  
Iteration 61: Movie 1, Reward: 0  
Iteration 62: Movie 1, Reward: 0  
Iteration 63: Movie 1, Reward: 0  
Iteration 64: Movie 1, Reward: 0  
Iteration 65: Movie 1, Reward: 1  
Iteration 66: Movie 1, Reward: 1  
Iteration 67: Movie 1, Reward: 1  
Iteration 68: Movie 1, Reward: 0  
Iteration 69: Movie 1, Reward: 1  
Iteration 70: Movie 1, Reward: 1  
Iteration 71: Movie 1, Reward: 1  
Iteration 72: Movie 1, Reward: 1  
Iteration 73: Movie 1, Reward: 1  
Iteration 74: Movie 1, Reward: 1  
Iteration 75: Movie 1, Reward: 1  
Iteration 76: Movie 1, Reward: 1  
Iteration 77: Movie 1, Reward: 0  
Iteration 78: Movie 1, Reward: 1  
Iteration 79: Movie 1, Reward: 0  
Iteration 80: Movie 1, Reward: 1  
Iteration 81: Movie 1, Reward: 1  
Iteration 82: Movie 1, Reward: 1  
Iteration 83: Movie 1, Reward: 1  
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Iteration 661: Movie 1, Reward: 1  
Iteration 662: Movie 1, Reward: 0  
Iteration 663: Movie 1, Reward: 0  
Iteration 664: Movie 1, Reward: 0  
Iteration 665: Movie 1, Reward: 1  
Iteration 666: Movie 1, Reward: 0  
Iteration 667: Movie 1, Reward: 1  
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Iteration 674: Movie 1, Reward: 0  
Iteration 675: Movie 1, Reward: 1  
Iteration 676: Movie 1, Reward: 1  
Iteration 677: Movie 1, Reward: 0  
Iteration 678: Movie 1, Reward: 1  
Iteration 679: Movie 1, Reward: 1  
Iteration 680: Movie 1, Reward: 0  
Iteration 681: Movie 1, Reward: 0  
Iteration 682: Movie 1, Reward: 1  
Iteration 683: Movie 1, Reward: 0  
Iteration 684: Movie 1, Reward: 0  
Iteration 685: Movie 1, Reward: 1  
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Iteration 698: Movie 1, Reward: 0  
Iteration 699: Movie 1, Reward: 1  
Iteration 700: Movie 1, Reward: 0  
Iteration 701: Movie 1, Reward: 1  
Iteration 702: Movie 1, Reward: 1  
Iteration 703: Movie 1, Reward: 1  
Iteration 704: Movie 1, Reward: 0  
Iteration 705: Movie 1, Reward: 0  
Iteration 706: Movie 1, Reward: 1  
Iteration 707: Movie 1, Reward: 1  
Iteration 708: Movie 1, Reward: 1  
Iteration 709: Movie 1, Reward: 1  
Iteration 710: Movie 1, Reward: 1  
Iteration 711: Movie 1, Reward: 1  
Iteration 712: Movie 1, Reward: 0  
Iteration 713: Movie 1, Reward: 0  
Iteration 714: Movie 1, Reward: 1  
Iteration 715: Movie 1, Reward: 1  
Iteration 716: Movie 1, Reward: 1  
Iteration 717: Movie 1, Reward: 1  
Iteration 718: Movie 1, Reward: 1  
Iteration 719: Movie 1, Reward: 0  
Iteration 720: Movie 1, Reward: 0  
Iteration 721: Movie 1, Reward: 0  
Iteration 722: Movie 1, Reward: 1  
Iteration 723: Movie 1, Reward: 0  
Iteration 724: Movie 1, Reward: 1  
Iteration 725: Movie 1, Reward: 1  
Iteration 726: Movie 1, Reward: 1  
Iteration 727: Movie 1, Reward: 0

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Iteration 737: Movie 1, Reward: 1  
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Iteration 746: Movie 1, Reward: 1  
Iteration 747: Movie 1, Reward: 1  
Iteration 748: Movie 1, Reward: 0  
Iteration 749: Movie 1, Reward: 1  
Iteration 750: Movie 1, Reward: 1  
Iteration 751: Movie 1, Reward: 0  
Iteration 752: Movie 1, Reward: 1  
Iteration 753: Movie 1, Reward: 1  
Iteration 754: Movie 1, Reward: 1  
Iteration 755: Movie 1, Reward: 1  
Iteration 756: Movie 1, Reward: 0  
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Iteration 881: Movie 1, Reward: 0  
Iteration 882: Movie 1, Reward: 0  
Iteration 883: Movie 1, Reward: 1  
Iteration 884: Movie 1, Reward: 1  
Iteration 885: Movie 1, Reward: 1  
Iteration 886: Movie 1, Reward: 0  
Iteration 887: Movie 1, Reward: 1  
Iteration 888: Movie 1, Reward: 1  
Iteration 889: Movie 1, Reward: 1  
Iteration 890: Movie 1, Reward: 1  
Iteration 891: Movie 1, Reward: 0  
Iteration 892: Movie 1, Reward: 0  
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Iteration 896: Movie 1, Reward: 0  
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Iteration 898: Movie 1, Reward: 1  
Iteration 899: Movie 1, Reward: 0  
Iteration 900: Movie 1, Reward: 0  
Iteration 901: Movie 1, Reward: 0  
Iteration 902: Movie 1, Reward: 1  
Iteration 903: Movie 1, Reward: 1  
Iteration 904: Movie 1, Reward: 1  
Iteration 905: Movie 1, Reward: 0  
Iteration 906: Movie 1, Reward: 1  
Iteration 907: Movie 1, Reward: 0  
Iteration 908: Movie 1, Reward: 1  
Iteration 909: Movie 1, Reward: 1  
Iteration 910: Movie 1, Reward: 1  
Iteration 911: Movie 1, Reward: 1  
Iteration 912: Movie 1, Reward: 0  
Iteration 913: Movie 1, Reward: 1  
Iteration 914: Movie 1, Reward: 1  
Iteration 915: Movie 1, Reward: 1  
Iteration 916: Movie 1, Reward: 0  
Iteration 917: Movie 1, Reward: 1  
Iteration 918: Movie 1, Reward: 1  
Iteration 919: Movie 1, Reward: 0  
Iteration 920: Movie 1, Reward: 0  
Iteration 921: Movie 1, Reward: 0  
Iteration 922: Movie 1, Reward: 0  
Iteration 923: Movie 1, Reward: 1  
Iteration 924: Movie 1, Reward: 0  
Iteration 925: Movie 1, Reward: 1  
Iteration 926: Movie 1, Reward: 1  
Iteration 927: Movie 1, Reward: 1  
Iteration 928: Movie 1, Reward: 0  
Iteration 929: Movie 1, Reward: 0  
Iteration 930: Movie 1, Reward: 1  
Iteration 931: Movie 1, Reward: 1  
Iteration 932: Movie 1, Reward: 1  
Iteration 933: Movie 1, Reward: 1  
Iteration 934: Movie 1, Reward: 1  
Iteration 935: Movie 1, Reward: 1  
Iteration 936: Movie 1, Reward: 1  
Iteration 937: Movie 1, Reward: 1  
Iteration 938: Movie 1, Reward: 1  
Iteration 939: Movie 1, Reward: 0  
Iteration 940: Movie 1, Reward: 1  
Iteration 941: Movie 1, Reward: 1  
Iteration 942: Movie 1, Reward: 0  
Iteration 943: Movie 1, Reward: 0  
Iteration 944: Movie 1, Reward: 1  
Iteration 945: Movie 1, Reward: 1  
Iteration 946: Movie 1, Reward: 1  
Iteration 947: Movie 1, Reward: 1  
Iteration 948: Movie 1, Reward: 0  
Iteration 949: Movie 1, Reward: 0  
Iteration 950: Movie 1, Reward: 1  
Iteration 951: Movie 1, Reward: 1

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Iteration 952: Movie 1, Reward: 1
Iteration 953: Movie 1, Reward: 0
Iteration 954: Movie 1, Reward: 0
Iteration 955: Movie 1, Reward: 0
Iteration 956: Movie 1, Reward: 1
Iteration 957: Movie 1, Reward: 1
Iteration 958: Movie 1, Reward: 1
Iteration 959: Movie 1, Reward: 1
Iteration 960: Movie 1, Reward: 1
Iteration 961: Movie 1, Reward: 0
Iteration 962: Movie 1, Reward: 1
Iteration 963: Movie 1, Reward: 0
Iteration 964: Movie 1, Reward: 0
Iteration 965: Movie 1, Reward: 1
Iteration 966: Movie 1, Reward: 0
Iteration 967: Movie 1, Reward: 0
Iteration 968: Movie 1, Reward: 1
Iteration 969: Movie 1, Reward: 1
Iteration 970: Movie 1, Reward: 0
Iteration 971: Movie 1, Reward: 0
Iteration 972: Movie 1, Reward: 1
Iteration 973: Movie 1, Reward: 0
Iteration 974: Movie 1, Reward: 0
Iteration 975: Movie 1, Reward: 1
Iteration 976: Movie 1, Reward: 1
Iteration 977: Movie 1, Reward: 1
Iteration 978: Movie 1, Reward: 0
Iteration 979: Movie 1, Reward: 0
Iteration 980: Movie 1, Reward: 1
Iteration 981: Movie 1, Reward: 1
Iteration 982: Movie 1, Reward: 1
Iteration 983: Movie 1, Reward: 1
Iteration 984: Movie 1, Reward: 0
Iteration 985: Movie 1, Reward: 0
Iteration 986: Movie 1, Reward: 1
Iteration 987: Movie 1, Reward: 1
Iteration 988: Movie 1, Reward: 1
Iteration 989: Movie 1, Reward: 1
Iteration 990: Movie 1, Reward: 1
Iteration 991: Movie 1, Reward: 1
Iteration 992: Movie 1, Reward: 1
Iteration 993: Movie 1, Reward: 1
Iteration 994: Movie 1, Reward: 0
Iteration 995: Movie 1, Reward: 1
Iteration 996: Movie 1, Reward: 0
Iteration 997: Movie 1, Reward: 1
Iteration 998: Movie 1, Reward: 1
Iteration 999: Movie 1, Reward: 1
Iteration 1000: Movie 1, Reward: 1
```

## Using Epsilon-Greedy Policy (1.5M)

Implement the epsilon-greedy policy, where with probability  $\epsilon$  you explore (recommend a random movie) and with probability  $(1-\epsilon)$  you exploit (recommend the best-known movie).

Try with  $\epsilon = 0.1, 0.2, 0.5$  and print each iteration. What value of  $\epsilon$  yields the best performance? (Mandatory)

