You may also like…

RECOMMENDER SYSTEMS

with JavaScript using Graph Theory

@olarclara

THUNDER PLAINS
{developer conference}

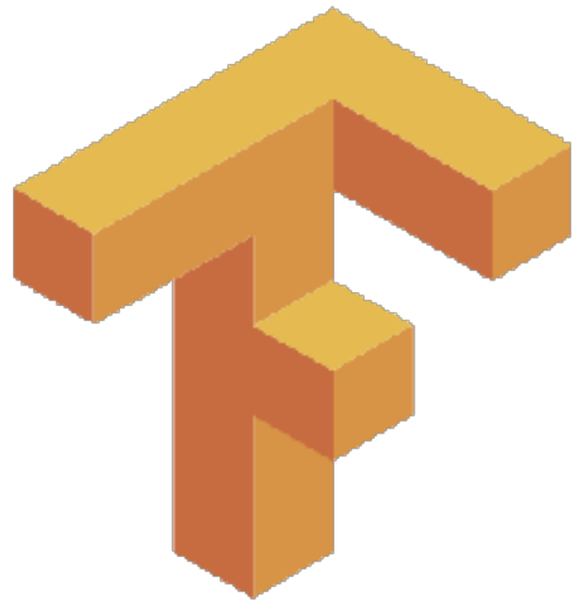
@olarclara 🇧🇷

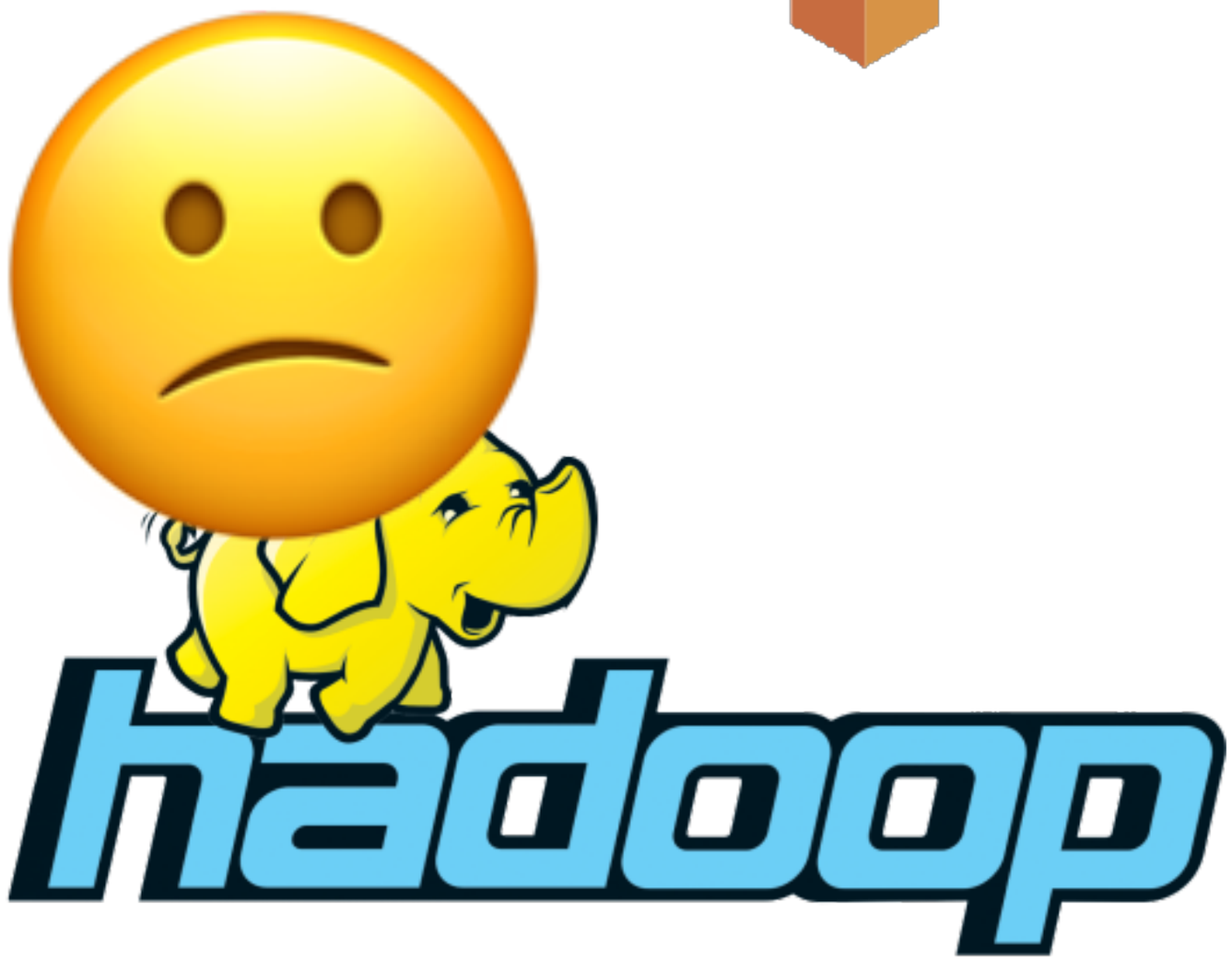
- front-end engineer
- former AI researcher
- dog lover 🐶

what they all have in common?

recommender systems


scikit
learn




hadoop


Java™

the problem

Reelgood

Login | Sign Up

Netflix Roulette

Netflix

Send Feedback

FIND SOMETHING TO WATCH:

GENRE Documentary

TYPE Movies TV Shows

IMDB > 9

SPIN AGAIN

No one likes that anyways

Life (2009)

IM Documentary 1 Season

id Attenborough looks at the extraordinary
s to which animals and plants go in order to
ive. Featuring epic spectacles, amazing TV
s and examples of new wildlife...

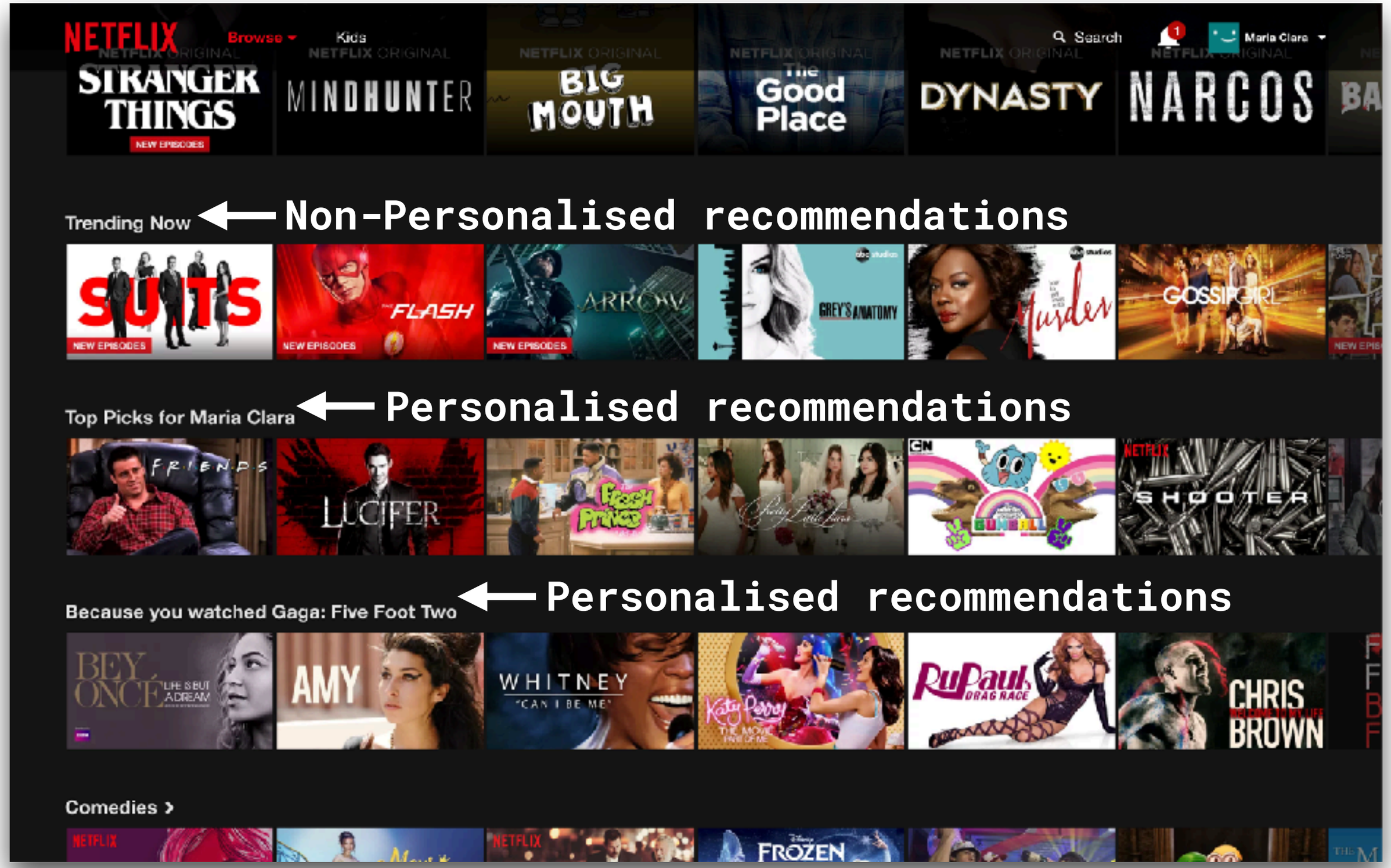
WATCH

MORE INFO

Done with random? See where to watch anything on any source with Reelgood. The ultimate streaming tv guide.

