

Recommender Systems

Thibault Allart

Agenda

1. Introduction to recommender systems and first steps into bandit.
2. Contextual bandit.
3. Matrix factorization and deep recommender system.
4. Historical sampling bias.
5. List recommendation, position based model and EM algorithm.
6. A first look into reinforcement learning.
7. Deploying and calling an API using Flask, Nginx and Docker.
8. Project.
9. Soutenances.

Introduction

1. The diversity of recommender systems.
2. Bandit framework.
3. Epsilon greedy algorithm.
4. Upper Confidence Bound algorithm.
5. Thompson sampling algorithm.
6. Non stationary rewards.
7. Delayed rewards.

The diversity of recommender systems.

The screenshot displays the LDLC website homepage. At the top, there's a search bar with placeholder text "Chercher un produit, une marque, une catégorie.", a menu icon, and a user profile icon. Below the header, there are two main sections: "TOP DES VENTES" and "NOUVEAUTÉS".

TOP DES VENTES:

- Seagate BarraCuda 2 To (ST2000DM008) - 69€95
- Seagate BarraCuda 1 To (ST1000DM010) - 47€95
- Samsung SSD 860 QVO 1 To - 139€94
- AMD Ryzen 5 3600 Wraith Stealth (3.6 GHz / 4.2 GHz) - 239€95

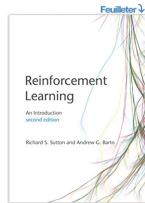
NOUVEAUTÉS:

- Acer Aspire 3 A315-42-R2LC - 459€90
- Legamaster MagicWipe - 16€68
- Emporio Armani Connected Smartwatch 3 Gen.5 (44.5 mm) - 409€00
- Legamaster Emoticon Magnétique Triste - 9€30

On the right side of the page, there are several promotional and social media sections:

- A "DESTOCKAGE" section featuring a yellow banner with "LE COIN DES AFFAIRES" and a percentage symbol, with the text "Occasion, retours, fin de série...". A "J'EN PROFITE" button is present.
- A "REJOIGNEZ-NOUS:" section with icons for Facebook, Twitter, YouTube, and Instagram.
- An "Inscription Newsletter" form with a placeholder "Votre email" and an "OK" button.

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Revoir



Action et aventure



Nouveautés >



The diversity of recommender systems.

The screenshot shows a Spotify interface for a playlist named "Stan Radio". The cover art features three circular portraits of Eminem, System of a Down, and Papa Roach. The title "Stan Radio" is displayed prominently at the top, along with a subtitle indicating it's a "PLAYLIST" created by Spotify with 49 songs and a duration of 3 hr 24 min. Below the title, there are buttons for "PAUSE", a heart icon, and a three-dot menu. The number of followers is shown as 478. A search bar labeled "Filter" is visible above the track list. The track list itself has columns for TITLE, ARTIST, ALBUM, and DURATION. The first track listed is "Stan" by Eminem, Dido, from "The Marshall Mat...". The duration of the current track is 6:44. The track list continues with other songs like "Breaking the Habit" by Linkin Park, "Soldier" by Eminem, "Break Stuff" by Limp Bizkit, "Dope Boys" by The Game, "Donald Trump" by Mac Miller, "Scary Movies" by Bad Meets Evil, and "In Your Head" by Eminem. The interface includes standard playback controls (rewind, play/pause, forward) and a progress bar showing 0:33 of a total duration of 6:44.

TITLE	ARTIST	ALBUM	DURATION
Stan	Eminem, Dido	The Marshall Mat...	6:44
Breaking the Habit	Linkin Park	Meteora	3:17
Soldier	Eminem	The Eminem Show	3:46
Break Stuff	Limp Bizkit	Significant Other	2:47
Dope Boys	The Game	LAX	4:01
Donald Trump	Mac Miller	Best Day Ever (5th...)	2:45
Scary Movies	Bad Meets Evil	Ridin' Dirty, Vol.10	3:48
In Your Head	Eminem	Revival	3:03

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The diversity of recommender systems.