```
In [23]: # run the environment with an agent that is guided by a epsilon-greedy policy
#-----write your code below this line-----

print("\nEpsilon-Greedy policy iterations:")
for epsilon in [0.1, 0.2, 0.5]:
    movie_estimates = {movie: 0 for movie in df['movieId'].unique()}
    movie_counts = {movie: 0 for movie in df['movieId'].unique()}

    for i in range(1000):
        if np.random.rand() < epsilon:
            arm = np.random.choice(df['movieId'].unique()) # Explore
        else:
            arm = max(movie_estimates, key=movie_estimates.get) # Exploit

        reward = np.random.choice(df[df['movieId'] == arm]['Reward'])
        movie_counts[arm] += 1
        movie_estimates[arm] = ((movie_estimates[arm] * (movie_counts[arm] - 1)) +

        total_rewards_epsilon[epsilon] += reward
        cumulative_rewards_epsilon[epsilon].append(total_rewards_epsilon[epsilon])

    print(f"Epsilon {epsilon}, Iteration {i+1}: Movie {arm}, Reward: {reward}")
```

Epsilon-Greedy policy iterations:

Epsilon 0.1, Iteration 1: Movie 1, Reward: 0  
Epsilon 0.1, Iteration 2: Movie 1, Reward: 0  
Epsilon 0.1, Iteration 3: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 4: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 5: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 6: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 7: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 8: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 9: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 10: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 11: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 12: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 13: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 14: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 15: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 16: Movie 46559, Reward: 0  
Epsilon 0.1, Iteration 17: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 18: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 19: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 20: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 21: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 22: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 23: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 24: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 25: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 26: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 27: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 28: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 29: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 30: Movie 6001, Reward: 1  
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Epsilon 0.1, Iteration 32: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 33: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 34: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 35: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 36: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 37: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 38: Movie 3740, Reward: 1  
Epsilon 0.1, Iteration 39: Movie 3740, Reward: 0  
Epsilon 0.1, Iteration 40: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 41: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 42: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 43: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 44: Movie 72737, Reward: 0  
Epsilon 0.1, Iteration 45: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 46: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 47: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 48: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 49: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 50: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 51: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 52: Movie 6001, Reward: 0  
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Epsilon 0.1, Iteration 54: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 55: Movie 6001, Reward: 1

Epsilon 0.1, Iteration 56: Movie 6001, Reward: 1  
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Epsilon 0.1, Iteration 62: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 63: Movie 6001, Reward: 0  
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Epsilon 0.1, Iteration 70: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 71: Movie 6001, Reward: 0  
Epsilon 0.1, Iteration 72: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 73: Movie 6001, Reward: 1  
Epsilon 0.1, Iteration 74: Movie 115828, Reward: 1  
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Epsilon 0.1, Iteration 99: Movie 115828, Reward: 1  
Epsilon 0.1, Iteration 100: Movie 115828, Reward: 1  
Epsilon 0.1, Iteration 101: Movie 115828, Reward: 1  
Epsilon 0.1, Iteration 102: Movie 115828, Reward: 1  
Epsilon 0.1, Iteration 103: Movie 115828, Reward: 1  
Epsilon 0.1, Iteration 104: Movie 2067, Reward: 1  
Epsilon 0.1, Iteration 105: Movie 2067, Reward: 1  
Epsilon 0.1, Iteration 106: Movie 2067, Reward: 1  
Epsilon 0.1, Iteration 107: Movie 2067, Reward: 1  
Epsilon 0.1, Iteration 108: Movie 2067, Reward: 1  
Epsilon 0.1, Iteration 109: Movie 2067, Reward: 0  
Epsilon 0.1, Iteration 110: Movie 115828, Reward: 1  
Epsilon 0.1, Iteration 111: Movie 115828, Reward: 1

Epsilon 0.1, Iteration 112: Movie 115828, Reward: 1  
Epsilon 0.1, Iteration 113: Movie 115828, Reward: 1  
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Epsilon 0.1, Iteration 115: Movie 115828, Reward: 1  
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Epsilon 0.1, Iteration 123: Movie 115828, Reward: 1  
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Epsilon 0.2, Iteration 996: Movie 4628, Reward: 0  
Epsilon 0.2, Iteration 997: Movie 87520, Reward: 0  
Epsilon 0.2, Iteration 998: Movie 96488, Reward: 1  
Epsilon 0.2, Iteration 999: Movie 96488, Reward: 1  
Epsilon 0.2, Iteration 1000: Movie 96488, Reward: 1  
Epsilon 0.5, Iteration 1: Movie 1, Reward: 1  
Epsilon 0.5, Iteration 2: Movie 7245, Reward: 0  
Epsilon 0.5, Iteration 3: Movie 1, Reward: 1  
Epsilon 0.5, Iteration 4: Movie 1, Reward: 1  
Epsilon 0.5, Iteration 5: Movie 147282, Reward: 1  
Epsilon 0.5, Iteration 6: Movie 1, Reward: 1  
Epsilon 0.5, Iteration 7: Movie 1056, Reward: 0  
Epsilon 0.5, Iteration 8: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 9: Movie 1, Reward: 1  
Epsilon 0.5, Iteration 10: Movie 110, Reward: 1  
Epsilon 0.5, Iteration 11: Movie 1, Reward: 1  
Epsilon 0.5, Iteration 12: Movie 69606, Reward: 0  
Epsilon 0.5, Iteration 13: Movie 457, Reward: 0  
Epsilon 0.5, Iteration 14: Movie 3067, Reward: 0  
Epsilon 0.5, Iteration 15: Movie 4580, Reward: 0

Epsilon 0.5, Iteration 16: Movie 1, Reward: 1  
Epsilon 0.5, Iteration 17: Movie 1, Reward: 1  
Epsilon 0.5, Iteration 18: Movie 261, Reward: 1  
Epsilon 0.5, Iteration 19: Movie 1, Reward: 0  
Epsilon 0.5, Iteration 20: Movie 110, Reward: 1  
Epsilon 0.5, Iteration 21: Movie 3959, Reward: 1  
Epsilon 0.5, Iteration 22: Movie 1591, Reward: 0  
Epsilon 0.5, Iteration 23: Movie 182639, Reward: 1  
Epsilon 0.5, Iteration 24: Movie 110, Reward: 1  
Epsilon 0.5, Iteration 25: Movie 110, Reward: 1  
Epsilon 0.5, Iteration 26: Movie 167064, Reward: 1  
Epsilon 0.5, Iteration 27: Movie 2405, Reward: 0  
Epsilon 0.5, Iteration 28: Movie 110, Reward: 0  
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Epsilon 0.5, Iteration 30: Movie 57910, Reward: 0  
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Epsilon 0.5, Iteration 32: Movie 261, Reward: 1  
Epsilon 0.5, Iteration 33: Movie 261, Reward: 0  
Epsilon 0.5, Iteration 34: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 35: Movie 1940, Reward: 1  
Epsilon 0.5, Iteration 36: Movie 2048, Reward: 0  
Epsilon 0.5, Iteration 37: Movie 6193, Reward: 1  
Epsilon 0.5, Iteration 38: Movie 2585, Reward: 1  
Epsilon 0.5, Iteration 39: Movie 173351, Reward: 1  
Epsilon 0.5, Iteration 40: Movie 4602, Reward: 0  
Epsilon 0.5, Iteration 41: Movie 8117, Reward: 1  
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Epsilon 0.5, Iteration 43: Movie 38304, Reward: 1  
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Epsilon 0.5, Iteration 47: Movie 132084, Reward: 0  
Epsilon 0.5, Iteration 48: Movie 156387, Reward: 1  
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Epsilon 0.5, Iteration 764: Movie 168250, Reward: 1  
Epsilon 0.5, Iteration 765: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 766: Movie 6992, Reward: 0  
Epsilon 0.5, Iteration 767: Movie 3327, Reward: 1  
Epsilon 0.5, Iteration 768: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 769: Movie 86922, Reward: 1  
Epsilon 0.5, Iteration 770: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 771: Movie 67923, Reward: 1  
Epsilon 0.5, Iteration 772: Movie 3254, Reward: 0  
Epsilon 0.5, Iteration 773: Movie 5874, Reward: 0  
Epsilon 0.5, Iteration 774: Movie 45361, Reward: 0  
Epsilon 0.5, Iteration 775: Movie 3841, Reward: 1  
Epsilon 0.5, Iteration 776: Movie 48045, Reward: 1  
Epsilon 0.5, Iteration 777: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 778: Movie 7089, Reward: 1  
Epsilon 0.5, Iteration 779: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 780: Movie 32011, Reward: 0  
Epsilon 0.5, Iteration 781: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 782: Movie 88, Reward: 1  
Epsilon 0.5, Iteration 783: Movie 88, Reward: 0  
Epsilon 0.5, Iteration 784: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 785: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 786: Movie 1855, Reward: 0  
Epsilon 0.5, Iteration 787: Movie 193581, Reward: 1  
Epsilon 0.5, Iteration 788: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 789: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 790: Movie 662, Reward: 0  
Epsilon 0.5, Iteration 791: Movie 165343, Reward: 0  
Epsilon 0.5, Iteration 792: Movie 125, Reward: 1  
Epsilon 0.5, Iteration 793: Movie 125, Reward: 1  
Epsilon 0.5, Iteration 794: Movie 26116, Reward: 1  
Epsilon 0.5, Iteration 795: Movie 125, Reward: 1  
Epsilon 0.5, Iteration 796: Movie 4393, Reward: 1  
Epsilon 0.5, Iteration 797: Movie 125, Reward: 0  
Epsilon 0.5, Iteration 798: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 799: Movie 8117, Reward: 1

Epsilon 0.5, Iteration 800: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 801: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 802: Movie 96567, Reward: 1  
Epsilon 0.5, Iteration 803: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 804: Movie 67734, Reward: 0  
Epsilon 0.5, Iteration 805: Movie 1432, Reward: 0  
Epsilon 0.5, Iteration 806: Movie 4617, Reward: 0  
Epsilon 0.5, Iteration 807: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 808: Movie 782, Reward: 1  
Epsilon 0.5, Iteration 809: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 810: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 811: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 812: Movie 2620, Reward: 0  
Epsilon 0.5, Iteration 813: Movie 86892, Reward: 1  
Epsilon 0.5, Iteration 814: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 815: Movie 79251, Reward: 1  
Epsilon 0.5, Iteration 816: Movie 45732, Reward: 0  
Epsilon 0.5, Iteration 817: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 818: Movie 30846, Reward: 0  
Epsilon 0.5, Iteration 819: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 820: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 821: Movie 1207, Reward: 1  
Epsilon 0.5, Iteration 822: Movie 26810, Reward: 1  
Epsilon 0.5, Iteration 823: Movie 7082, Reward: 1  
Epsilon 0.5, Iteration 824: Movie 38294, Reward: 0  
Epsilon 0.5, Iteration 825: Movie 1207, Reward: 1  
Epsilon 0.5, Iteration 826: Movie 4427, Reward: 1  
Epsilon 0.5, Iteration 827: Movie 4799, Reward: 0  
Epsilon 0.5, Iteration 828: Movie 6266, Reward: 0  
Epsilon 0.5, Iteration 829: Movie 39449, Reward: 0  
Epsilon 0.5, Iteration 830: Movie 8199, Reward: 0  
Epsilon 0.5, Iteration 831: Movie 27873, Reward: 0  
Epsilon 0.5, Iteration 832: Movie 5442, Reward: 0  
Epsilon 0.5, Iteration 833: Movie 1207, Reward: 0  
Epsilon 0.5, Iteration 834: Movie 185031, Reward: 1  
Epsilon 0.5, Iteration 835: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 836: Movie 73290, Reward: 1  
Epsilon 0.5, Iteration 837: Movie 46865, Reward: 0  
Epsilon 0.5, Iteration 838: Movie 7570, Reward: 0  
Epsilon 0.5, Iteration 839: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 840: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 841: Movie 56174, Reward: 0  
Epsilon 0.5, Iteration 842: Movie 274, Reward: 1  
Epsilon 0.5, Iteration 843: Movie 59725, Reward: 0  
Epsilon 0.5, Iteration 844: Movie 49396, Reward: 0  
Epsilon 0.5, Iteration 845: Movie 68952, Reward: 0  
Epsilon 0.5, Iteration 846: Movie 2866, Reward: 0  
Epsilon 0.5, Iteration 847: Movie 274, Reward: 1  
Epsilon 0.5, Iteration 848: Movie 94150, Reward: 1  
Epsilon 0.5, Iteration 849: Movie 56156, Reward: 0  
Epsilon 0.5, Iteration 850: Movie 180, Reward: 0  
Epsilon 0.5, Iteration 851: Movie 5139, Reward: 0  
Epsilon 0.5, Iteration 852: Movie 4412, Reward: 0  
Epsilon 0.5, Iteration 853: Movie 72601, Reward: 0  
Epsilon 0.5, Iteration 854: Movie 49013, Reward: 0  
Epsilon 0.5, Iteration 855: Movie 274, Reward: 1



Epsilon 0.5, Iteration 856: Movie 71160, Reward: 0  
Epsilon 0.5, Iteration 857: Movie 274, Reward: 1  
Epsilon 0.5, Iteration 858: Movie 274, Reward: 0  
Epsilon 0.5, Iteration 859: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 860: Movie 66427, Reward: 0  
Epsilon 0.5, Iteration 861: Movie 741, Reward: 1  
Epsilon 0.5, Iteration 862: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 863: Movie 1335, Reward: 0  
Epsilon 0.5, Iteration 864: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 865: Movie 25771, Reward: 1  
Epsilon 0.5, Iteration 866: Movie 4744, Reward: 0  
Epsilon 0.5, Iteration 867: Movie 5300, Reward: 1  
Epsilon 0.5, Iteration 868: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 869: Movie 175401, Reward: 1  
Epsilon 0.5, Iteration 870: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 871: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 872: Movie 580, Reward: 0  
Epsilon 0.5, Iteration 873: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 874: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 875: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 876: Movie 95717, Reward: 0  
Epsilon 0.5, Iteration 877: Movie 876, Reward: 1  
Epsilon 0.5, Iteration 878: Movie 6250, Reward: 0  
Epsilon 0.5, Iteration 879: Movie 2795, Reward: 0  
Epsilon 0.5, Iteration 880: Movie 40617, Reward: 0  
Epsilon 0.5, Iteration 881: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 882: Movie 97188, Reward: 1  
Epsilon 0.5, Iteration 883: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 884: Movie 180031, Reward: 1  
Epsilon 0.5, Iteration 885: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 886: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 887: Movie 54001, Reward: 1  
Epsilon 0.5, Iteration 888: Movie 96610, Reward: 0  
Epsilon 0.5, Iteration 889: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 890: Movie 61160, Reward: 1  
Epsilon 0.5, Iteration 891: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 892: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 893: Movie 92309, Reward: 1  
Epsilon 0.5, Iteration 894: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 895: Movie 117192, Reward: 1  
Epsilon 0.5, Iteration 896: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 897: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 898: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 899: Movie 3567, Reward: 1  
Epsilon 0.5, Iteration 900: Movie 64032, Reward: 0  
Epsilon 0.5, Iteration 901: Movie 141408, Reward: 0  
Epsilon 0.5, Iteration 902: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 903: Movie 4993, Reward: 0  
Epsilon 0.5, Iteration 904: Movie 2887, Reward: 0  
Epsilon 0.5, Iteration 905: Movie 92259, Reward: 1  
Epsilon 0.5, Iteration 906: Movie 7160, Reward: 1  
Epsilon 0.5, Iteration 907: Movie 1376, Reward: 0  
Epsilon 0.5, Iteration 908: Movie 92259, Reward: 0  
Epsilon 0.5, Iteration 909: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 910: Movie 4517, Reward: 0  
Epsilon 0.5, Iteration 911: Movie 118702, Reward: 0

Epsilon 0.5, Iteration 912: Movie 1132, Reward: 1  
Epsilon 0.5, Iteration 913: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 914: Movie 4278, Reward: 1  
Epsilon 0.5, Iteration 915: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 916: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 917: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 918: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 919: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 920: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 921: Movie 98230, Reward: 0  
Epsilon 0.5, Iteration 922: Movie 5611, Reward: 0  
Epsilon 0.5, Iteration 923: Movie 62799, Reward: 0  
Epsilon 0.5, Iteration 924: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 925: Movie 1459, Reward: 1  
Epsilon 0.5, Iteration 926: Movie 96417, Reward: 1  
Epsilon 0.5, Iteration 927: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 928: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 929: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 930: Movie 26562, Reward: 0  
Epsilon 0.5, Iteration 931: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 932: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 933: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 934: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 935: Movie 2640, Reward: 0  
Epsilon 0.5, Iteration 936: Movie 91542, Reward: 1  
Epsilon 0.5, Iteration 937: Movie 166015, Reward: 0  
Epsilon 0.5, Iteration 938: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 939: Movie 6597, Reward: 0  
Epsilon 0.5, Iteration 940: Movie 144210, Reward: 1  
Epsilon 0.5, Iteration 941: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 942: Movie 5063, Reward: 0  
Epsilon 0.5, Iteration 943: Movie 50806, Reward: 0  
Epsilon 0.5, Iteration 944: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 945: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 946: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 947: Movie 71550, Reward: 0  
Epsilon 0.5, Iteration 948: Movie 5902, Reward: 0  
Epsilon 0.5, Iteration 949: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 950: Movie 6158, Reward: 0  
Epsilon 0.5, Iteration 951: Movie 99853, Reward: 1  
Epsilon 0.5, Iteration 952: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 953: Movie 7387, Reward: 1  
Epsilon 0.5, Iteration 954: Movie 7096, Reward: 1  
Epsilon 0.5, Iteration 955: Movie 481, Reward: 0  
Epsilon 0.5, Iteration 956: Movie 247, Reward: 1  
Epsilon 0.5, Iteration 957: Movie 247, Reward: 0  
Epsilon 0.5, Iteration 958: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 959: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 960: Movie 2193, Reward: 0  
Epsilon 0.5, Iteration 961: Movie 27695, Reward: 0  
Epsilon 0.5, Iteration 962: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 963: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 964: Movie 86066, Reward: 1  
Epsilon 0.5, Iteration 965: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 966: Movie 8117, Reward: 1  
Epsilon 0.5, Iteration 967: Movie 8117, Reward: 1