VISIT REELGOOD

recommendations can be personalised or not


NETFLIX
Browse
Kids
Search
Maria Clara
STRANGER THINGS
NEW EPISODES
MINDHUNTER
BIG MOUTH
The Good Place
DYNASTY
NARCOS
Trending Now
Non-Personalised recommendations
SUITS
NEW EPISODES
THE FLASH
NEW EPISODES
ARROW
NEW EPISODES
GREY'S ANATOMY
How to Get Away with Murder
GOSSIP GIRL
Top Picks for Maria Clara
Personalised recommendations
FRIENDS
LUCIFER
Fresh Prince
Pretty Little Liars
GUMBALL
NETFLIX
SHOOTER
Because you watched Gaga: Five Foot Two
Personalised recommendations
BEYONCE LIFE IS BUT A DREAM
AMY
WHITNEY "CAN I BE ME"
Katy Perry THE MOVIE PART OF ME
RuPaul's DRAG RACE
CHRIS BROWN
Comedies ›
NETFLIX
NETFLIX
FROZEN

2 of every 3 hours streamed on Netflix is discovered on the Home page

(Source: The Netflix Recommender System: Algorithms, Business Value, and Innovation)

NETFLIX

Netflix Prize

COMPLETED

Home | Rules | Leaderboard | Update

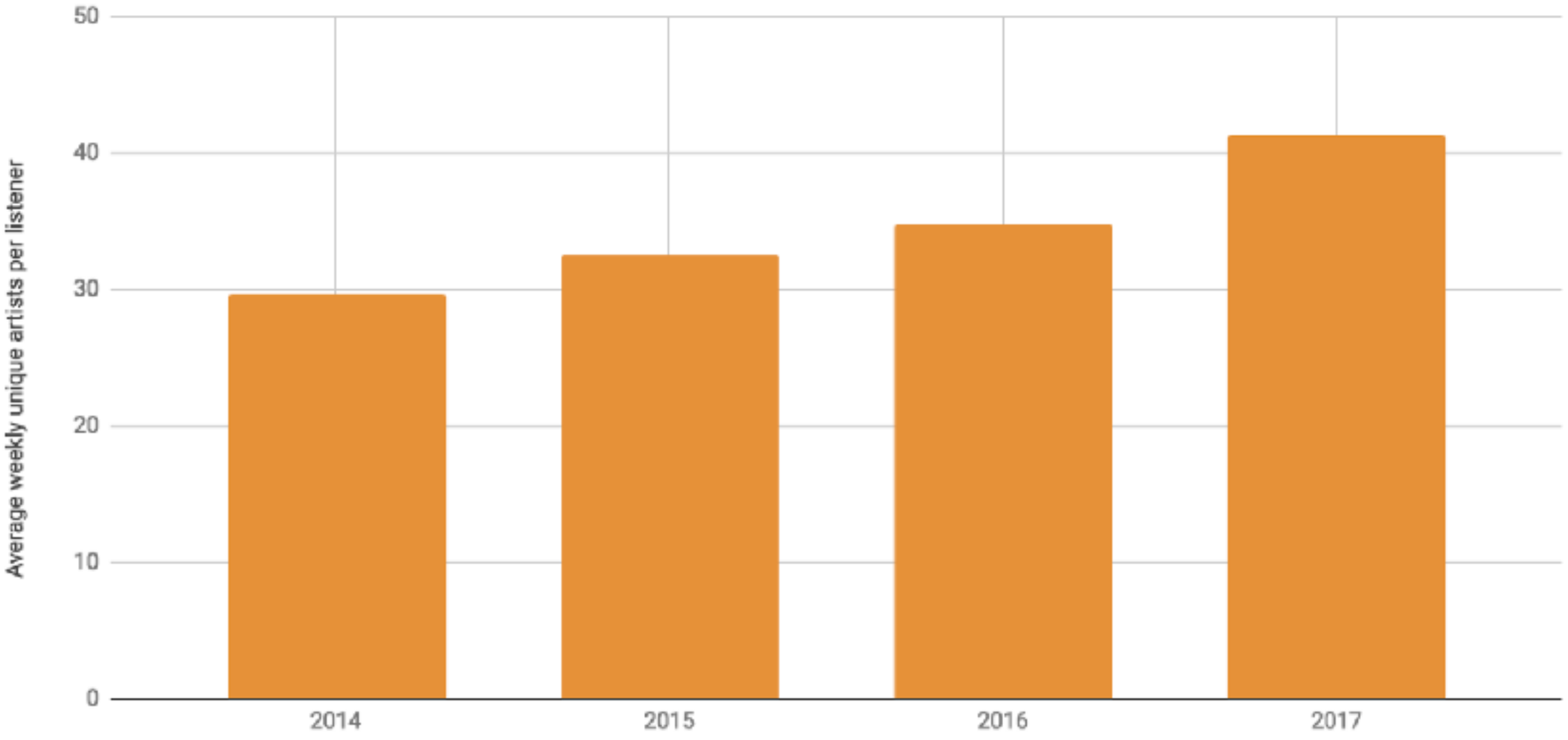
FAQ | Forum | Netflix Home

goals of recommender systems

#1 increase sells, views, listens…

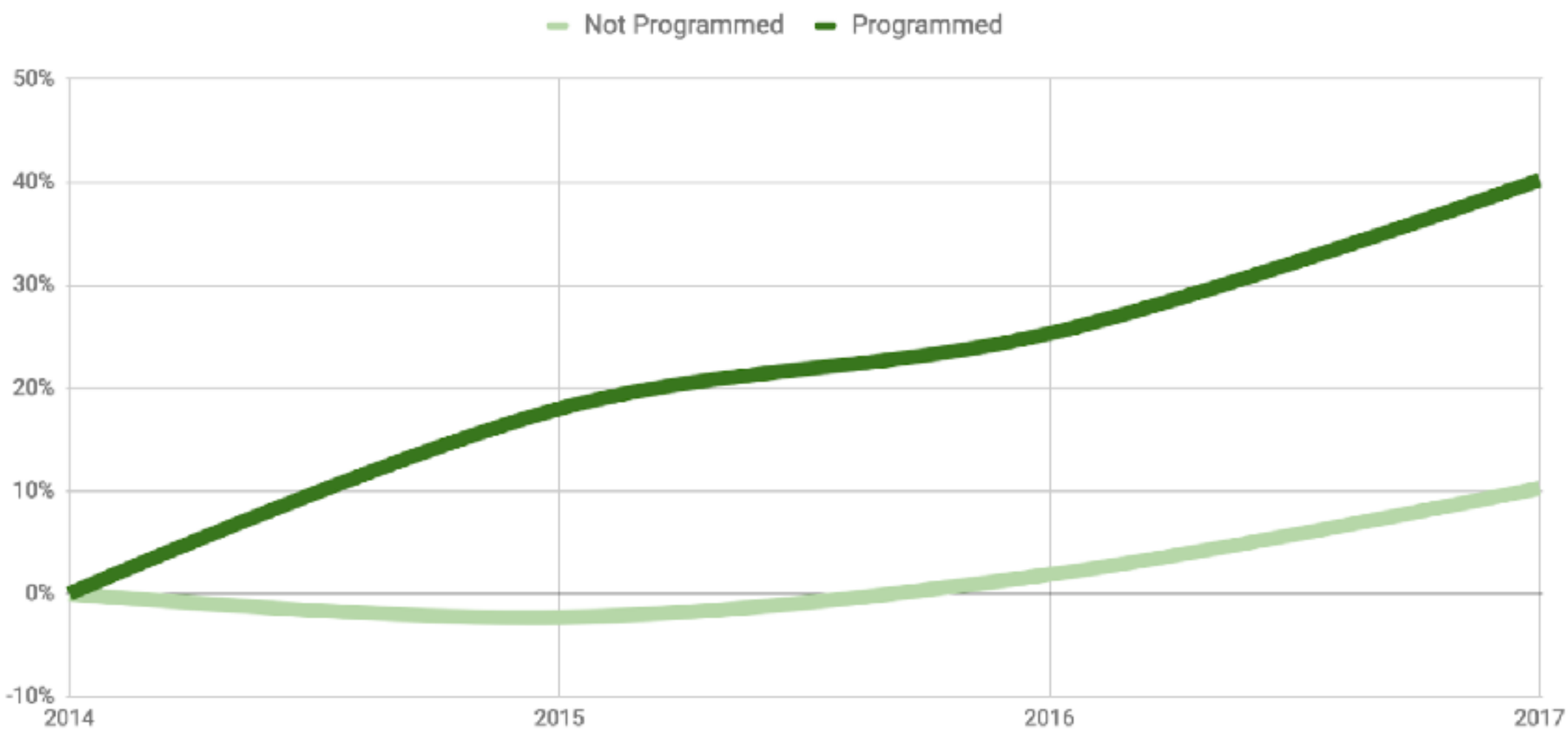
#2 sell more diverse items

The average listener is streaming ~40 unique artists per week.



(Source https://insights.spotify.com/us/2017/11/02/listening-diversity-spotify/)

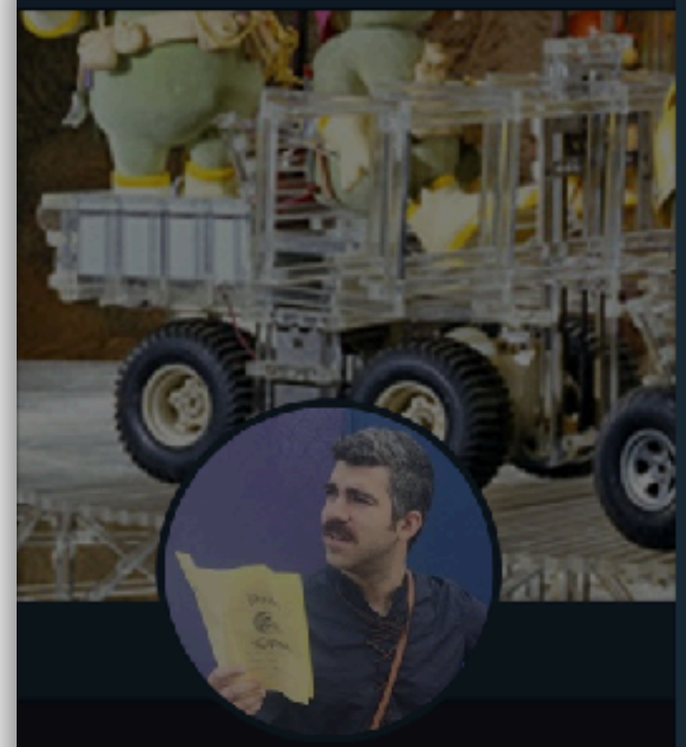
Where Is Spotify's Growth in Artist Diversity Coming From?



(Source https://insights.spotify.com/us/2017/11/02/listening-diversity-spotify/)

#3 increase user satisfaction

Home Moments Notifi



Dave Horwitz
@Dave_Horwitz

Rich, young, and hot to troll.
instagram.com/dopeashirts4sale
tinyurl.com/nbyb6po

Los Angeles, CA
tinyurl.com/jful88m
Joined April 2011

Dave Horwitz
@Dave_Horwitz

Follow

.@Spotify a friend in NYC just informed me that this tweet has reached the highest heights: dirty subway ad!

11:26 AM - 21 Jun 2016

9 Retweets 128 Likes

12 9 128

Tweet your reply

Allison Raskin @AllisonRaskin · 21 Jun 2016
Replying to @Dave_Horwitz @Spotify
Do you now own part of that subway car?