Qui suivre

Jeff Dean et Gabriel Peyré suivent



Andrew M. Webb

@AndrewM_Webb
Machine learning R&D | I make maths/science animations | Top tweets: tinyurl.com/yxdoxs2z

Suivre

Jeff Dean et Gabriel Peyré suivent



(Berger | Dillon)
@InertialObserver

PhD student of Theoretical Particle Physics @UCIrvine | @NSF Fellow |
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Suivre



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TOU DOUM !

Suivre

Voir plus

Accueil

Gabriel Peyré a aimé
math prof @mathematicsprof · 8h
Truly a polynomial for all seasons, both applied and theoretical.

Gabriel Peyré @gabrielpeyre · 9h
Beside being useful to prove Weierstrass polynomial approximation theorem quantitatively, Bernstein polynomial approximation enjoys many desirable properties. [en.wikipedia.org/wiki/Bernstein...](https://en.wikipedia.org/wiki/Bernstein)

Bernstein polynomial:
$$B_n(t) \cong \binom{n}{k} t^k (1-t)^{n-k}$$

Bernstein approximation:
$$f_n(t) \stackrel{\text{def}}{=} \sum_{k=0}^n f\left(\frac{k}{n}\right) B_n^k(t)$$

0:04 7,3 k vues

15 79

Gabriel Peyré a retweeté
Francis Bach @BachFrancis · 6 janv.
To jump start the new year, a blog post on geometric series. francisbach.com/the-sum-of-a-g...

57 224

Jeff Dean a aimé
The Human Experience @thehumanxp · 12h
Space saving corner

The diversity of recommender systems.

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What's on your mind?

Lauren Post loves lazy sundays with Julian. ♥ =) 54 minutes ago via Mobile Web · Comment · Like

Claire Hagler was tagged in an album.

Shenanigans 2 hours ago

Ronn Homer Don't forget to clean the snow off of the cars before driving. It still have cause accidents with the snow blowing off your car an blinding other drivers. I saw this happen back in 1996. 3 hours ago · Comment · Like

Julie Seldman if you dont clean them off you will get a ticket... its illegal to drive with snow on ur car.... fyi.. 57 minutes ago

Ronn Homer I saw someone this morning driving that cleaned one side of the front windshield and one on the rear and all the snow on the roof was still there. 15 minutes ago

Tanya Betelak Fuck you pizza rolls, for burning my mouth so bad the other night. D: 3 hours ago · Comment · Like

Write a comment...

Requests See All

1 friend suggestion
1 myheart request

Suggestions See All

Brenda Stallsworth Mary Ann Marshall is a mutual friend. Add as friend

Bonnie Horse 11 mutual friends Add as friend

Sponsored

New Mac Snack Wrap™ \$1.49 The taste of a Big Mac® - the size of a snack. Talk about true love! 1,705,715 people are fans of McDonald's. Become a Fan