```

Epsilon 0.5, Iteration 968: Movie 107951, Reward: 1
Epsilon 0.5, Iteration 969: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 970: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 971: Movie 1078, Reward: 1
Epsilon 0.5, Iteration 972: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 973: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 974: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 975: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 976: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 977: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 978: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 979: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 980: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 981: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 982: Movie 6909, Reward: 1
Epsilon 0.5, Iteration 983: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 984: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 985: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 986: Movie 94867, Reward: 0
Epsilon 0.5, Iteration 987: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 988: Movie 3768, Reward: 0
Epsilon 0.5, Iteration 989: Movie 58351, Reward: 1
Epsilon 0.5, Iteration 990: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 991: Movie 5466, Reward: 1
Epsilon 0.5, Iteration 992: Movie 8012, Reward: 1
Epsilon 0.5, Iteration 993: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 994: Movie 1977, Reward: 0
Epsilon 0.5, Iteration 995: Movie 91470, Reward: 0
Epsilon 0.5, Iteration 996: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 997: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 998: Movie 90945, Reward: 0
Epsilon 0.5, Iteration 999: Movie 8117, Reward: 1
Epsilon 0.5, Iteration 1000: Movie 8117, Reward: 1

```

## Using UCB (1M)

Implement the UCB algorithm for movie recommendations and print each iteration.  
(Mandatory)

```

In [24]: # run the environment with an agent that is guided by a UCB
#-----write your code below this line-----

print("\nUCB policy iterations:")
movie_estimates = {movie: 0 for movie in df['movieId'].unique()}
movie_counts = {movie: 0 for movie in df['movieId'].unique()}

def calculate_ucb(estimate, count, total_count):
    return estimate + np.sqrt(2 * np.log(total_count) / count) if count > 0 else fl

for i in range(1000):
    if i < len(movie_estimates):
        arm = list(movie_estimates.keys())[i] # Explore all movies at least once
    else:

```

```
    ucb_values = {movie: calculate_ucb(movie_estimates[movie], movie_counts[mov
    arm = max(ucb_values, key=ucb_values.get)

    reward = np.random.choice(df[df['movieId'] == arm]['Reward'])
    movie_counts[arm] += 1
    movie_estimates[arm] = ((movie_estimates[arm] * (movie_counts[arm] - 1)) + rewa