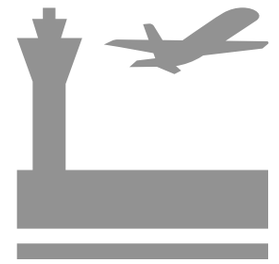
Tweet

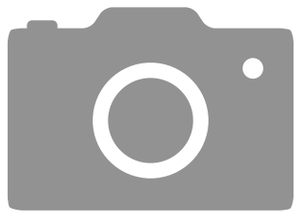
#4 increase user fidelity

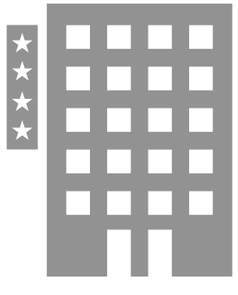
#5 better understanding of the user needs

basic model

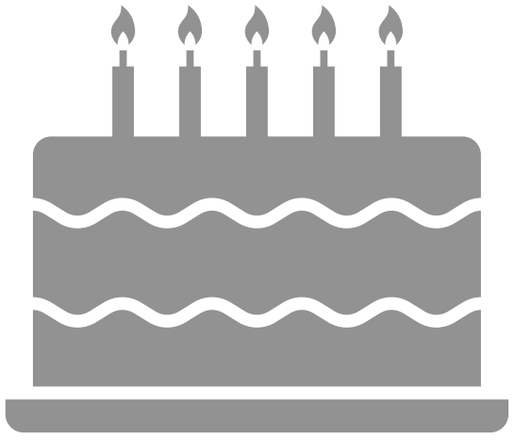
items



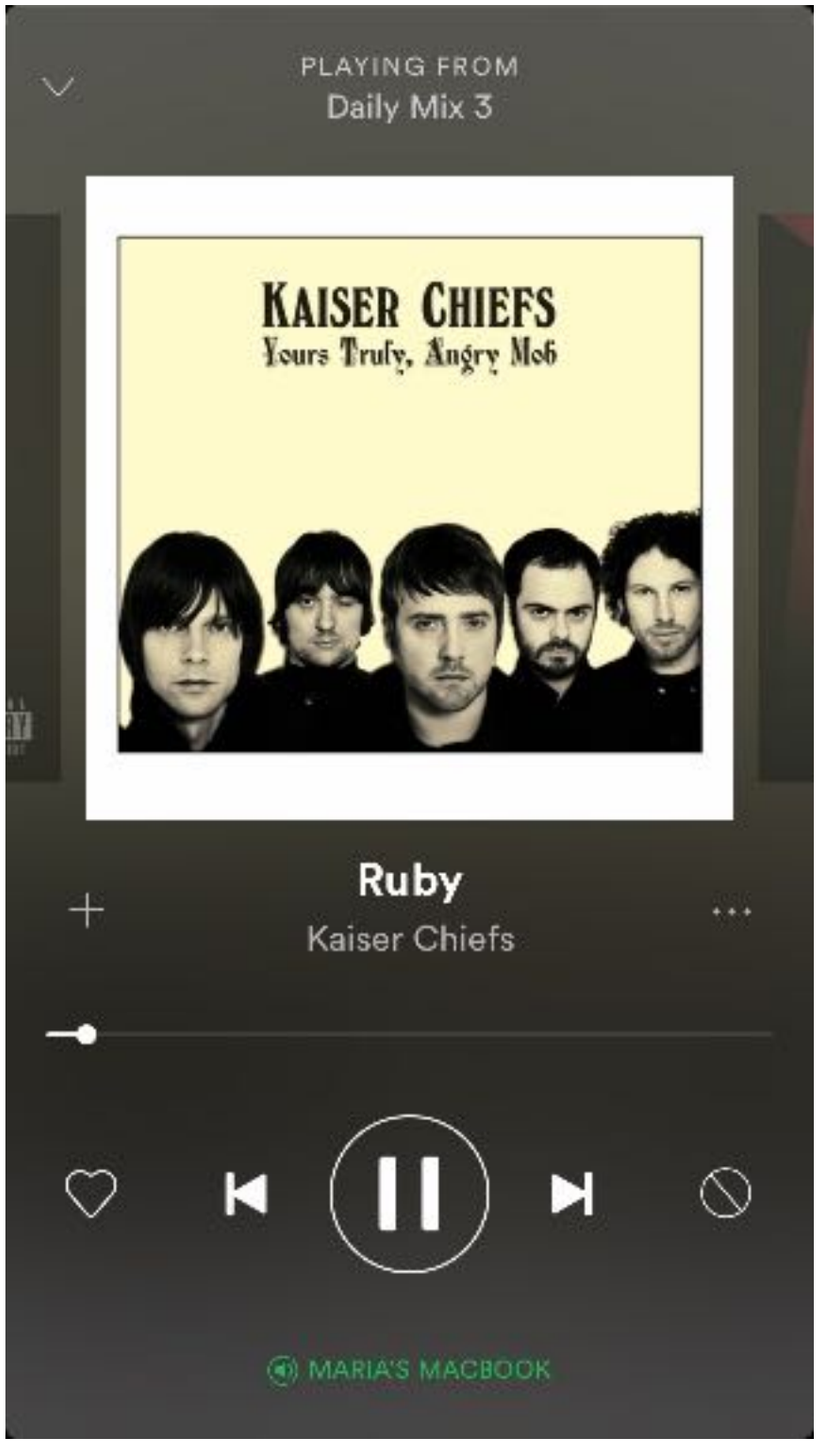




users

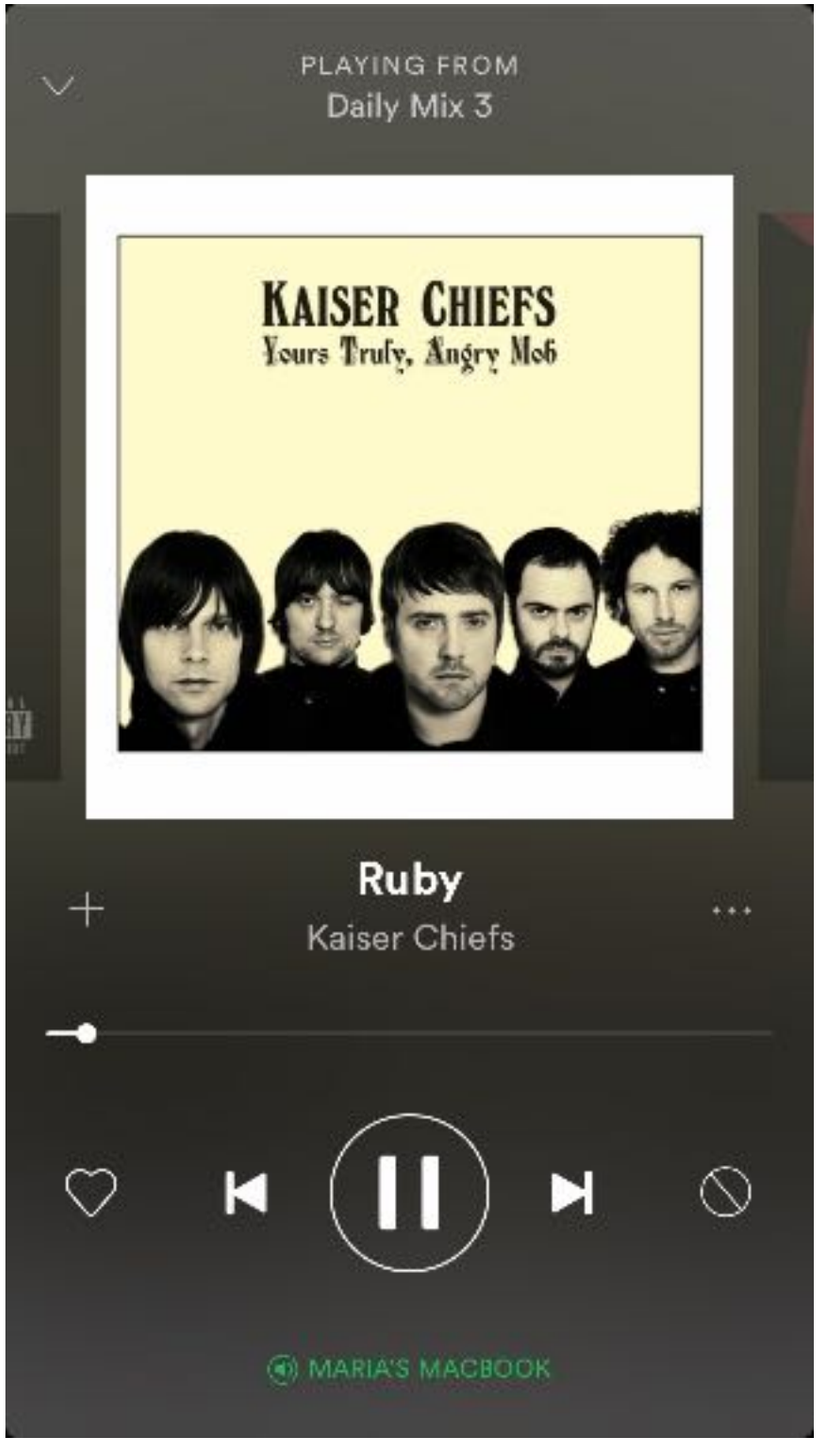


transactions

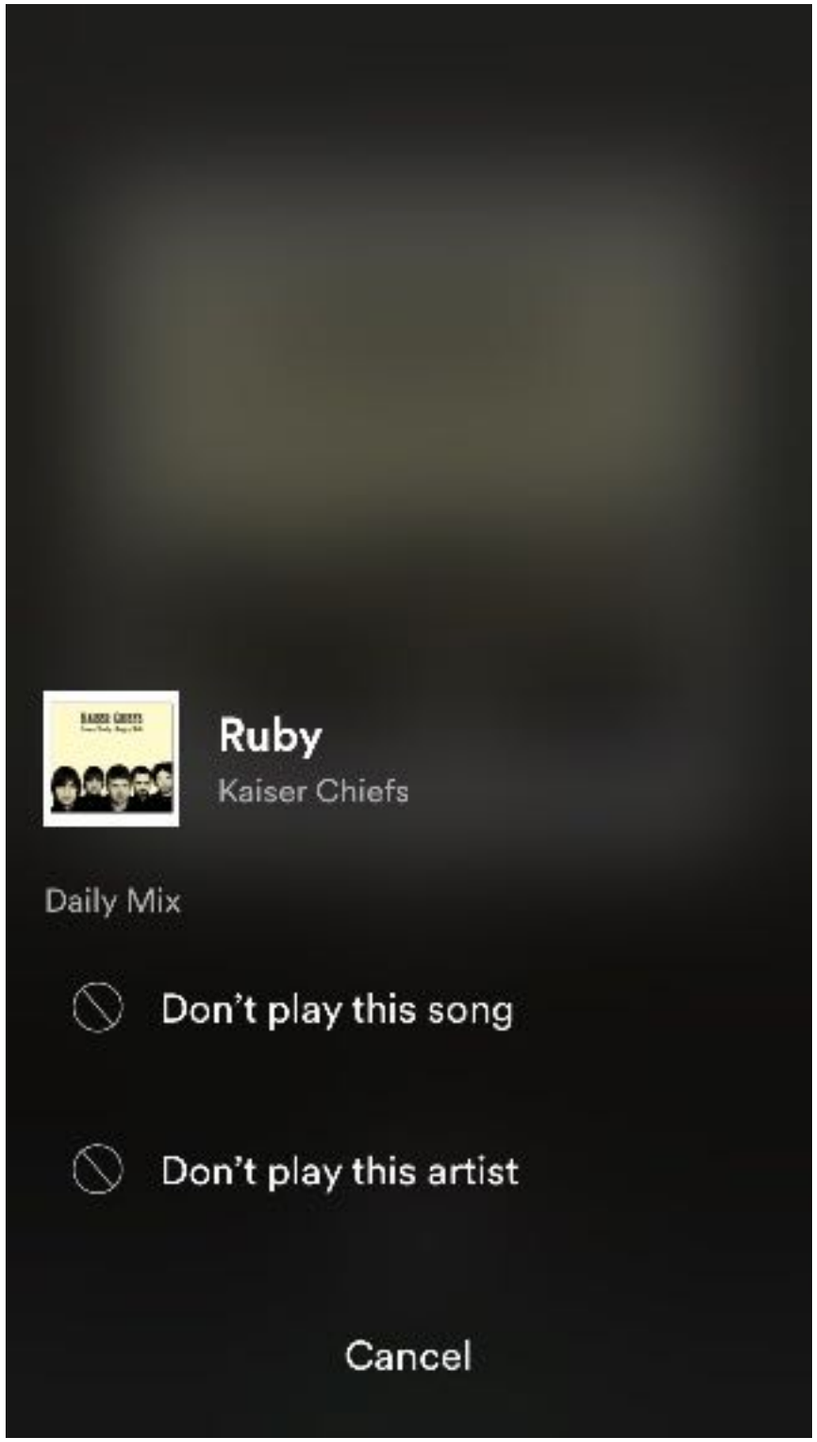

PLAYING FROM
Daily Mix 3
KAISER CHIEFS
Yours Truly, Angry Mob
Ruby
Kaiser Chiefs
MARIA'S MACBOOK

Like


PLAYING FROM
Daily Mix 3
KAISER CHIEFS
Yours Truly, Angry Mob
Ruby
Kaiser Chiefs
Saved to Your Library.
ADD IT TO A PLAYLIST TOO?


PLAYING FROM
Daily Mix 3
KAISER CHIEFS
Yours Truly, Angry Mob
Ruby
Kaiser Chiefs
MARIA'S MACBOOK

Dislike


Ruby
Kaiser Chiefs
Daily Mix
Don't play this song
Don't play this artist
Cancel

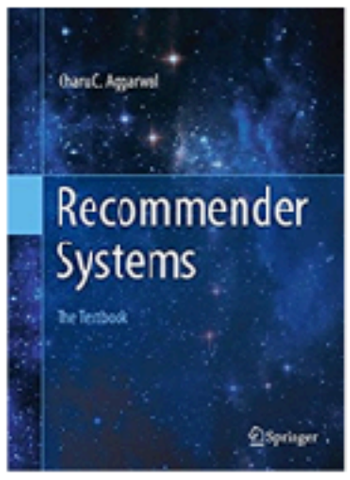
recommendation techniques

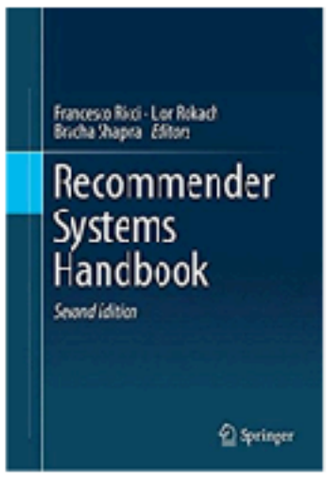
#1 content-based filtering