Events See All

Michael Wagner's birthday Today
Michelle Mauss's birthday Monday

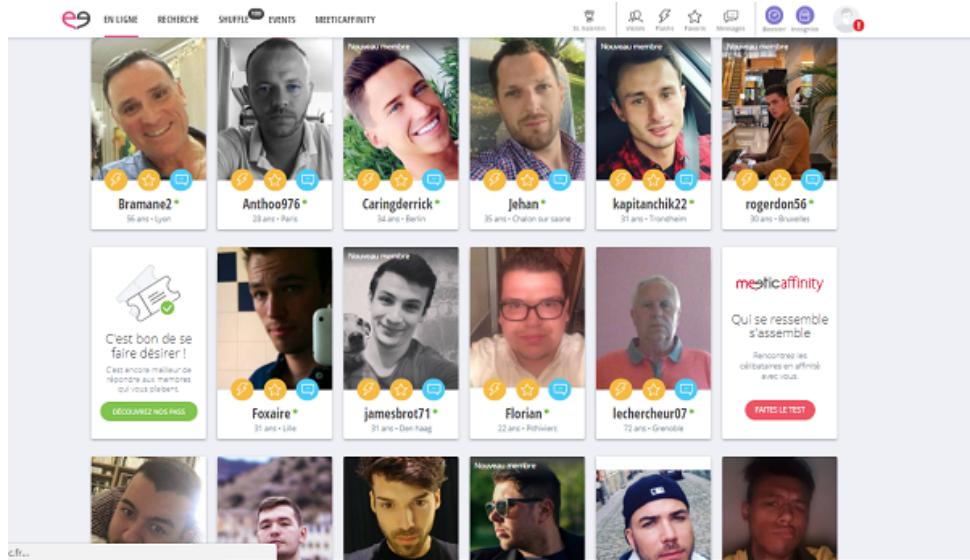
Connect With Friends

Invite friends to join Facebook.
To find people you know who are already using Facebook, check out the Friend Finder.
To connect with friends on the go, check out Facebook for your mobile phone. Chat (15)

See All

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The diversity of recommender systems.



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The diversity of recommender systems.

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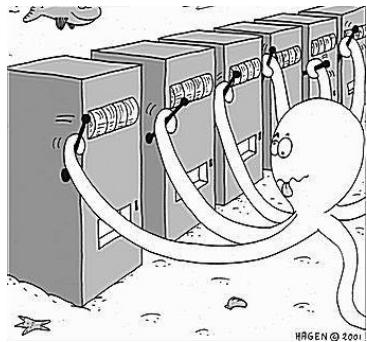
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Starting with a simpler problem

Let's start to simplify the problem by assuming that:

- We recommend only one item at the time
- We have no informations (about the user, product, etc)
- The rewards are stationary

Bandit framework



Start the first [notebook](#).

Epsilon-greedy

REQUIRE : $\epsilon \in [0, 1]$

1. At round t ,
2. with probability ϵ :
3. $A_t \sim \text{Uniform}(1, \dots, K)$
4. with probability $1 - \epsilon$:
5. $A_t = \text{argmax}_{a \in 1, \dots, K}(Q_a)$

UCB

Optimistic in the face of uncertainty we play the arm with the higher Upper Confidence Bound.

$$A_t = \operatorname{argmax}_a \left[Q_t(a) + \sqrt{\frac{c \log t}{N_t(a)}} \right]$$

Bayesian inference

If you need a recap on Bayesian inference, you can look [here](#).

Recall that

Posterior probability \propto Likelihood \times Prior probability

$$f(\theta|x) \propto f(x|\theta) \times f(\theta)$$

If prior and posterior are in the same probability distribution family they are then called conjugate distributions.

A long list of conjugate prior can be found on [wikipedia](#).

Thompson sampling

REQUIRE: A distribution function f parametrized by θ and a priors g on θ distribution.

1. $p^0(\theta|x) = g(\theta)$
2. At round t ,
3. sample $(\theta'_a)_{a \in 1, \dots, K}$ from the posterior distribution p^t .
4. play $A_t = \text{argmax}_{a \in 1, \dots, K}(\theta'_a)$
5. update posterior distribution using observed reward, i.e.
$$p^{t+1}(\theta|x) = f(x|\theta) \times p^t(\theta|x)$$

Deepmind bsuite

For the project, you are free to start from scratch or to use existing libraries like [OpenAI Gym](#) or [Deepmind bsuite](#).

This [Notebook](#) illustrate how to use bsuite.

Notebooks

1. Bandits
2. Contextual bandits
3. (Deep) Matrix factorization
4. Rating environment, i.e explicit feedback

References

Books:

- [Reinforcement Learning: An Introduction](#) from Richard S. Sutton and Andrew Barto
- [Bandit Algorithms](#) from Tor Lattimore and Csaba Szepesvari.

Lectures

- [Lectures on Reinforcement Learning](#) from Emilie Kaufmann.
- [Lectures on Deep Learning](#) from Olivier Grisel, Charles Ollion et al.