    total_rewards_ucb += reward
    cumulative_rewards_ucb.append(total_rewards_ucb)
    print(f"Iteration {i+1}: Movie {arm}, Reward: {reward}")
```

## UCB policy iterations:

Iteration 1: Movie 1, Reward: 1  
Iteration 2: Movie 3, Reward: 0  
Iteration 3: Movie 6, Reward: 0  
Iteration 4: Movie 47, Reward: 1  
Iteration 5: Movie 50, Reward: 0  
Iteration 6: Movie 70, Reward: 1  
Iteration 7: Movie 101, Reward: 0  
Iteration 8: Movie 110, Reward: 0  
Iteration 9: Movie 151, Reward: 1  
Iteration 10: Movie 157, Reward: 0  
Iteration 11: Movie 163, Reward: 1  
Iteration 12: Movie 216, Reward: 1  
Iteration 13: Movie 223, Reward: 1  
Iteration 14: Movie 231, Reward: 0  
Iteration 15: Movie 235, Reward: 1  
Iteration 16: Movie 260, Reward: 1  
Iteration 17: Movie 296, Reward: 0  
Iteration 18: Movie 316, Reward: 0  
Iteration 19: Movie 333, Reward: 1  
Iteration 20: Movie 349, Reward: 0  
Iteration 21: Movie 356, Reward: 0  
Iteration 22: Movie 362, Reward: 0  
Iteration 23: Movie 367, Reward: 0  
Iteration 24: Movie 423, Reward: 0  
Iteration 25: Movie 441, Reward: 0  
Iteration 26: Movie 457, Reward: 0  
Iteration 27: Movie 480, Reward: 0  
Iteration 28: Movie 500, Reward: 1  
Iteration 29: Movie 527, Reward: 1  
Iteration 30: Movie 543, Reward: 0  
Iteration 31: Movie 552, Reward: 0  
Iteration 32: Movie 553, Reward: 1  
Iteration 33: Movie 590, Reward: 1  
Iteration 34: Movie 592, Reward: 1  
Iteration 35: Movie 593, Reward: 1  
Iteration 36: Movie 596, Reward: 0  
Iteration 37: Movie 608, Reward: 1  
Iteration 38: Movie 648, Reward: 0  
Iteration 39: Movie 661, Reward: 0  
Iteration 40: Movie 673, Reward: 0  
Iteration 41: Movie 733, Reward: 0  
Iteration 42: Movie 736, Reward: 0  
Iteration 43: Movie 780, Reward: 0  
Iteration 44: Movie 804, Reward: 1  
Iteration 45: Movie 919, Reward: 0  
Iteration 46: Movie 923, Reward: 1  
Iteration 47: Movie 940, Reward: 1  
Iteration 48: Movie 943, Reward: 1  
Iteration 49: Movie 954, Reward: 1  
Iteration 50: Movie 1009, Reward: 0  
Iteration 51: Movie 1023, Reward: 0  
Iteration 52: Movie 1024, Reward: 0  
Iteration 53: Movie 1025, Reward: 1  
Iteration 54: Movie 1029, Reward: 0  
Iteration 55: Movie 1030, Reward: 0

Iteration 56: Movie 1031, Reward: 0  
Iteration 57: Movie 1032, Reward: 1  
Iteration 58: Movie 1042, Reward: 1  
Iteration 59: Movie 1049, Reward: 0  
Iteration 60: Movie 1060, Reward: 1  
Iteration 61: Movie 1073, Reward: 1  
Iteration 62: Movie 1080, Reward: 1  
Iteration 63: Movie 1089, Reward: 1  
Iteration 64: Movie 1090, Reward: 1  
Iteration 65: Movie 1092, Reward: 0  
Iteration 66: Movie 1097, Reward: 1  
Iteration 67: Movie 1127, Reward: 0  
Iteration 68: Movie 1136, Reward: 1  
Iteration 69: Movie 1196, Reward: 1  
Iteration 70: Movie 1197, Reward: 0  
Iteration 71: Movie 1198, Reward: 1  
Iteration 72: Movie 1206, Reward: 1  
Iteration 73: Movie 1208, Reward: 1  
Iteration 74: Movie 1210, Reward: 1  
Iteration 75: Movie 1213, Reward: 1  
Iteration 76: Movie 1214, Reward: 1  
Iteration 77: Movie 1219, Reward: 1  
Iteration 78: Movie 1220, Reward: 0  
Iteration 79: Movie 1222, Reward: 1  
Iteration 80: Movie 1224, Reward: 1  
Iteration 81: Movie 1226, Reward: 1  
Iteration 82: Movie 1240, Reward: 0  
Iteration 83: Movie 1256, Reward: 1  
Iteration 84: Movie 1258, Reward: 0  
Iteration 85: Movie 1265, Reward: 0  
Iteration 86: Movie 1270, Reward: 1  
Iteration 87: Movie 1275, Reward: 1  
Iteration 88: Movie 1278, Reward: 1  
Iteration 89: Movie 1282, Reward: 1  
Iteration 90: Movie 1291, Reward: 1  
Iteration 91: Movie 1298, Reward: 1  
Iteration 92: Movie 1348, Reward: 0  
Iteration 93: Movie 1377, Reward: 1  
Iteration 94: Movie 1396, Reward: 0  
Iteration 95: Movie 1408, Reward: 1  
Iteration 96: Movie 1445, Reward: 0  
Iteration 97: Movie 1473, Reward: 1  
Iteration 98: Movie 1500, Reward: 1  
Iteration 99: Movie 1517, Reward: 0  
Iteration 100: Movie 1552, Reward: 0  
Iteration 101: Movie 1573, Reward: 1  
Iteration 102: Movie 1580, Reward: 1  
Iteration 103: Movie 1587, Reward: 1  
Iteration 104: Movie 1617, Reward: 0  
Iteration 105: Movie 1620, Reward: 1  
Iteration 106: Movie 1625, Reward: 1  
Iteration 107: Movie 1644, Reward: 0  
Iteration 108: Movie 1676, Reward: 1  
Iteration 109: Movie 1732, Reward: 1  
Iteration 110: Movie 1777, Reward: 1  
Iteration 111: Movie 1793, Reward: 1

Iteration 112: Movie 1804, Reward: 0  
Iteration 113: Movie 1805, Reward: 1  
Iteration 114: Movie 1920, Reward: 0  
Iteration 115: Movie 1927, Reward: 1  
Iteration 116: Movie 1954, Reward: 0  
Iteration 117: Movie 1967, Reward: 1  
Iteration 118: Movie 2000, Reward: 1  
Iteration 119: Movie 2005, Reward: 0  
Iteration 120: Movie 2012, Reward: 0  
Iteration 121: Movie 2018, Reward: 0  
Iteration 122: Movie 2028, Reward: 1  
Iteration 123: Movie 2033, Reward: 1  
Iteration 124: Movie 2046, Reward: 0  
Iteration 125: Movie 2048, Reward: 0  
Iteration 126: Movie 2054, Reward: 0  
Iteration 127: Movie 2058, Reward: 1  
Iteration 128: Movie 2078, Reward: 1  
Iteration 129: Movie 2090, Reward: 0  
Iteration 130: Movie 2093, Reward: 0  
Iteration 131: Movie 2094, Reward: 0  
Iteration 132: Movie 2096, Reward: 1  
Iteration 133: Movie 2099, Reward: 1  
Iteration 134: Movie 2105, Reward: 0  
Iteration 135: Movie 2115, Reward: 0  
Iteration 136: Movie 2116, Reward: 0  
Iteration 137: Movie 2137, Reward: 1  
Iteration 138: Movie 2139, Reward: 0  
Iteration 139: Movie 2141, Reward: 0  
Iteration 140: Movie 2143, Reward: 0  
Iteration 141: Movie 2161, Reward: 1  
Iteration 142: Movie 2174, Reward: 0  
Iteration 143: Movie 2193, Reward: 0  
Iteration 144: Movie 2253, Reward: 0  
Iteration 145: Movie 2268, Reward: 0  
Iteration 146: Movie 2273, Reward: 1  
Iteration 147: Movie 2291, Reward: 1  
Iteration 148: Movie 2329, Reward: 1  
Iteration 149: Movie 2338, Reward: 0  
Iteration 150: Movie 2353, Reward: 0  
Iteration 151: Movie 2366, Reward: 1  
Iteration 152: Movie 2387, Reward: 0  
Iteration 153: Movie 2389, Reward: 0  
Iteration 154: Movie 2395, Reward: 1  
Iteration 155: Movie 2406, Reward: 0  
Iteration 156: Movie 2414, Reward: 1  
Iteration 157: Movie 2427, Reward: 1  
Iteration 158: Movie 2450, Reward: 1  
Iteration 159: Movie 2459, Reward: 1  
Iteration 160: Movie 2470, Reward: 0  
Iteration 161: Movie 2478, Reward: 0  
Iteration 162: Movie 2492, Reward: 1  
Iteration 163: Movie 2502, Reward: 1  
Iteration 164: Movie 2528, Reward: 0  
Iteration 165: Movie 2529, Reward: 1  
Iteration 166: Movie 2542, Reward: 1  
Iteration 167: Movie 2571, Reward: 1

Iteration 168: Movie 2580, Reward: 1  
Iteration 169: Movie 2596, Reward: 0  
Iteration 170: Movie 2616, Reward: 0  
Iteration 171: Movie 2617, Reward: 1  
Iteration 172: Movie 2628, Reward: 0  
Iteration 173: Movie 2640, Reward: 1  
Iteration 174: Movie 2641, Reward: 1  
Iteration 175: Movie 2644, Reward: 1  
Iteration 176: Movie 2648, Reward: 1  
Iteration 177: Movie 2654, Reward: 0  
Iteration 178: Movie 2657, Reward: 0  
Iteration 179: Movie 2692, Reward: 1  
Iteration 180: Movie 2700, Reward: 0  
Iteration 181: Movie 2716, Reward: 0  
Iteration 182: Movie 2761, Reward: 1  
Iteration 183: Movie 2797, Reward: 0  
Iteration 184: Movie 2826, Reward: 0  
Iteration 185: Movie 2858, Reward: 0  
Iteration 186: Movie 2872, Reward: 1  
Iteration 187: Movie 2899, Reward: 0  
Iteration 188: Movie 2916, Reward: 0  
Iteration 189: Movie 2944, Reward: 1  
Iteration 190: Movie 2947, Reward: 1  
Iteration 191: Movie 2948, Reward: 1  
Iteration 192: Movie 2949, Reward: 1  
Iteration 193: Movie 2959, Reward: 1  
Iteration 194: Movie 2985, Reward: 0  
Iteration 195: Movie 2987, Reward: 0  
Iteration 196: Movie 2991, Reward: 1  
Iteration 197: Movie 2993, Reward: 1  
Iteration 198: Movie 2997, Reward: 1  
Iteration 199: Movie 3033, Reward: 1  
Iteration 200: Movie 3034, Reward: 1  
Iteration 201: Movie 3052, Reward: 0  
Iteration 202: Movie 3053, Reward: 0  
Iteration 203: Movie 3062, Reward: 1  
Iteration 204: Movie 3147, Reward: 1  
Iteration 205: Movie 3168, Reward: 0  
Iteration 206: Movie 3176, Reward: 0  
Iteration 207: Movie 3243, Reward: 0  
Iteration 208: Movie 3247, Reward: 1  
Iteration 209: Movie 3253, Reward: 0  
Iteration 210: Movie 3273, Reward: 1  
Iteration 211: Movie 3386, Reward: 1  
Iteration 212: Movie 3439, Reward: 0  
Iteration 213: Movie 3440, Reward: 0  
Iteration 214: Movie 3441, Reward: 1  
Iteration 215: Movie 3448, Reward: 1  
Iteration 216: Movie 3450, Reward: 0  
Iteration 217: Movie 3479, Reward: 1  
Iteration 218: Movie 3489, Reward: 1  
Iteration 219: Movie 3527, Reward: 1  
Iteration 220: Movie 3578, Reward: 0  
Iteration 221: Movie 3617, Reward: 0  
Iteration 222: Movie 3639, Reward: 0  
Iteration 223: Movie 3671, Reward: 1



Iteration 224: Movie 3702, Reward: 0  
Iteration 225: Movie 3703, Reward: 1  
Iteration 226: Movie 3729, Reward: 0  
Iteration 227: Movie 3740, Reward: 0  
Iteration 228: Movie 3744, Reward: 0  
Iteration 229: Movie 3793, Reward: 0  
Iteration 230: Movie 3809, Reward: 1  
Iteration 231: Movie 4006, Reward: 1  
Iteration 232: Movie 5060, Reward: 1  
Iteration 233: Movie 318, Reward: 1  
Iteration 234: Movie 1704, Reward: 1  
Iteration 235: Movie 6874, Reward: 1  
Iteration 236: Movie 8798, Reward: 1  
Iteration 237: Movie 46970, Reward: 0  
Iteration 238: Movie 48516, Reward: 1  
Iteration 239: Movie 58559, Reward: 1  
Iteration 240: Movie 60756, Reward: 0  
Iteration 241: Movie 68157, Reward: 0  
Iteration 242: Movie 71535, Reward: 0  
Iteration 243: Movie 74458, Reward: 1  
Iteration 244: Movie 77455, Reward: 1  
Iteration 245: Movie 79132, Reward: 1  
Iteration 246: Movie 80489, Reward: 0  
Iteration 247: Movie 80906, Reward: 1  
Iteration 248: Movie 86345, Reward: 1  
Iteration 249: Movie 89774, Reward: 1  