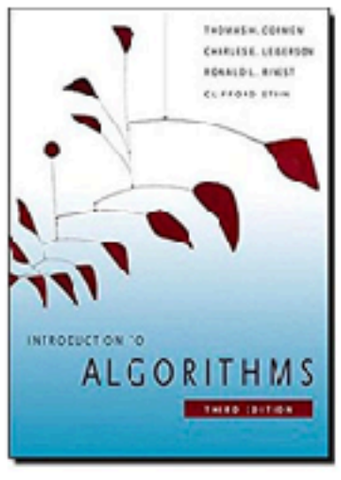
Inspired by your browsing history See more

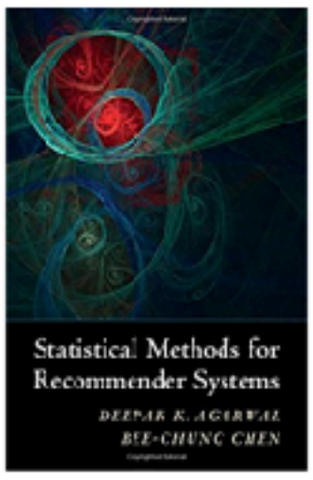


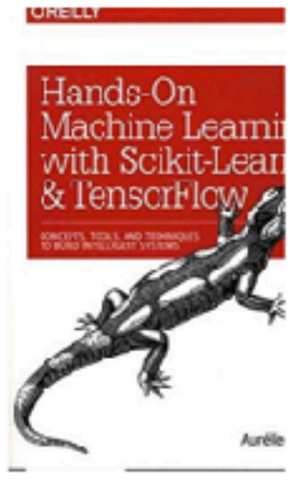

Related to items you've viewed See more











#2 collaborative-based filtering

Customers who bought this item also bought

ASUS Designo MX27UC 27" 4K UHD IPS DP HDMI USB Type-C Eye Care Monitor with Adaptive...
2,097
$597.00 prime

AmazonBasics USB Type-C to USB Type-C 2.0 Cable - 6 Feet (1.8 Meters) - White
234
$7.66 prime

AmazonBasics USB Type-C to USB-A Male 3.1 Gen2 Cable - 3 Feet (0.9 Meters) - White
77
$9.99 prime

USB Type-C, Anker Premium 5-Port 60W USB Wall Charger PowerPort+ 5 USB-C with Power...
453
$49.99 prime

Belkin USB-IF Certified USB-C to USB-C Thunderbolt 3 Cable, Compatible with...
51
$28.99 prime

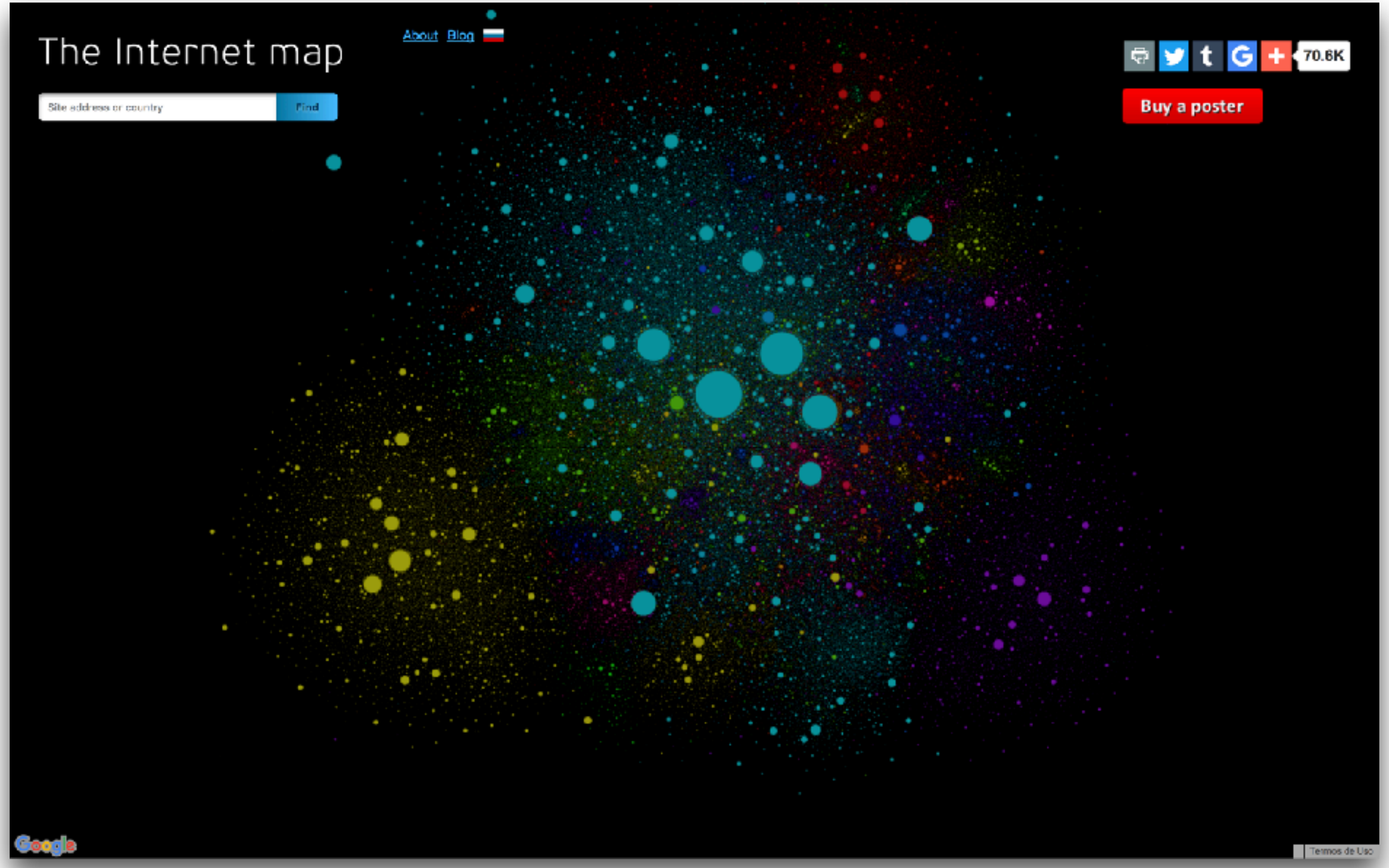
Cable Matters 72W 4-Port USB-C Charger with USB Power Delivery for Laptops, Tablets, and...
45
$34.99 prime