Iteration 250: Movie 91529, Reward: 1  
Iteration 251: Movie 91658, Reward: 0  
Iteration 252: Movie 99114, Reward: 1  
Iteration 253: Movie 106782, Reward: 1  
Iteration 254: Movie 109487, Reward: 1  
Iteration 255: Movie 112552, Reward: 0  
Iteration 256: Movie 114060, Reward: 0  
Iteration 257: Movie 115713, Reward: 1  
Iteration 258: Movie 122882, Reward: 1  
Iteration 259: Movie 131724, Reward: 1  
Iteration 260: Movie 31, Reward: 0  
Iteration 261: Movie 647, Reward: 0  
Iteration 262: Movie 688, Reward: 0  
Iteration 263: Movie 720, Reward: 1  
Iteration 264: Movie 849, Reward: 0  
Iteration 265: Movie 914, Reward: 0  
Iteration 266: Movie 1093, Reward: 1  
Iteration 267: Movie 1124, Reward: 1  
Iteration 268: Movie 1263, Reward: 0  
Iteration 269: Movie 1272, Reward: 1  
Iteration 270: Movie 1302, Reward: 0  
Iteration 271: Movie 1371, Reward: 0  
Iteration 272: Movie 2080, Reward: 0  
Iteration 273: Movie 2288, Reward: 0  
Iteration 274: Movie 2424, Reward: 1  
Iteration 275: Movie 2851, Reward: 1  
Iteration 276: Movie 3024, Reward: 0  
Iteration 277: Movie 3210, Reward: 1  
Iteration 278: Movie 3949, Reward: 1  
Iteration 279: Movie 4518, Reward: 1

Iteration 280: Movie 5048, Reward: 0  
Iteration 281: Movie 5181, Reward: 1  
Iteration 282: Movie 5746, Reward: 1  
Iteration 283: Movie 5764, Reward: 1  
Iteration 284: Movie 5919, Reward: 1  
Iteration 285: Movie 6238, Reward: 0  
Iteration 286: Movie 6835, Reward: 1  
Iteration 287: Movie 7899, Reward: 1  
Iteration 288: Movie 7991, Reward: 0  
Iteration 289: Movie 26409, Reward: 1  
Iteration 290: Movie 70946, Reward: 0  
Iteration 291: Movie 72378, Reward: 1  
Iteration 292: Movie 21, Reward: 1  
Iteration 293: Movie 32, Reward: 1  
Iteration 294: Movie 45, Reward: 0  
Iteration 295: Movie 52, Reward: 0  
Iteration 296: Movie 58, Reward: 0  
Iteration 297: Movie 106, Reward: 1  
Iteration 298: Movie 125, Reward: 1  
Iteration 299: Movie 126, Reward: 0  
Iteration 300: Movie 162, Reward: 0  
Iteration 301: Movie 171, Reward: 0  
Iteration 302: Movie 176, Reward: 1  
Iteration 303: Movie 190, Reward: 0  
Iteration 304: Movie 215, Reward: 1  
Iteration 305: Movie 222, Reward: 1  
Iteration 306: Movie 232, Reward: 1  
Iteration 307: Movie 247, Reward: 1  
Iteration 308: Movie 265, Reward: 1  
Iteration 309: Movie 319, Reward: 1  
Iteration 310: Movie 342, Reward: 0  
Iteration 311: Movie 345, Reward: 0  
Iteration 312: Movie 348, Reward: 0  
Iteration 313: Movie 351, Reward: 0  
Iteration 314: Movie 357, Reward: 1  
Iteration 315: Movie 368, Reward: 0  
Iteration 316: Movie 417, Reward: 0  
Iteration 317: Movie 450, Reward: 0  
Iteration 318: Movie 475, Reward: 0  
Iteration 319: Movie 492, Reward: 1  
Iteration 320: Movie 509, Reward: 1  
Iteration 321: Movie 538, Reward: 0  
Iteration 322: Movie 539, Reward: 0  
Iteration 323: Movie 588, Reward: 1  
Iteration 324: Movie 595, Reward: 1  
Iteration 325: Movie 599, Reward: 0  
Iteration 326: Movie 708, Reward: 0  
Iteration 327: Movie 759, Reward: 1  
Iteration 328: Movie 800, Reward: 0  
Iteration 329: Movie 892, Reward: 0  
Iteration 330: Movie 898, Reward: 0  
Iteration 331: Movie 899, Reward: 1  
Iteration 332: Movie 902, Reward: 1  
Iteration 333: Movie 904, Reward: 1  
Iteration 334: Movie 908, Reward: 1  
Iteration 335: Movie 910, Reward: 0

Iteration 336: Movie 912, Reward: 0  
Iteration 337: Movie 920, Reward: 1  
Iteration 338: Movie 930, Reward: 1  
Iteration 339: Movie 937, Reward: 1  
Iteration 340: Movie 1046, Reward: 1  
Iteration 341: Movie 1057, Reward: 0  
Iteration 342: Movie 1077, Reward: 1  
Iteration 343: Movie 1079, Reward: 1  
Iteration 344: Movie 1084, Reward: 1  
Iteration 345: Movie 1086, Reward: 1  
Iteration 346: Movie 1094, Reward: 0  
Iteration 347: Movie 1103, Reward: 1  
Iteration 348: Movie 1179, Reward: 1  
Iteration 349: Movie 1183, Reward: 0  
Iteration 350: Movie 1188, Reward: 1  
Iteration 351: Movie 1199, Reward: 1  
Iteration 352: Movie 1203, Reward: 1  
Iteration 353: Movie 1211, Reward: 1  
Iteration 354: Movie 1225, Reward: 1  
Iteration 355: Movie 1250, Reward: 1  
Iteration 356: Movie 1259, Reward: 1  
Iteration 357: Movie 1266, Reward: 1  
Iteration 358: Movie 1279, Reward: 1  
Iteration 359: Movie 1283, Reward: 0  
Iteration 360: Movie 1288, Reward: 1  
Iteration 361: Movie 1304, Reward: 1  
Iteration 362: Movie 1391, Reward: 0  
Iteration 363: Movie 1449, Reward: 1  
Iteration 364: Movie 1466, Reward: 0  
Iteration 365: Movie 1597, Reward: 0  
Iteration 366: Movie 1641, Reward: 1  
Iteration 367: Movie 1719, Reward: 1  
Iteration 368: Movie 1733, Reward: 1  
Iteration 369: Movie 1734, Reward: 1  
Iteration 370: Movie 1834, Reward: 1  
Iteration 371: Movie 1860, Reward: 0  
Iteration 372: Movie 1883, Reward: 0  
Iteration 373: Movie 1885, Reward: 0  
Iteration 374: Movie 1892, Reward: 0  
Iteration 375: Movie 1895, Reward: 0  
Iteration 376: Movie 1907, Reward: 0  
Iteration 377: Movie 1914, Reward: 1  
Iteration 378: Movie 1916, Reward: 0  
Iteration 379: Movie 1923, Reward: 0  
Iteration 380: Movie 1947, Reward: 0  
Iteration 381: Movie 1966, Reward: 1  
Iteration 382: Movie 1968, Reward: 1  
Iteration 383: Movie 2019, Reward: 1  
Iteration 384: Movie 2076, Reward: 0  
Iteration 385: Movie 2109, Reward: 0  
Iteration 386: Movie 2145, Reward: 0  
Iteration 387: Movie 2150, Reward: 0  
Iteration 388: Movie 2186, Reward: 1  
Iteration 389: Movie 2203, Reward: 1  
Iteration 390: Movie 2204, Reward: 1  
Iteration 391: Movie 2282, Reward: 1

Iteration 392: Movie 2324, Reward: 0  
Iteration 393: Movie 2336, Reward: 0  
Iteration 394: Movie 2351, Reward: 1  
Iteration 395: Movie 2359, Reward: 1  
Iteration 396: Movie 2390, Reward: 1  
Iteration 397: Movie 2467, Reward: 0  
Iteration 398: Movie 2583, Reward: 1  
Iteration 399: Movie 2599, Reward: 1  
Iteration 400: Movie 2683, Reward: 1  
Iteration 401: Movie 2712, Reward: 0  
Iteration 402: Movie 2762, Reward: 1  
Iteration 403: Movie 2763, Reward: 1  
Iteration 404: Movie 2770, Reward: 0  
Iteration 405: Movie 2791, Reward: 0  
Iteration 406: Movie 2843, Reward: 1  
Iteration 407: Movie 2874, Reward: 1  
Iteration 408: Movie 2921, Reward: 0  
Iteration 409: Movie 2926, Reward: 0  
Iteration 410: Movie 2973, Reward: 0  
Iteration 411: Movie 3044, Reward: 1  
Iteration 412: Movie 3060, Reward: 1  
Iteration 413: Movie 3079, Reward: 1  
Iteration 414: Movie 3083, Reward: 1  
Iteration 415: Movie 3160, Reward: 1  
Iteration 416: Movie 3175, Reward: 0  
Iteration 417: Movie 3204, Reward: 0  
Iteration 418: Movie 3255, Reward: 0  
Iteration 419: Movie 3317, Reward: 1  
Iteration 420: Movie 3358, Reward: 0  
Iteration 421: Movie 3365, Reward: 1  
Iteration 422: Movie 3408, Reward: 0  
Iteration 423: Movie 3481, Reward: 1  
Iteration 424: Movie 3508, Reward: 1  
Iteration 425: Movie 3538, Reward: 1  
Iteration 426: Movie 3591, Reward: 0  
Iteration 427: Movie 3788, Reward: 1  
Iteration 428: Movie 3851, Reward: 1  
Iteration 429: Movie 3897, Reward: 1  
Iteration 430: Movie 3911, Reward: 0  
Iteration 431: Movie 3967, Reward: 1  
Iteration 432: Movie 3996, Reward: 1  
Iteration 433: Movie 4002, Reward: 1  
Iteration 434: Movie 4014, Reward: 1  
Iteration 435: Movie 4020, Reward: 0  
Iteration 436: Movie 4021, Reward: 0  
Iteration 437: Movie 4027, Reward: 1  
Iteration 438: Movie 4029, Reward: 0  
Iteration 439: Movie 4033, Reward: 1  
Iteration 440: Movie 4034, Reward: 1  
Iteration 441: Movie 4074, Reward: 0  
Iteration 442: Movie 4121, Reward: 1  
Iteration 443: Movie 4144, Reward: 1  
Iteration 444: Movie 4166, Reward: 0  
Iteration 445: Movie 4226, Reward: 1  
Iteration 446: Movie 4239, Reward: 1  
Iteration 447: Movie 4246, Reward: 1

Iteration 448: Movie 4252, Reward: 0  
Iteration 449: Movie 4260, Reward: 0  
Iteration 450: Movie 4273, Reward: 1  
Iteration 451: Movie 4308, Reward: 1  
Iteration 452: Movie 4347, Reward: 1  
Iteration 453: Movie 4381, Reward: 0  
Iteration 454: Movie 4641, Reward: 1  
Iteration 455: Movie 4741, Reward: 0  
Iteration 456: Movie 4765, Reward: 1  
Iteration 457: Movie 4881, Reward: 1  
Iteration 458: Movie 4896, Reward: 0  
Iteration 459: Movie 4902, Reward: 0  
Iteration 460: Movie 4967, Reward: 1  
Iteration 461: Movie 34, Reward: 1  
Iteration 462: Movie 36, Reward: 1  
Iteration 463: Movie 39, Reward: 1  
Iteration 464: Movie 150, Reward: 1  
Iteration 465: Movie 153, Reward: 0  
Iteration 466: Movie 253, Reward: 0  
Iteration 467: Movie 261, Reward: 0  
Iteration 468: Movie 266, Reward: 0  
Iteration 469: Movie 290, Reward: 0  
Iteration 470: Movie 300, Reward: 1  
Iteration 471: Movie 344, Reward: 0  
Iteration 472: Movie 364, Reward: 1  
Iteration 473: Movie 380, Reward: 0  
Iteration 474: Movie 410, Reward: 0  
Iteration 475: Movie 474, Reward: 1  
Iteration 476: Movie 515, Reward: 1  
Iteration 477: Movie 531, Reward: 1  
Iteration 478: Movie 534, Reward: 1  
Iteration 479: Movie 589, Reward: 1  
Iteration 480: Movie 594, Reward: 1  
Iteration 481: Movie 597, Reward: 0  
Iteration 482: Movie 2, Reward: 0  
Iteration 483: Movie 4, Reward: 0  
Iteration 484: Movie 5, Reward: 0  
Iteration 485: Movie 7, Reward: 1  
Iteration 486: Movie 8, Reward: 0  
Iteration 487: Movie 10, Reward: 1  
Iteration 488: Movie 11, Reward: 1  
Iteration 489: Movie 13, Reward: 0  
Iteration 490: Movie 15, Reward: 1  
Iteration 491: Movie 16, Reward: 1  
Iteration 492: Movie 17, Reward: 1  
Iteration 493: Movie 19, Reward: 0  
Iteration 494: Movie 22, Reward: 0  
Iteration 495: Movie 24, Reward: 0  
Iteration 496: Movie 25, Reward: 1  
Iteration 497: Movie 26, Reward: 1  
Iteration 498: Movie 27, Reward: 1  
Iteration 499: Movie 41, Reward: 0  
Iteration 500: Movie 43, Reward: 0  
Iteration 501: Movie 46, Reward: 1  