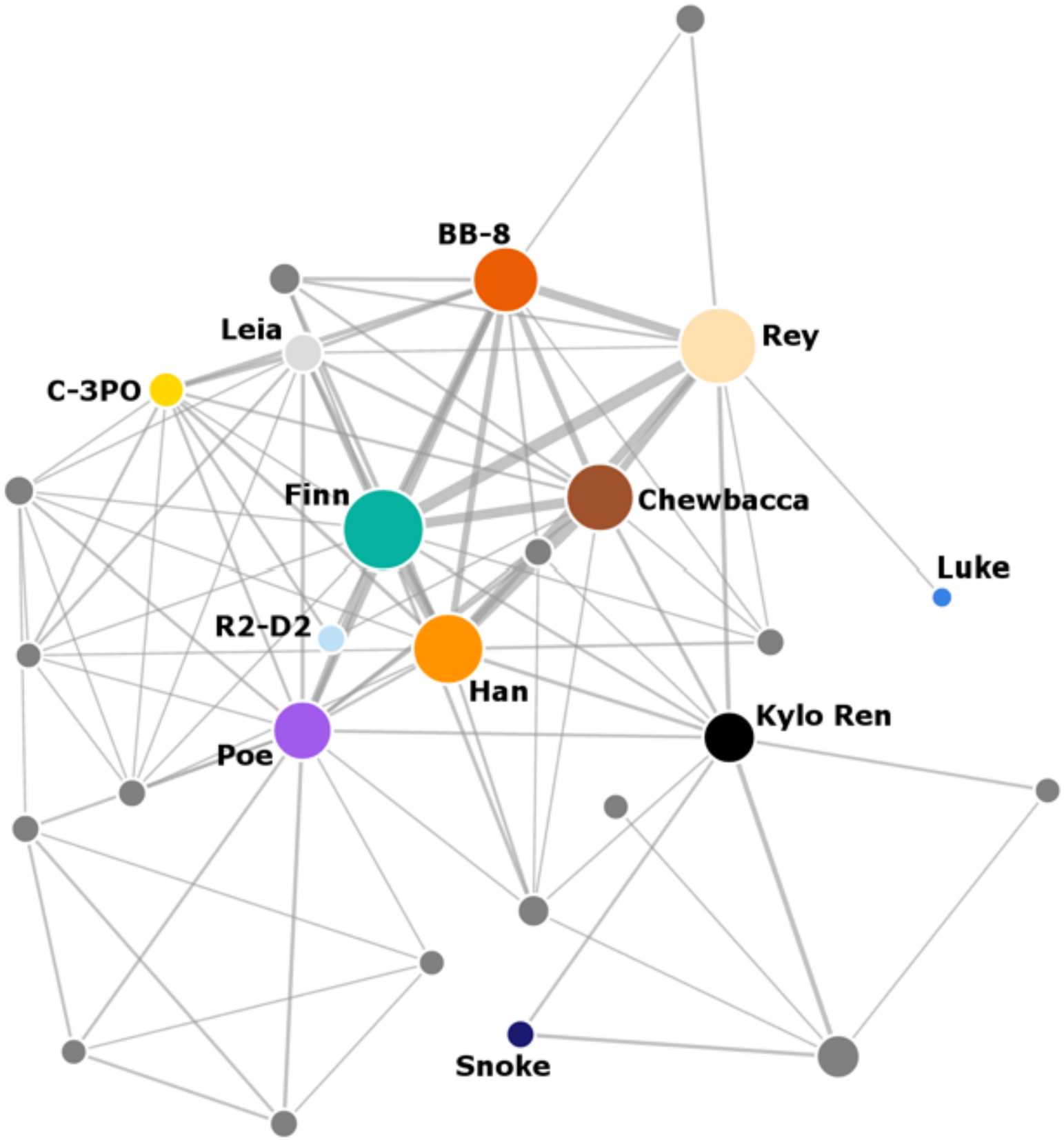
Apple MNF82LL/A 87W USB-C Power Adapter
76
$79.00 prime

other methods

- Demographic-based filtering;
- Knowledge-based filtering;
- Community-based filtering;
- Hybrid recommender systems;

graphs


The Internet map
About
Blog
Site address or country
Find
70.6K
Buy a poster
Google
Termos de Uso



(Source http://evelinag.com/blog/2016/01-25-social-network-force-awakens/index.html)

vertices (or nodes)

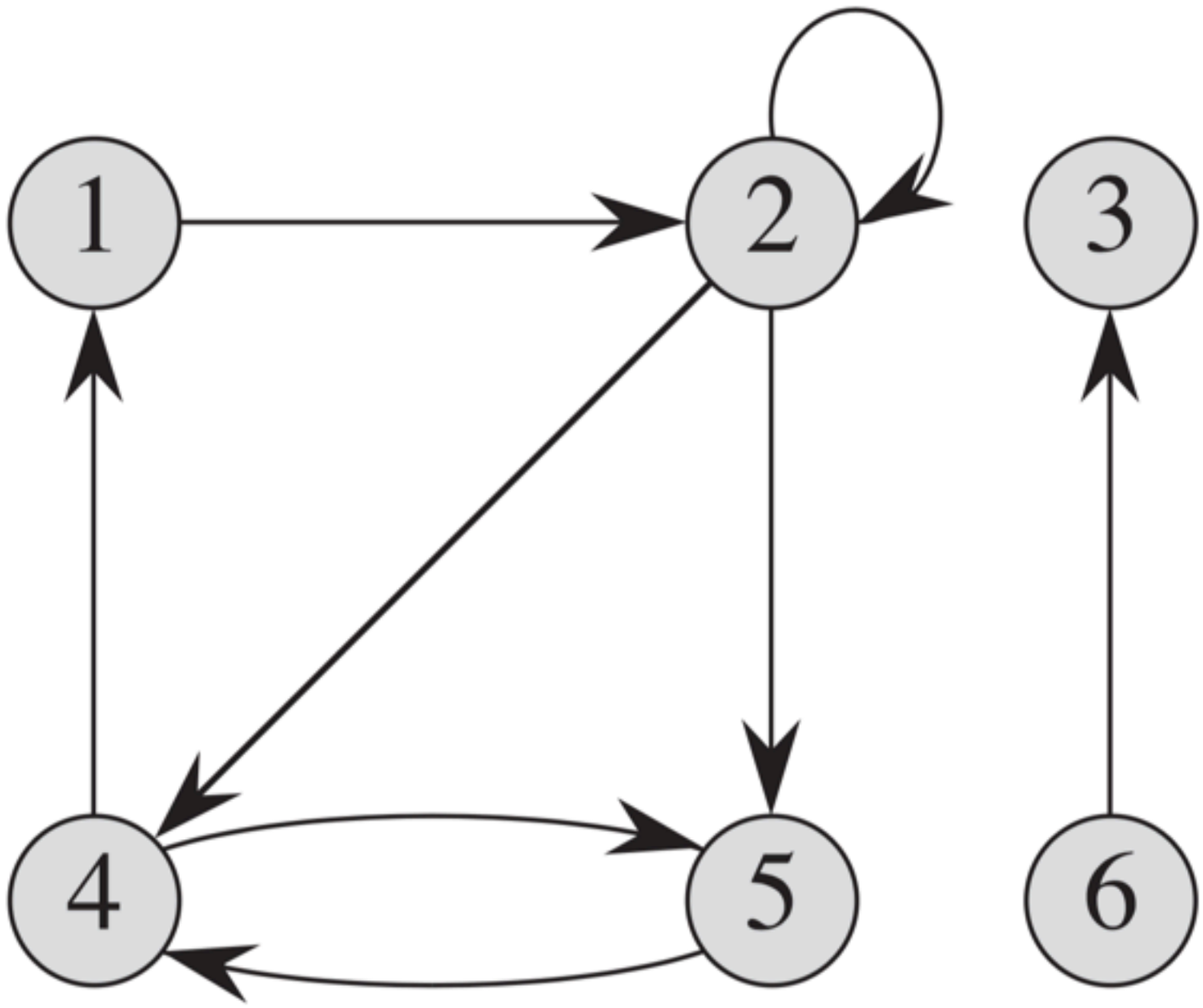
- Items on a network;
- Rey, Chewbacca, Han Solo, BB-8…

edges

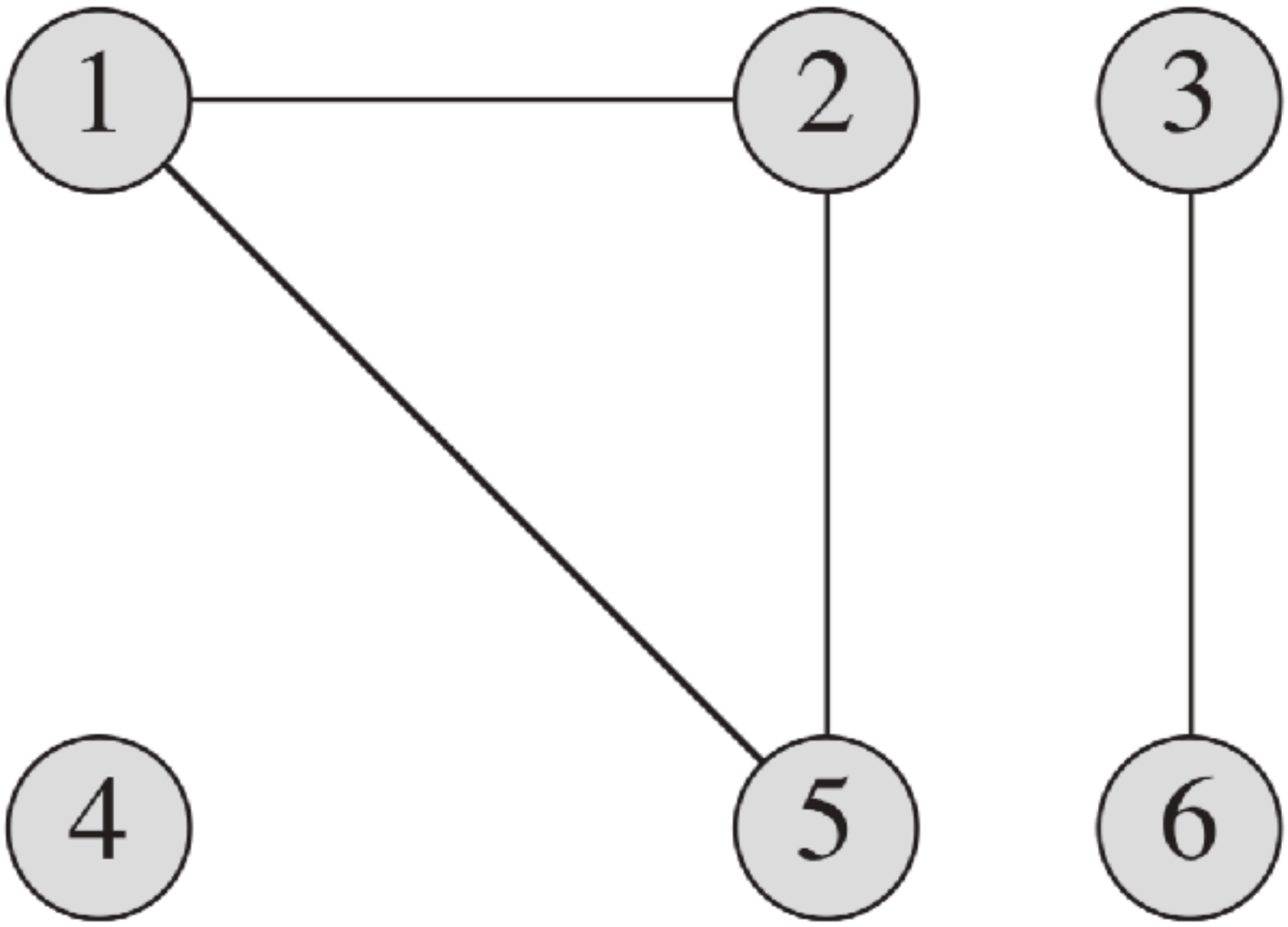
- Relation between items on a network;