Iteration 502: Movie 54, Reward: 0  
Iteration 503: Movie 60, Reward: 0

Iteration 504: Movie 61, Reward: 1  
Iteration 505: Movie 62, Reward: 0  
Iteration 506: Movie 65, Reward: 0  
Iteration 507: Movie 66, Reward: 1  
Iteration 508: Movie 76, Reward: 1  
Iteration 509: Movie 79, Reward: 0  
Iteration 510: Movie 86, Reward: 1  
Iteration 511: Movie 87, Reward: 0  
Iteration 512: Movie 88, Reward: 0  
Iteration 513: Movie 89, Reward: 0  
Iteration 514: Movie 92, Reward: 0  
Iteration 515: Movie 93, Reward: 0  
Iteration 516: Movie 95, Reward: 0  
Iteration 517: Movie 100, Reward: 0  
Iteration 518: Movie 102, Reward: 1  
Iteration 519: Movie 104, Reward: 0  
Iteration 520: Movie 105, Reward: 1  
Iteration 521: Movie 112, Reward: 1  
Iteration 522: Movie 113, Reward: 1  
Iteration 523: Movie 135, Reward: 0  
Iteration 524: Movie 140, Reward: 0  
Iteration 525: Movie 141, Reward: 1  
Iteration 526: Movie 145, Reward: 1  
Iteration 527: Movie 146, Reward: 0  
Iteration 528: Movie 158, Reward: 0  
Iteration 529: Movie 159, Reward: 0  
Iteration 530: Movie 160, Reward: 0  
Iteration 531: Movie 161, Reward: 1  
Iteration 532: Movie 165, Reward: 1  
Iteration 533: Movie 168, Reward: 1  
Iteration 534: Movie 170, Reward: 0  
Iteration 535: Movie 174, Reward: 0  
Iteration 536: Movie 177, Reward: 1  
Iteration 537: Movie 179, Reward: 0  
Iteration 538: Movie 180, Reward: 1  
Iteration 539: Movie 181, Reward: 0  
Iteration 540: Movie 185, Reward: 0  
Iteration 541: Movie 186, Reward: 0  
Iteration 542: Movie 189, Reward: 0  
Iteration 543: Movie 191, Reward: 1  
Iteration 544: Movie 195, Reward: 0  
Iteration 545: Movie 196, Reward: 1  
Iteration 546: Movie 201, Reward: 0  
Iteration 547: Movie 204, Reward: 1  
Iteration 548: Movie 205, Reward: 1  
Iteration 549: Movie 207, Reward: 0  
Iteration 550: Movie 208, Reward: 0  
Iteration 551: Movie 209, Reward: 0  
Iteration 552: Movie 210, Reward: 0  
Iteration 553: Movie 212, Reward: 0  
Iteration 554: Movie 217, Reward: 0  
Iteration 555: Movie 218, Reward: 1  
Iteration 556: Movie 219, Reward: 0  
Iteration 557: Movie 224, Reward: 1  
Iteration 558: Movie 225, Reward: 0  
Iteration 559: Movie 230, Reward: 1

Iteration 560: Movie 234, Reward: 1  
Iteration 561: Movie 236, Reward: 1  
Iteration 562: Movie 237, Reward: 1  
Iteration 563: Movie 239, Reward: 0  
Iteration 564: Movie 240, Reward: 0  
Iteration 565: Movie 243, Reward: 0  
Iteration 566: Movie 248, Reward: 1  
Iteration 567: Movie 250, Reward: 1  
Iteration 568: Movie 251, Reward: 0  
Iteration 569: Movie 252, Reward: 0  
Iteration 570: Movie 254, Reward: 0  
Iteration 571: Movie 256, Reward: 0  
Iteration 572: Movie 257, Reward: 0  
Iteration 573: Movie 258, Reward: 0  
Iteration 574: Movie 262, Reward: 1  
Iteration 575: Movie 267, Reward: 1  
Iteration 576: Movie 270, Reward: 1  
Iteration 577: Movie 271, Reward: 1  
Iteration 578: Movie 273, Reward: 0  
Iteration 579: Movie 274, Reward: 1  
Iteration 580: Movie 276, Reward: 0  
Iteration 581: Movie 277, Reward: 0  
Iteration 582: Movie 279, Reward: 0  
Iteration 583: Movie 281, Reward: 1  
Iteration 584: Movie 282, Reward: 0  
Iteration 585: Movie 288, Reward: 1  
Iteration 586: Movie 289, Reward: 0  
Iteration 587: Movie 291, Reward: 0  
Iteration 588: Movie 292, Reward: 0  
Iteration 589: Movie 293, Reward: 1  
Iteration 590: Movie 302, Reward: 0  
Iteration 591: Movie 303, Reward: 0  
Iteration 592: Movie 304, Reward: 0  
Iteration 593: Movie 310, Reward: 0  
Iteration 594: Movie 312, Reward: 0  
Iteration 595: Movie 313, Reward: 0  
Iteration 596: Movie 314, Reward: 1  
Iteration 597: Movie 315, Reward: 0  
Iteration 598: Movie 317, Reward: 0  
Iteration 599: Movie 327, Reward: 0  
Iteration 600: Movie 329, Reward: 1  
Iteration 601: Movie 330, Reward: 0  
Iteration 602: Movie 332, Reward: 0  
Iteration 603: Movie 336, Reward: 0  
Iteration 604: Movie 337, Reward: 1  
Iteration 605: Movie 339, Reward: 1  
Iteration 606: Movie 340, Reward: 0  
Iteration 607: Movie 343, Reward: 0  
Iteration 608: Movie 347, Reward: 1  
Iteration 609: Movie 350, Reward: 0  
Iteration 610: Movie 352, Reward: 0  
Iteration 611: Movie 353, Reward: 0  
Iteration 612: Movie 354, Reward: 1  
Iteration 613: Movie 355, Reward: 0  
Iteration 614: Movie 358, Reward: 0  
Iteration 615: Movie 359, Reward: 0

Iteration 616: Movie 360, Reward: 0  
Iteration 617: Movie 361, Reward: 0  
Iteration 618: Movie 366, Reward: 0  
Iteration 619: Movie 370, Reward: 0  
Iteration 620: Movie 371, Reward: 1  
Iteration 621: Movie 374, Reward: 0  
Iteration 622: Movie 377, Reward: 0  
Iteration 623: Movie 378, Reward: 0  
Iteration 624: Movie 381, Reward: 0  
Iteration 625: Movie 382, Reward: 0  
Iteration 626: Movie 383, Reward: 1  
Iteration 627: Movie 405, Reward: 0  
Iteration 628: Movie 412, Reward: 1  
Iteration 629: Movie 415, Reward: 0  
Iteration 630: Movie 416, Reward: 0  
Iteration 631: Movie 419, Reward: 0  
Iteration 632: Movie 426, Reward: 0  
Iteration 633: Movie 432, Reward: 0  
Iteration 634: Movie 434, Reward: 0  
Iteration 635: Movie 435, Reward: 0  
Iteration 636: Movie 437, Reward: 0  
Iteration 637: Movie 440, Reward: 0  
Iteration 638: Movie 445, Reward: 0  
Iteration 639: Movie 454, Reward: 0  
Iteration 640: Movie 455, Reward: 0  
Iteration 641: Movie 458, Reward: 0  
Iteration 642: Movie 460, Reward: 0  
Iteration 643: Movie 466, Reward: 0  
Iteration 644: Movie 468, Reward: 0  
Iteration 645: Movie 469, Reward: 0  
Iteration 646: Movie 472, Reward: 0  
Iteration 647: Movie 477, Reward: 0  
Iteration 648: Movie 485, Reward: 0  
Iteration 649: Movie 489, Reward: 0  
Iteration 650: Movie 490, Reward: 0  
Iteration 651: Movie 491, Reward: 0  
Iteration 652: Movie 493, Reward: 0  
Iteration 653: Movie 494, Reward: 1  
Iteration 654: Movie 497, Reward: 1  
Iteration 655: Movie 502, Reward: 0  
Iteration 656: Movie 505, Reward: 0  
Iteration 657: Movie 508, Reward: 0  
Iteration 658: Movie 510, Reward: 0  
Iteration 659: Movie 516, Reward: 0  
Iteration 660: Movie 520, Reward: 0  
Iteration 661: Movie 524, Reward: 0  
Iteration 662: Movie 532, Reward: 0  
Iteration 663: Movie 536, Reward: 0  
Iteration 664: Movie 537, Reward: 0  
Iteration 665: Movie 540, Reward: 0  
Iteration 666: Movie 542, Reward: 1  
Iteration 667: Movie 546, Reward: 0  
Iteration 668: Movie 548, Reward: 0  
Iteration 669: Movie 569, Reward: 0  
Iteration 670: Movie 575, Reward: 1  
Iteration 671: Movie 587, Reward: 1



Iteration 672: Movie 606, Reward: 0  
Iteration 673: Movie 609, Reward: 0  
Iteration 674: Movie 616, Reward: 1  
Iteration 675: Movie 628, Reward: 0  
Iteration 676: Movie 631, Reward: 1  
Iteration 677: Movie 637, Reward: 1  
Iteration 678: Movie 640, Reward: 0  
Iteration 679: Movie 662, Reward: 0  
Iteration 680: Movie 667, Reward: 0  
Iteration 681: Movie 694, Reward: 0  
Iteration 682: Movie 697, Reward: 0  
Iteration 683: Movie 700, Reward: 0  
Iteration 684: Movie 704, Reward: 0  
Iteration 685: Movie 709, Reward: 1  
Iteration 686: Movie 710, Reward: 0  
Iteration 687: Movie 711, Reward: 1  
Iteration 688: Movie 719, Reward: 0  
Iteration 689: Movie 747, Reward: 0  
Iteration 690: Movie 762, Reward: 0  
Iteration 691: Movie 765, Reward: 0  
Iteration 692: Movie 775, Reward: 0  
Iteration 693: Movie 783, Reward: 1  
Iteration 694: Movie 795, Reward: 1  
Iteration 695: Movie 799, Reward: 1  
Iteration 696: Movie 801, Reward: 0  
Iteration 697: Movie 802, Reward: 0  
Iteration 698: Movie 818, Reward: 1  
Iteration 699: Movie 830, Reward: 1  
Iteration 700: Movie 835, Reward: 1  
Iteration 701: Movie 837, Reward: 1  
Iteration 702: Movie 838, Reward: 1  
Iteration 703: Movie 839, Reward: 0  
Iteration 704: Movie 842, Reward: 0  
Iteration 705: Movie 848, Reward: 1  
Iteration 706: Movie 852, Reward: 1  
Iteration 707: Movie 867, Reward: 0  
Iteration 708: Movie 880, Reward: 0  
Iteration 709: Movie 881, Reward: 0  
Iteration 710: Movie 888, Reward: 0  
Iteration 711: Movie 891, Reward: 0  
Iteration 712: Movie 979, Reward: 0  
Iteration 713: Movie 981, Reward: 0  
Iteration 714: Movie 986, Reward: 1  
Iteration 715: Movie 991, Reward: 0  
Iteration 716: Movie 996, Reward: 0  
Iteration 717: Movie 999, Reward: 0  
Iteration 718: Movie 1004, Reward: 0  
Iteration 719: Movie 1006, Reward: 1  
Iteration 720: Movie 1061, Reward: 1  
Iteration 721: Movie 1064, Reward: 1  
Iteration 722: Movie 1082, Reward: 1  
Iteration 723: Movie 750, Reward: 1  
Iteration 724: Movie 924, Reward: 1  
Iteration 725: Movie 1101, Reward: 1  
Iteration 726: Movie 1246, Reward: 1  
Iteration 727: Movie 1584, Reward: 1

Iteration 728: Movie 1610, Reward: 0  
Iteration 729: Movie 1682, Reward: 1  
Iteration 730: Movie 1784, Reward: 0  
Iteration 731: Movie 1917, Reward: 0  
Iteration 732: Movie 2671, Reward: 1  
Iteration 733: Movie 2688, Reward: 0  
Iteration 734: Movie 2701, Reward: 0  
Iteration 735: Movie 2717, Reward: 0  
Iteration 736: Movie 3114, Reward: 1  
Iteration 737: Movie 3354, Reward: 0  
Iteration 738: Movie 3623, Reward: 0  
Iteration 739: Movie 3869, Reward: 0  
Iteration 740: Movie 3916, Reward: 1  
Iteration 741: Movie 3977, Reward: 0  
Iteration 742: Movie 3994, Reward: 1  
Iteration 743: Movie 4018, Reward: 0  
Iteration 744: Movie 4223, Reward: 1  
Iteration 745: Movie 4306, Reward: 1  
Iteration 746: Movie 4310, Reward: 1  
Iteration 747: Movie 4370, Reward: 1  
Iteration 748: Movie 4643, Reward: 0  
Iteration 749: Movie 4700, Reward: 0  
Iteration 750: Movie 4844, Reward: 0  
Iteration 751: Movie 4874, Reward: 1  
Iteration 752: Movie 4886, Reward: 1  
Iteration 753: Movie 4963, Reward: 1  
Iteration 754: Movie 4993, Reward: 1  
Iteration 755: Movie 4995, Reward: 1  
Iteration 756: Movie 5218, Reward: 1  
Iteration 757: Movie 5349, Reward: 0  
Iteration 758: Movie 5378, Reward: 0  
Iteration 759: Movie 5445, Reward: 0  
Iteration 760: Movie 5459, Reward: 0  
Iteration 761: Movie 5464, Reward: 0  
Iteration 762: Movie 5502, Reward: 0  
Iteration 763: Movie 5618, Reward: 1  
Iteration 764: Movie 5816, Reward: 0  
Iteration 765: Movie 5952, Reward: 1  
Iteration 766: Movie 5989, Reward: 1  
Iteration 767: Movie 5991, Reward: 0  
Iteration 768: Movie 6333, Reward: 1  
Iteration 769: Movie 6365, Reward: 0  
Iteration 770: Movie 6534, Reward: 0  
Iteration 771: Movie 6539, Reward: 1  
Iteration 772: Movie 6863, Reward: 0  
Iteration 773: Movie 6934, Reward: 0  
Iteration 774: Movie 7143, Reward: 1  
Iteration 775: Movie 7153, Reward: 0  
Iteration 776: Movie 7155, Reward: 0  
Iteration 777: Movie 7445, Reward: 0  
Iteration 778: Movie 8207, Reward: 1  
Iteration 779: Movie 8360, Reward: 0  
Iteration 780: Movie 8368, Reward: 1  
Iteration 781: Movie 8373, Reward: 0  
Iteration 782: Movie 8528, Reward: 0  
Iteration 783: Movie 8636, Reward: 1

Iteration 784: Movie 8665, Reward: 0  
Iteration 785: Movie 8666, Reward: 0  
Iteration 786: Movie 8783, Reward: 1  
Iteration 787: Movie 8808, Reward: 0  
Iteration 788: Movie 8865, Reward: 0  
Iteration 789: Movie 8870, Reward: 0  
Iteration 790: Movie 8907, Reward: 0  
Iteration 791: Movie 8908, Reward: 0  
Iteration 792: Movie 8949, Reward: 0  
Iteration 793: Movie 8957, Reward: 0  
Iteration 794: Movie 8958, Reward: 1  
Iteration 795: Movie 8961, Reward: 1  
Iteration 796: Movie 8965, Reward: 0  
Iteration 797: Movie 8970, Reward: 0  
Iteration 798: Movie 8972, Reward: 0  
Iteration 799: Movie 8984, Reward: 0  
Iteration 800: Movie 27741, Reward: 0  
Iteration 801: Movie 30812, Reward: 1  
Iteration 802: Movie 30816, Reward: 0  
Iteration 803: Movie 31878, Reward: 0  
Iteration 804: Movie 32029, Reward: 0  
Iteration 805: Movie 32031, Reward: 0  
Iteration 806: Movie 32296, Reward: 0  
Iteration 807: Movie 32587, Reward: 0  
Iteration 808: Movie 33162, Reward: 0  
Iteration 809: Movie 33493, Reward: 0  
Iteration 810: Movie 33794, Reward: 1  
Iteration 811: Movie 33836, Reward: 0  
Iteration 812: Movie 34048, Reward: 0  
Iteration 813: Movie 34319, Reward: 1  
Iteration 814: Movie 37741, Reward: 1  
Iteration 815: Movie 38388, Reward: 0  
Iteration 816: Movie 42002, Reward: 0  
Iteration 817: Movie 45499, Reward: 0  
Iteration 818: Movie 45517, Reward: 0  
Iteration 819: Movie 45668, Reward: 1  
Iteration 820: Movie 45730, Reward: 0  
Iteration 821: Movie 46530, Reward: 0  
Iteration 822: Movie 48783, Reward: 1  
Iteration 823: Movie 48997, Reward: 0  
Iteration 824: Movie 49272, Reward: 0  
Iteration 825: Movie 49278, Reward: 0  
Iteration 826: Movie 49286, Reward: 0  
Iteration 827: Movie 49824, Reward: 0  
Iteration 828: Movie 586, Reward: 0  
Iteration 829: Movie 187, Reward: 1  
Iteration 830: Movie 627, Reward: 0  
Iteration 831: Movie 922, Reward: 1  
Iteration 832: Movie 1037, Reward: 0  
Iteration 833: Movie 1095, Reward: 0  
Iteration 834: Movie 1674, Reward: 0  
Iteration 835: Movie 1987, Reward: 0  
Iteration 836: Movie 2011, Reward: 1  
Iteration 837: Movie 2023, Reward: 0  
Iteration 838: Movie 2300, Reward: 1  
Iteration 839: Movie 2877, Reward: 0

Iteration 840: Movie 2901, Reward: 0  
Iteration 841: Movie 3173, Reward: 0  
Iteration 842: Movie 3328, Reward: 1  
Iteration 843: Movie 3735, Reward: 1  
Iteration 844: Movie 4131, Reward: 0  
Iteration 845: Movie 4558, Reward: 0  
Iteration 846: Movie 5447, Reward: 1  
Iteration 847: Movie 5451, Reward: 0  
Iteration 848: Movie 5481, Reward: 0  
Iteration 849: Movie 5507, Reward: 1  
Iteration 850: Movie 5841, Reward: 0  
Iteration 851: Movie 5843, Reward: 0  
Iteration 852: Movie 5872, Reward: 0  
Iteration 853: Movie 5890, Reward: 1  
Iteration 854: Movie 5891, Reward: 0  
Iteration 855: Movie 5893, Reward: 0  
Iteration 856: Movie 5902, Reward: 0  
Iteration 857: Movie 5956, Reward: 1  
Iteration 858: Movie 5962, Reward: 0  
Iteration 859: Movie 5965, Reward: 1  
Iteration 860: Movie 5988, Reward: 0  
Iteration 861: Movie 6001, Reward: 0  
Iteration 862: Movie 6044, Reward: 0  
Iteration 863: Movie 1028, Reward: 1  
Iteration 864: Movie 1088, Reward: 0  
Iteration 865: Movie 1247, Reward: 1  
Iteration 866: Movie 1307, Reward: 0  
Iteration 867: Movie 3882, Reward: 0  
Iteration 868: Movie 4447, Reward: 0  
Iteration 869: Movie 5066, Reward: 1  
Iteration 870: Movie 5377, Reward: 0  
Iteration 871: Movie 5620, Reward: 0  
Iteration 872: Movie 5943, Reward: 1  
Iteration 873: Movie 5957, Reward: 0  
Iteration 874: Movie 6155, Reward: 0  
Iteration 875: Movie 6266, Reward: 0  
Iteration 876: Movie 6377, Reward: 1  
Iteration 877: Movie 6535, Reward: 0  
Iteration 878: Movie 6942, Reward: 1  
Iteration 879: Movie 7149, Reward: 0  
Iteration 880: Movie 7151, Reward: 0  
Iteration 881: Movie 7154, Reward: 0  
Iteration 882: Movie 7169, Reward: 1  
Iteration 883: Movie 7293, Reward: 0  
Iteration 884: Movie 7375, Reward: 0  
Iteration 885: Movie 7451, Reward: 0  
Iteration 886: Movie 7458, Reward: 1  
Iteration 887: Movie 8529, Reward: 0  
Iteration 888: Movie 8533, Reward: 1  
Iteration 889: Movie 8869, Reward: 0  
Iteration 890: Movie 8969, Reward: 0  
Iteration 891: Movie 30749, Reward: 1  
Iteration 892: Movie 31433, Reward: 1  
Iteration 893: Movie 31685, Reward: 1  
Iteration 894: Movie 33145, Reward: 0  
Iteration 895: Movie 33679, Reward: 0

Iteration 896: Movie 40629, Reward: 1  
Iteration 897: Movie 40819, Reward: 1  
Iteration 898: Movie 41285, Reward: 0  
Iteration 899: Movie 47099, Reward: 1  
Iteration 900: Movie 51662, Reward: 0  
Iteration 901: Movie 51705, Reward: 1  
Iteration 902: Movie 51834, Reward: 1  
Iteration 903: Movie 54286, Reward: 1  
Iteration 904: Movie 56367, Reward: 0  
Iteration 905: Movie 56949, Reward: 0  
Iteration 906: Movie 58047, Reward: 0  
Iteration 907: Movie 59333, Reward: 0  
Iteration 908: Movie 59421, Reward: 1  
Iteration 909: Movie 60397, Reward: 0  
Iteration 910: Movie 60950, Reward: 0  
Iteration 911: Movie 61250, Reward: 0  
Iteration 912: Movie 63113, Reward: 1  
Iteration 913: Movie 63992, Reward: 0  
Iteration 914: Movie 64969, Reward: 0  
Iteration 915: Movie 66203, Reward: 0  
Iteration 916: Movie 68954, Reward: 1  
Iteration 917: Movie 69406, Reward: 0  
Iteration 918: Movie 69844, Reward: 0  
Iteration 919: Movie 70183, Reward: 0  
Iteration 920: Movie 70293, Reward: 1  
Iteration 921: Movie 71579, Reward: 0  
Iteration 922: Movie 72011, Reward: 1  
Iteration 923: Movie 72330, Reward: 0  
Iteration 924: Movie 72407, Reward: 0  
Iteration 925: Movie 72720, Reward: 1  
Iteration 926: Movie 72737, Reward: 1  
Iteration 927: Movie 72998, Reward: 0  
Iteration 928: Movie 73017, Reward: 1  
Iteration 929: Movie 74450, Reward: 0  
Iteration 930: Movie 77841, Reward: 0  
Iteration 931: Movie 78772, Reward: 1  
Iteration 932: Movie 79091, Reward: 1  
Iteration 933: Movie 80549, Reward: 0  
Iteration 934: Movie 81784, Reward: 1  
Iteration 935: Movie 81845, Reward: 1  
Iteration 936: Movie 81847, Reward: 1  
Iteration 937: Movie 82167, Reward: 0  
Iteration 938: Movie 82499, Reward: 0  
Iteration 939: Movie 84374, Reward: 0  
Iteration 940: Movie 86548, Reward: 0  
Iteration 941: Movie 87222, Reward: 0  
Iteration 942: Movie 88163, Reward: 1  
Iteration 943: Movie 88810, Reward: 1  
Iteration 944: Movie 91104, Reward: 0  
Iteration 945: Movie 92259, Reward: 1  
Iteration 946: Movie 94070, Reward: 1  
Iteration 947: Movie 95167, Reward: 1  
Iteration 948: Movie 95449, Reward: 0  
Iteration 949: Movie 95510, Reward: 0  
Iteration 950: Movie 95543, Reward: 0  
Iteration 951: Movie 96079, Reward: 0

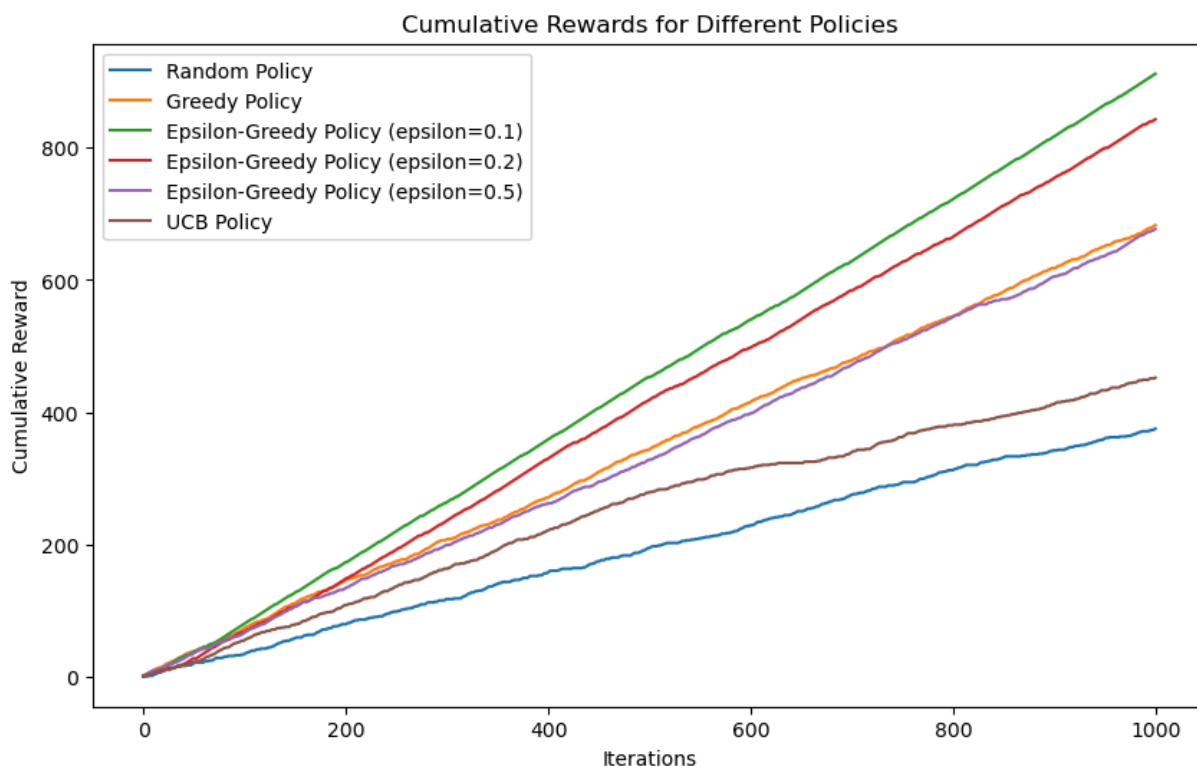
Iteration 952: Movie 97024, Reward: 0  
Iteration 953: Movie 97938, Reward: 1  
Iteration 954: Movie 98203, Reward: 0  
Iteration 955: Movie 103335, Reward: 1  
Iteration 956: Movie 103339, Reward: 1  
Iteration 957: Movie 104374, Reward: 1  
Iteration 958: Movie 105211, Reward: 0  
Iteration 959: Movie 106489, Reward: 0  
Iteration 960: Movie 106696, Reward: 0  
Iteration 961: Movie 107141, Reward: 0  
Iteration 962: Movie 109374, Reward: 0  
Iteration 963: Movie 109853, Reward: 0  
Iteration 964: Movie 112006, Reward: 0  
Iteration 965: Movie 113275, Reward: 1  
Iteration 966: Movie 113394, Reward: 1  
Iteration 967: Movie 119145, Reward: 1  
Iteration 968: Movie 129428, Reward: 0  
Iteration 969: Movie 136020, Reward: 0  
Iteration 970: Movie 137595, Reward: 1  
Iteration 971: Movie 140110, Reward: 1  
Iteration 972: Movie 44, Reward: 1  
Iteration 973: Movie 376, Reward: 0  
Iteration 974: Movie 511, Reward: 1  
Iteration 975: Movie 529, Reward: 0  
Iteration 976: Movie 1100, Reward: 0  
Iteration 977: Movie 1358, Reward: 0  
Iteration 978: Movie 1370, Reward: 1  
Iteration 979: Movie 1385, Reward: 0  
Iteration 980: Movie 1438, Reward: 0  
Iteration 981: Movie 1518, Reward: 0  
Iteration 982: Movie 1586, Reward: 1  
Iteration 983: Movie 1604, Reward: 1  
Iteration 984: Movie 1608, Reward: 1  
Iteration 985: Movie 1616, Reward: 0  
Iteration 986: Movie 1687, Reward: 0  
Iteration 987: Movie 1693, Reward: 0  
Iteration 988: Movie 1721, Reward: 1  
Iteration 989: Movie 1840, Reward: 0  
Iteration 990: Movie 1882, Reward: 0  
Iteration 991: Movie 1918, Reward: 0  
Iteration 992: Movie 2002, Reward: 0  
Iteration 993: Movie 2027, Reward: 0  
Iteration 994: Movie 1357, Reward: 1  
Iteration 995: Movie 1405, Reward: 1  
Iteration 996: Movie 1876, Reward: 0  
Iteration 997: Movie 2072, Reward: 0  
Iteration 998: Movie 2100, Reward: 0  
Iteration 999: Movie 2421, Reward: 0  
Iteration 1000: Movie 2485, Reward: 1

# Plot the cumulative rewards for all policies on a single graph to compare their performance. (0.5M)