- Rey talks to Chewbacca, Rey talks to Finn, Rey talks to Poe;

directed graph

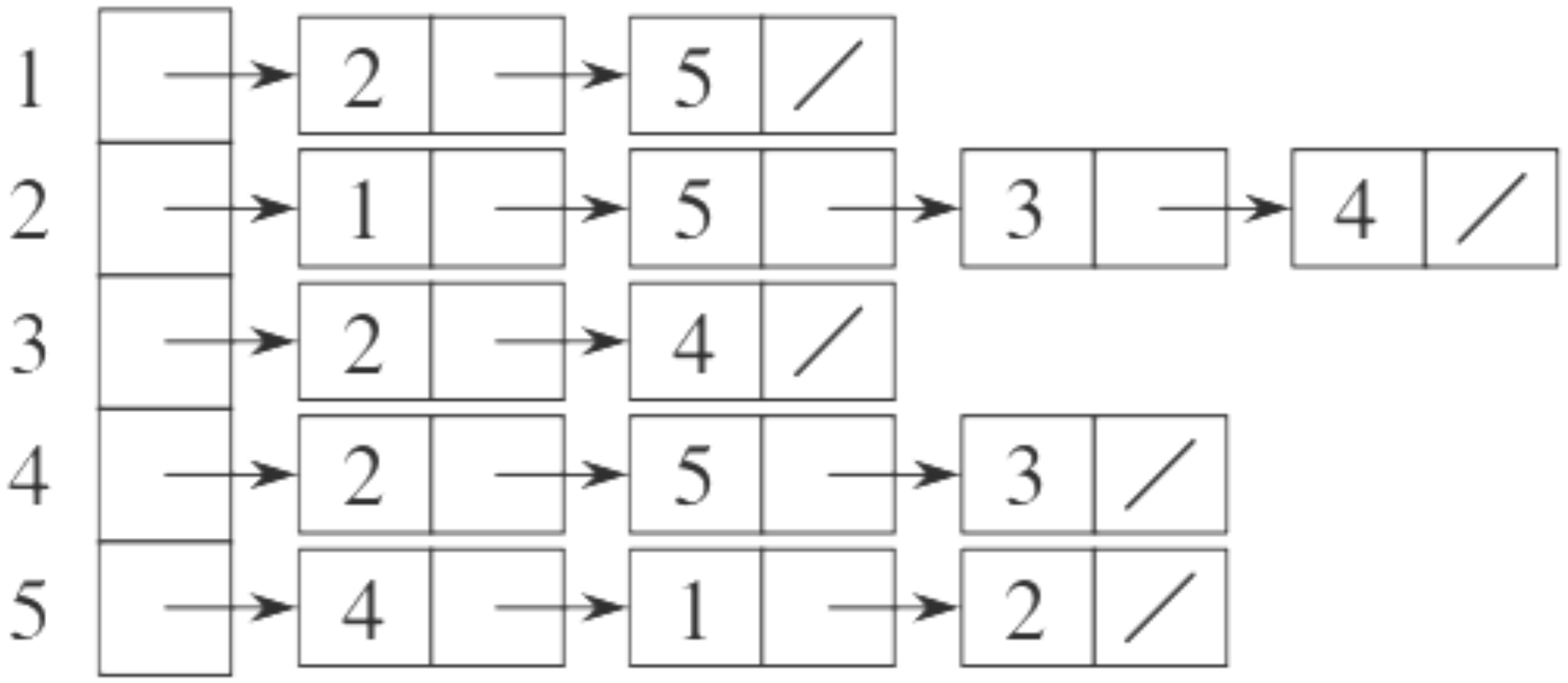


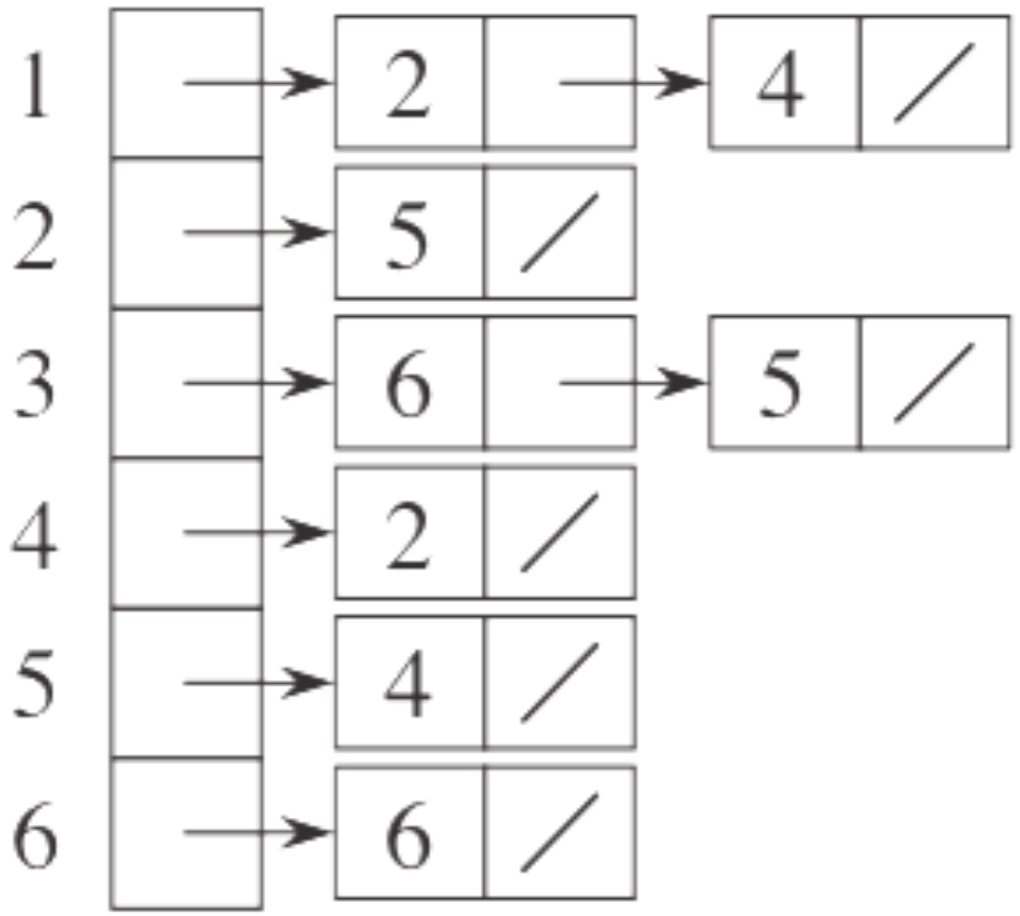
undirected graph



representing graphs

adjacency lists


1
2
5
2
1
5
3
4
3
2
4
4
2
5
3
5
4
1
2


1
2
3
4
5
6
2
4
5
6
5
2
4
6

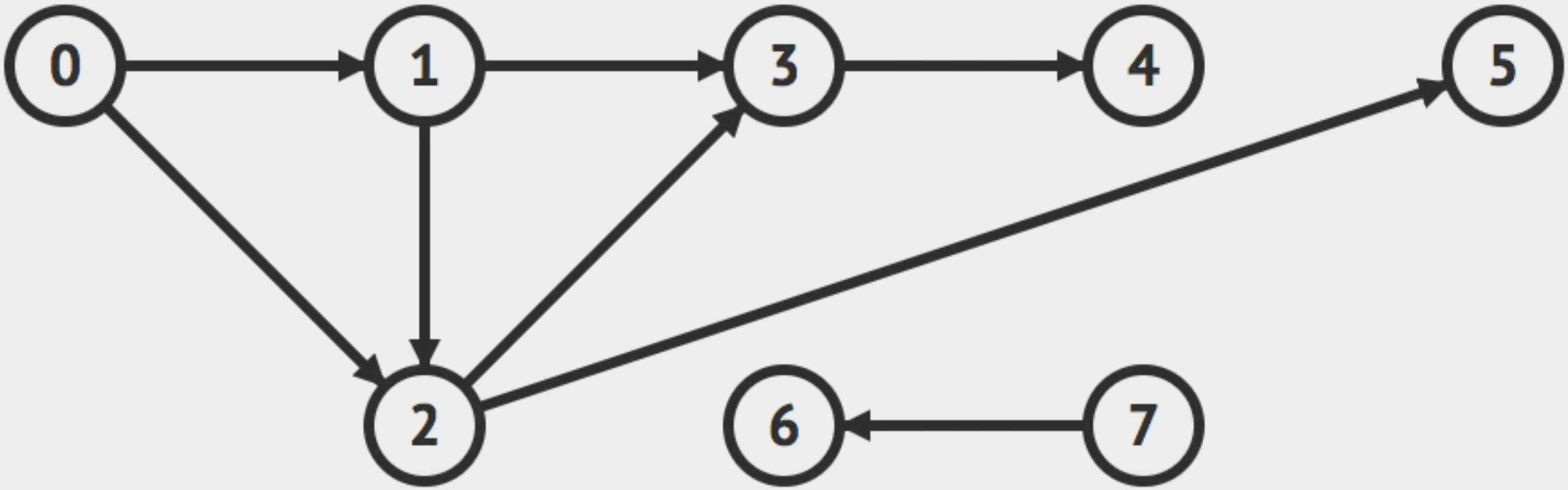
adjacency matrix

	1	2	3	4	5
1	0	1	0	0	1
2	1	0	1	1	1
3	0	1	0	1	0
4	0	1	1	0	1
5	1	1	0	1	0

	1	2	3	4	5	6
1	0	1	0	1	0	0
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	1	0	0	0	0
5	0	0	0	1	0	0
6	0	0	0	0	0	1

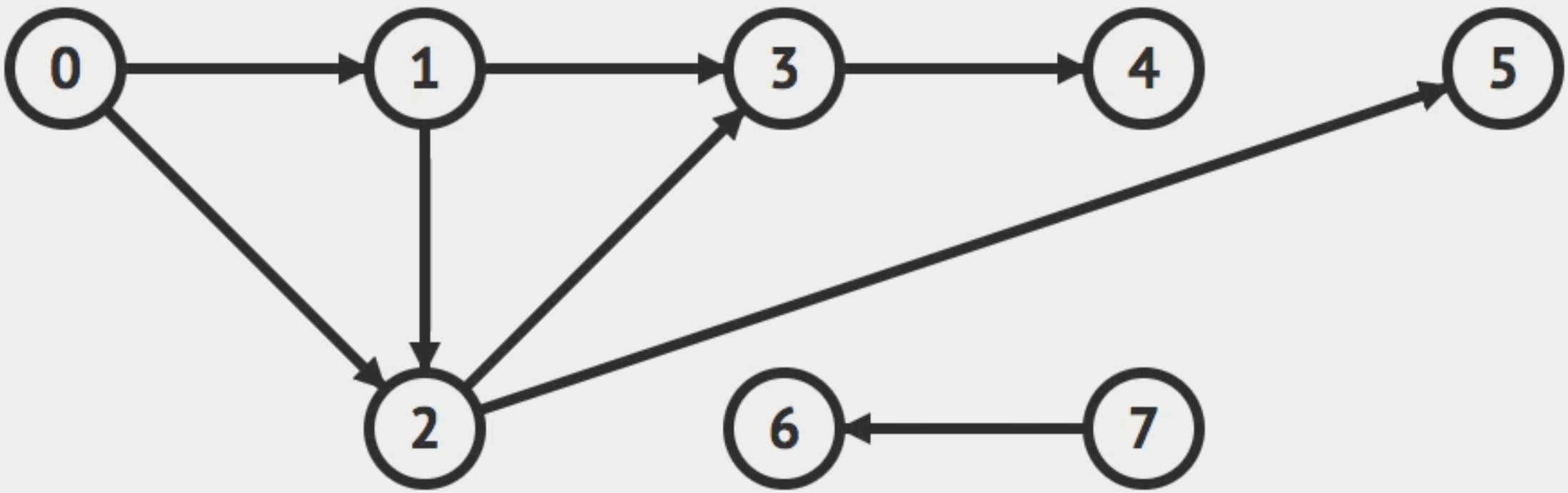
searching Graphs

breadth-first search



(Source https://visualgo.net/)

depth-first search

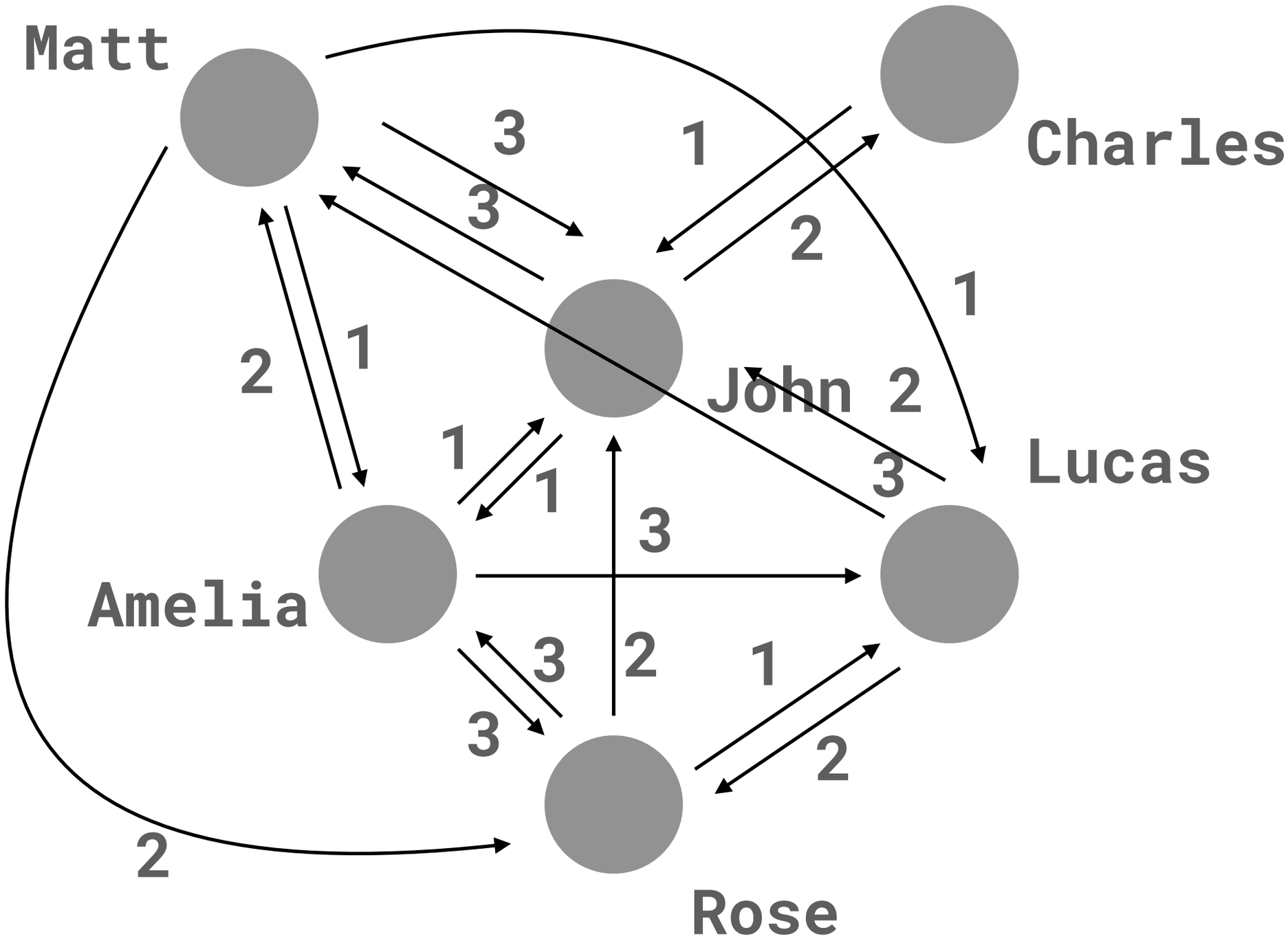


(Source https://visualgo.net/)

let's build a graph

```
const Graph = function () {
  this.vertices = {};
};

Graph.prototype.add = function (name, edges) {
  edges = edges || null;
  this.vertices[name] = edges;
};
```

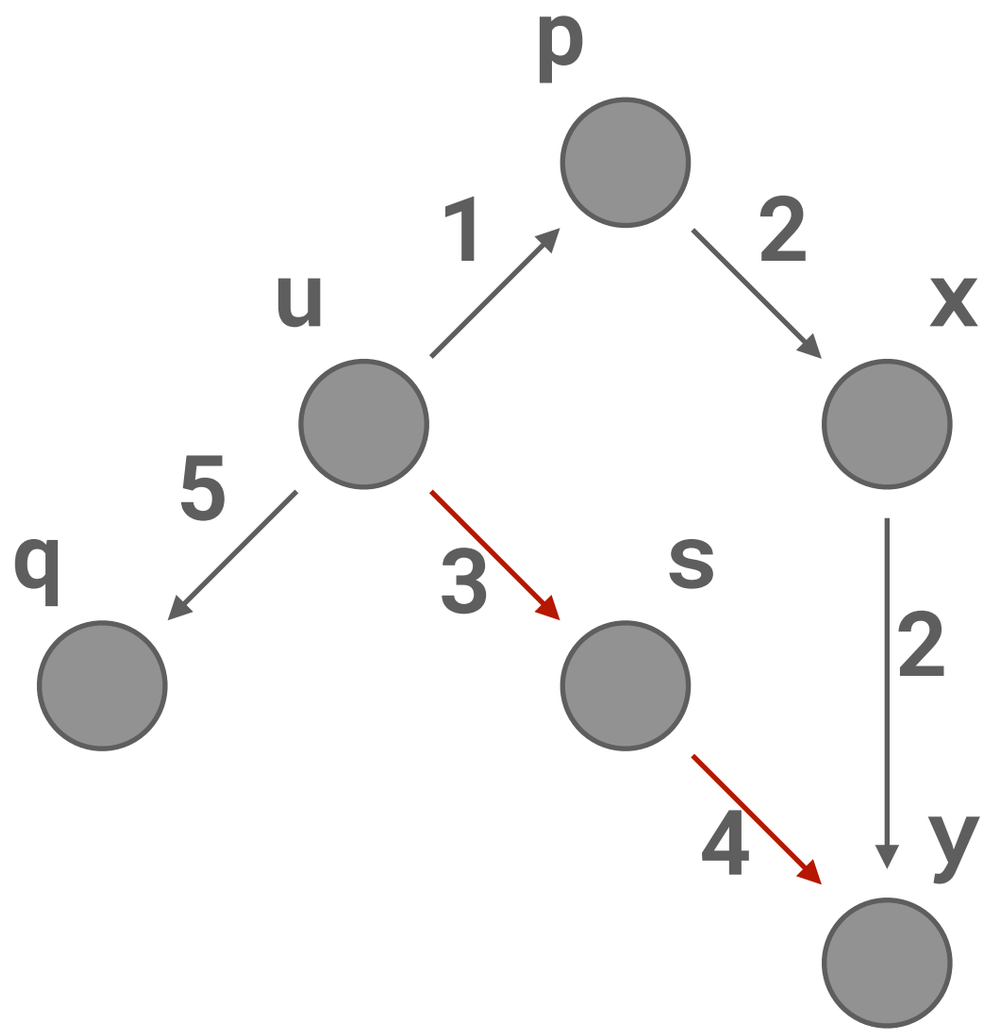
```
const G = new Graph();
G.add('Amelia', { John: 1, Rose: 3, Lucas: 3, Matt: 2 })
G.add('John', { Rose: 1, Matt: 3, Charles: 2 })
G.add('Rose', { Amelia: 3, Lucas: 1, John: 2 })
G.add('Lucas', { Matt: 3, John: 2, Rose: 2 })
G.add('Matt', { Amelia: 1, John: 3, Rose: 2, Lucas: 1 })
G.add('Charles', { John: 1 })

// Graph = {
//   vertices:
//   {
//     Amelia: { John: 1, Rose: 3, Lucas: 3, Matt: 2 },
//     John: { Rose: 1, Matt: 3, Charles: 2 },
//     Rose: { Amelia: 3, Lucas: 1, John: 2 },
//     Lucas: { Matt: 3, John: 2, Rose: 2 },
//     Matt: { Amelia: 1, John: 3, Rose: 2, Lucas: 1 },
//     Charles: { John: 1 }
//   }
// }
```


Matt
Charles
John
Lucas
Amelia
Rose
3
1
3
2
2
1
1
2
1
1
3
3
2
3
1
3
2
2

searching the graph for recommendations

shortest-path problem

shortest path from u to y



Numerische Mathematik 1, 269—271 (1959)

A Note on Two Problems in Connexion with Graphs

By

E. W. DIJKSTRA

We consider n points (nodes), some or all pairs of which are connected by a branch; the length of each branch is given. We restrict ourselves to the case where at least one path exists between any two nodes. We now consider two problems.

Problem 1. Construct the tree of minimum total length between the n nodes. (A tree is a graph with one and only one path between every two nodes.)

In the course of the construction that we present here, the branches are subdivided into three sets:

I. the branches definitely assigned to the tree under construction (they will form a subtree);

II. the branches from which the next branch to be added to set I, will be selected;

III. the remaining branches (rejected or not yet considered).

The nodes are subdivided into two sets:

A. the nodes connected by the branches of set I,

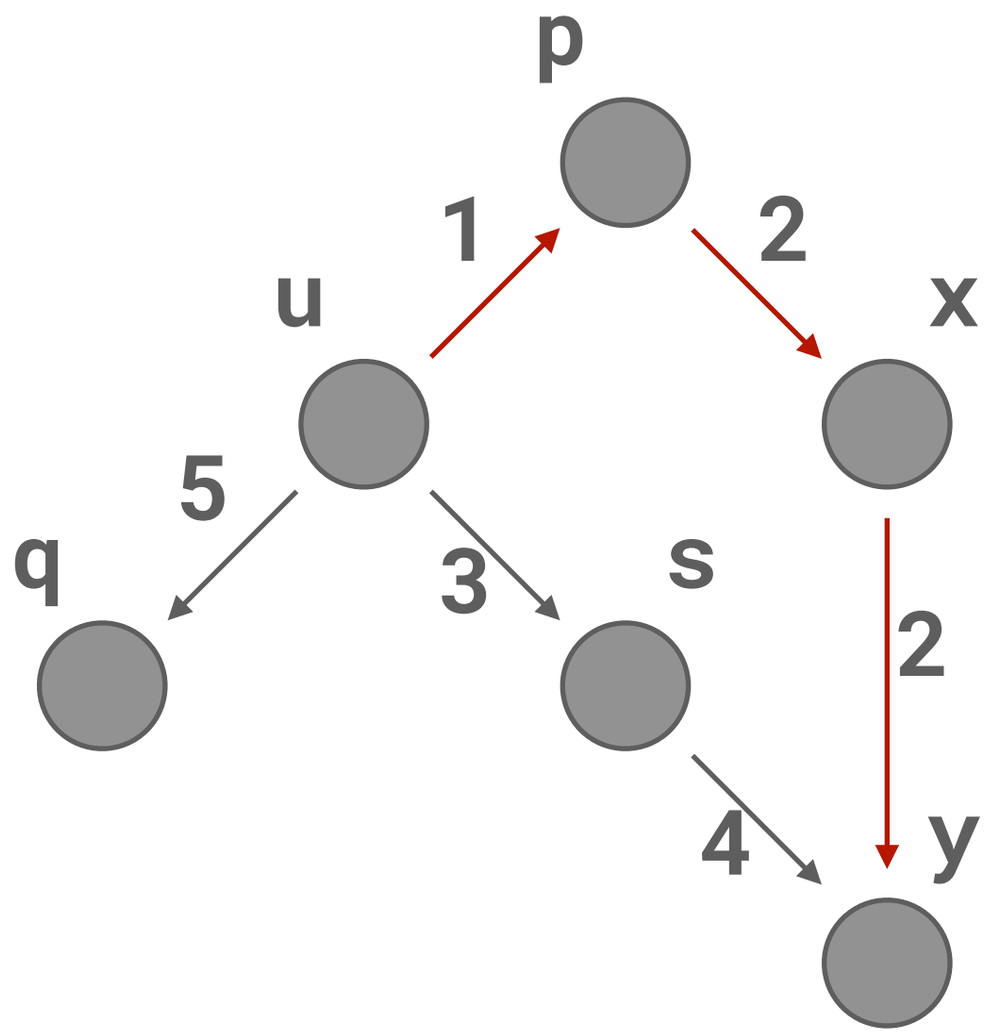
B. the remaining nodes (one and only one branch of set II will lead to each of these nodes).

We start the construction by choosing an arbitrary node as the only member of set A, and by placing all branches that end in this node in set II. To start with, set I is empty. From then onwards we perform the following two steps repeatedly.

Step 1. The shortest branch of set II is removed from this set and added to set I. As a result one node is transferred from set B to set A.

Step 2. Consider the branches leading from the node, that has just been trans-

shortest path from u to z

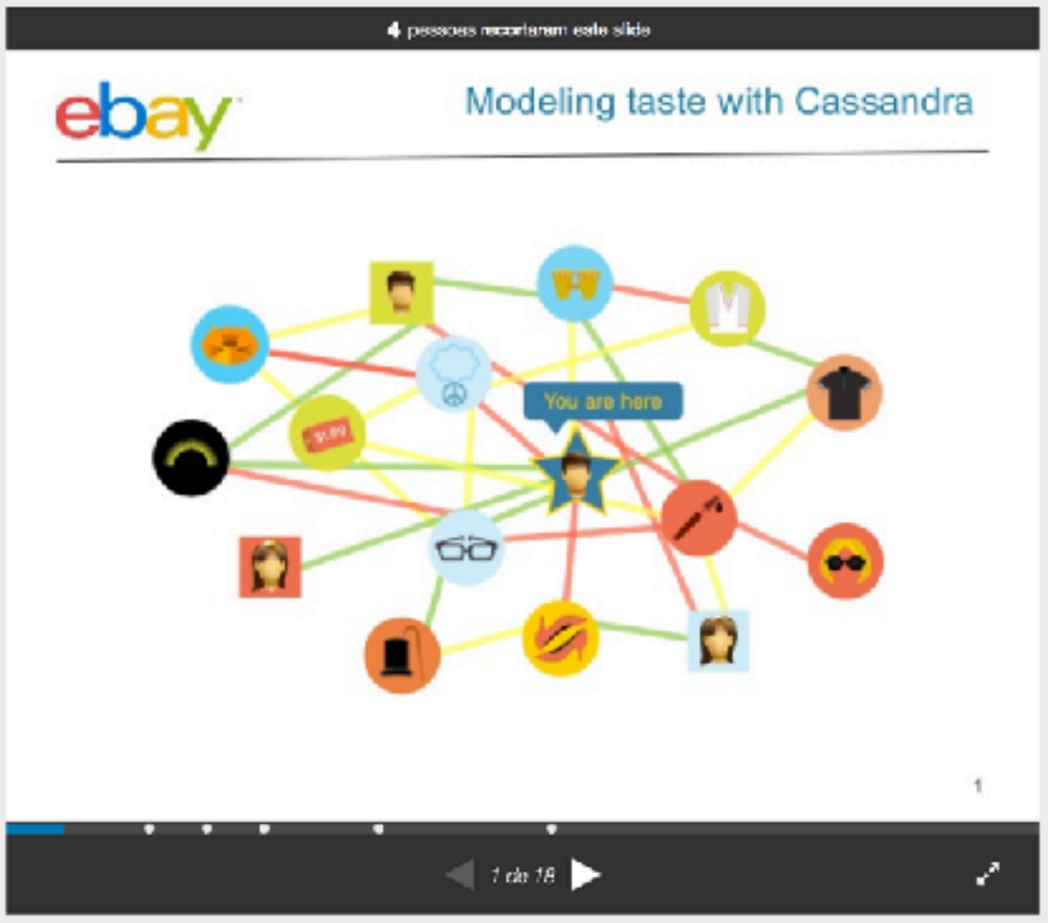


```
Graph.prototype.Dijkstra = function (source) {
  let Q = {}, dist = {}, prev = {};

  for (let vertex in this.vertices) {
    dist[vertex] = Infinity;
    prev[vertex] = undefined;
    Q[vertex] = this.vertices[vertex];
  }

  dist[source] = 0;

  while (!_isEmpty(Q)) {···
  }
  return dist;
};
```

```
Graph.prototype.Dijkstra = function (source) {
  let Q = {}, dist = {}, prev = {};

  for (let vertex in this.vertices) { ···
  }

  dist[source] = 0;

  while (!_isEmpty(Q)) {
    let u = _distanceFromVertex(Q, dist);
    delete Q[u];

    for (let neighbor in this.vertices[u]) {
      let alt = dist[u] + G.length(u, neighbor);

      if (alt < dist[neighbor]) {
        dist[neighbor] = alt;
        prev[neighbor] = u;
      }
    }
  }
  return dist;
};
```

is this approach scalable?

4 pessoas recortaram este slide



Graph Based Recommendation Systems at eBay

25.447 visualizações

DataStax Academy
+ Seguir

Recomendadas


Neo4j - graph database for recommendations
prakalk

Case Study: Real-time Recommendations with a Graph Database
DATAVERSITY


Bootstrapping Recommendations with Neo4j
Max De Marzi


Recommendations with Neo4j
Michal Bachman


Building a recommendation engine with python and neo4j
Mark Needham


Recommender Systems (Machine Learning Summer School 2014 @ CMU)
Xavier Amatriain


Recommender system algorithm and architecture
Liang Xiang

Pinterest Engineering Follow
Inventive engineers building the first visual discovery engine, 100 billion ideas and counting.
https://careers.pinterest.com/careers/engineering
Mar 31 · 3 min read

Introducing Pixie, an advanced graph-based recommendation system

By: Pong Eksombatchai & Mark Ulrich | Pinterest engineers, Discovery

At Pinterest, a primary engineering challenge is helping people discover and do things every day, which means serving the right idea to the right person at the right time. While most other recommender systems have a small pool of possible candidates, for instance 100,000 movies, Pinterest has to recommend from more than 100 billion ideas saved by 150 million people around the world in real-time. We set a performance goal of 60 milliseconds p99 latency, and to achieve it, we built Pixie, a flexible, graph-based system for making personalized recommendations in real-time. Pixie now powers recommendations across Pinterest in Related Pins, home feed and Explore, and accounts for about half of all Pins saved.

Top highlight

Pixie

We started from a bipartite graph where each edge shows that a person saved a Pin to a board.

what we learned/ what to look forward?

questions?

thank you!

https://olarclara.github.io 👩🏾‍💻