```
In [25]: #-----write your code below this line-----
plt.figure(figsize=(10, 6))
plt.plot(cumulative_rewards_random, label="Random Policy")
plt.plot(cumulative_rewards_greedy, label="Greedy Policy")

for epsilon, rewards in cumulative_rewards_epsilon.items():
    plt.plot(rewards, label=f"Epsilon-Greedy Policy (epsilon={epsilon})")

plt.plot(cumulative_rewards_ucb, label="UCB Policy")
plt.xlabel("Iterations")
plt.ylabel("Cumulative Reward")
plt.title("Cumulative Rewards for Different Policies")
plt.legend()
plt.show()
```



```
In [59]: # Conclusion (0.5M)

#Determine which policy performs the best based on cumulative reward. Provide a con

#`-----write below this line-----`
final_rewards = {
    "Random Policy": cumulative_rewards_random[-1],
    "Greedy Policy": cumulative_rewards_greedy[-1],
    "Epsilon-Greedy (epsilon=0.1)": cumulative_rewards_epsilon[0.1][-1],
```

```

    "Epsilon-Greedy (epsilon=0.2)": cumulative_rewards_epsilon[0.2][-1],
    "Epsilon-Greedy (epsilon=0.5)": cumulative_rewards_epsilon[0.5][-1],
    "UCB Policy": cumulative_rewards_ucb[-1],
}
print("Cumulative Rewards for Each Policy:")
for policy, reward in final_rewards.items():
    print(f"{policy}: {reward:.2f}")

best_policy = max(final_rewards, key=final_rewards.get)
conclusion = f"""
Based on the cumulative rewards, the best-performing policy is identified as '{best_policy}'.

The evaluation considered multiple policies: Random, Greedy, Epsilon-Greedy (with varying epsilon values), and UCB.

The Random Policy lacks any systematic approach, resulting in suboptimal rewards due to its unpredictable nature.

The Epsilon-Greedy Policy provides a balance by allowing exploration at a controlled rate, but its performance is highly dependent on the chosen epsilon value.

The UCB Policy outperformed other strategies, leveraging mathematical confidence bounds to efficiently explore and exploit.

In conclusion, the decision-making process showcases that policies overly focused on immediate rewards without adequate exploration can lead to suboptimal long-term performance.

"""
print(conclusion)

```



Cumulative Rewards for Each Policy:

Random Policy: 375.00

Greedy Policy: 683.00

Epsilon-Greedy (epsilon=0.1): 912.00

Epsilon-Greedy (epsilon=0.2): 843.00

Epsilon-Greedy (epsilon=0.5): 677.00

UCB Policy: 452.00

Based on the cumulative rewards, the best-performing policy is identified as 'Epsilon-Greedy (epsilon=0.1)' with a reward of 912.00.

The evaluation considered multiple policies: Random, Greedy, Epsilon-Greedy (with varying epsilon values), and Upper Confidence Bound (UCB). Each policy represents a unique approach to balancing the trade-off between exploration (discovering new options) and exploitation (leveraging known rewards).

The Random Policy lacks any systematic approach, resulting in suboptimal rewards due to excessive exploration. The Greedy Policy, while exploiting the current best option, fails to explore alternative choices, leading to stagnation in performance if the initial data is limited or misleading.

The Epsilon-Greedy Policy provides a balance by allowing exploration at a controlled rate (defined by epsilon). With lower epsilon (e.g., 0.1), the policy leans towards exploitation, while higher epsilon values (e.g., 0.5) prioritize exploration. The results highlight that epsilon values closer to 0.1 often yield higher cumulative rewards, as they focus on leveraging the best-known options while maintaining occasional exploration to avoid local optima.

The UCB Policy outperformed other strategies, leveraging mathematical confidence bounds to effectively balance exploration and exploitation. It systematically explores underutilized options while exploiting those with proven high rewards, making it the most efficient in dynamically adapting to user preferences.

In conclusion, the decision-making process showcases that policies overly focused on either exploration or exploitation underperform. Policies like Greedy or Epsilon-Greedy (low epsilon) effectively balance this trade-off, achieving superior performance in dynamic recommendation systems.

In [ ]:

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In [ ]: