



# Music & the Internet

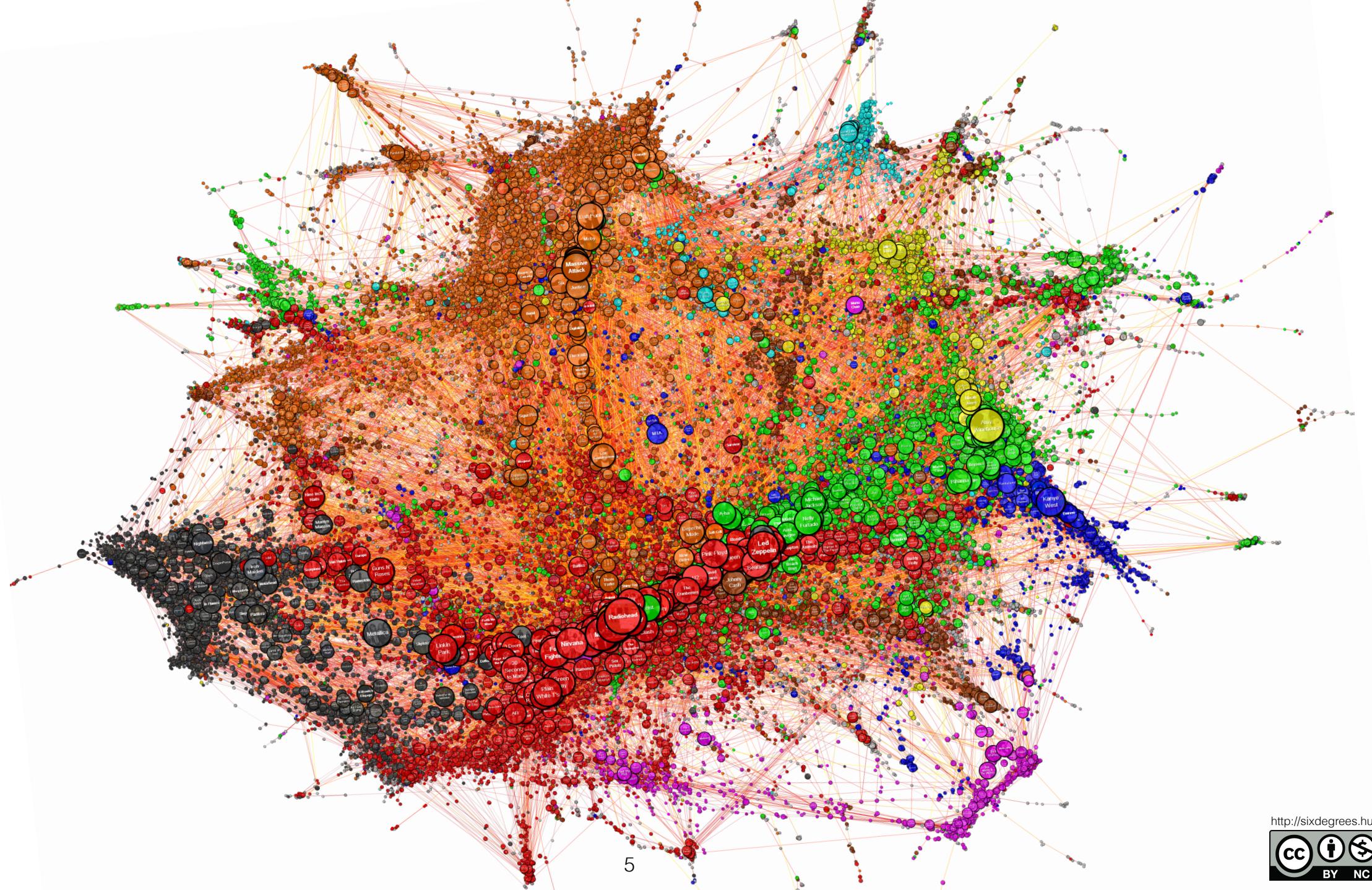
## MUMT301

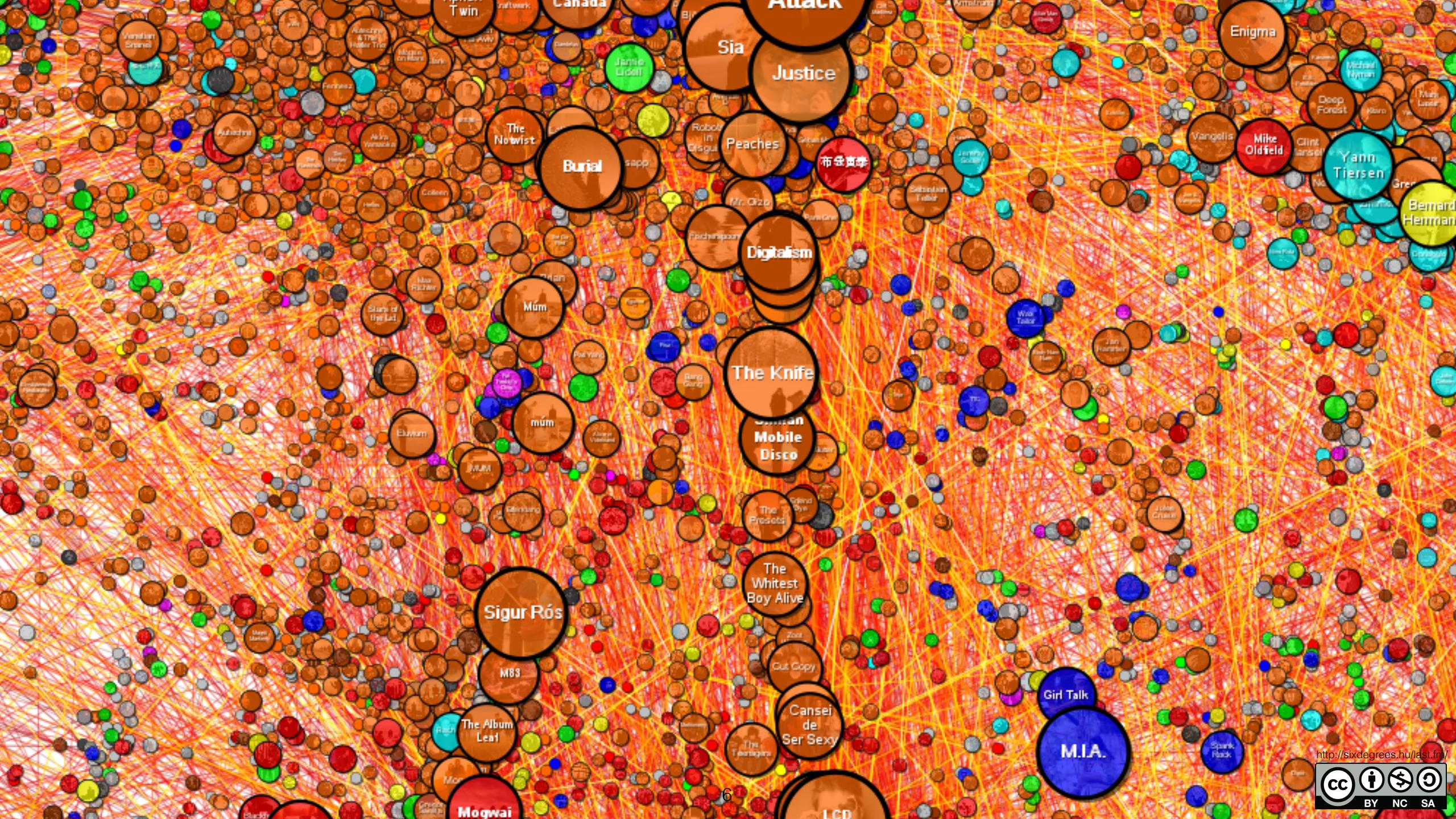
Gabriel Vigliensoni  
Schulich School of Music  
McGill University

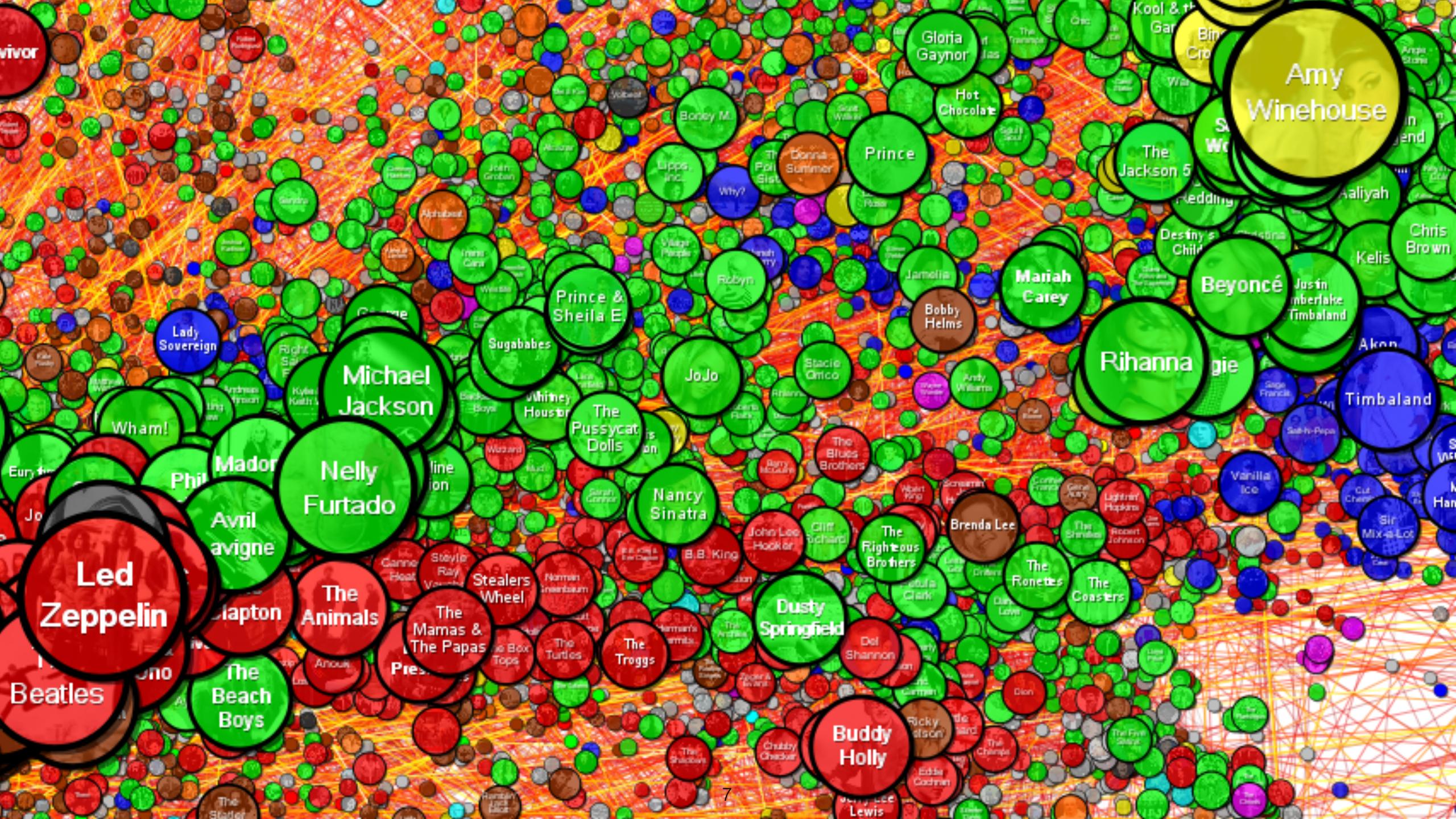
# Plan

- Automatic music recommendation
- Internet radio broadcasting and streaming media software
- The Infinite Dial 2017
- Intellectual property, copyright, and copyright alternatives
- Ishani's presentation
- Mid-term preparation
- Potential final projects

Automatic **music recommendation** systems







# Motivation

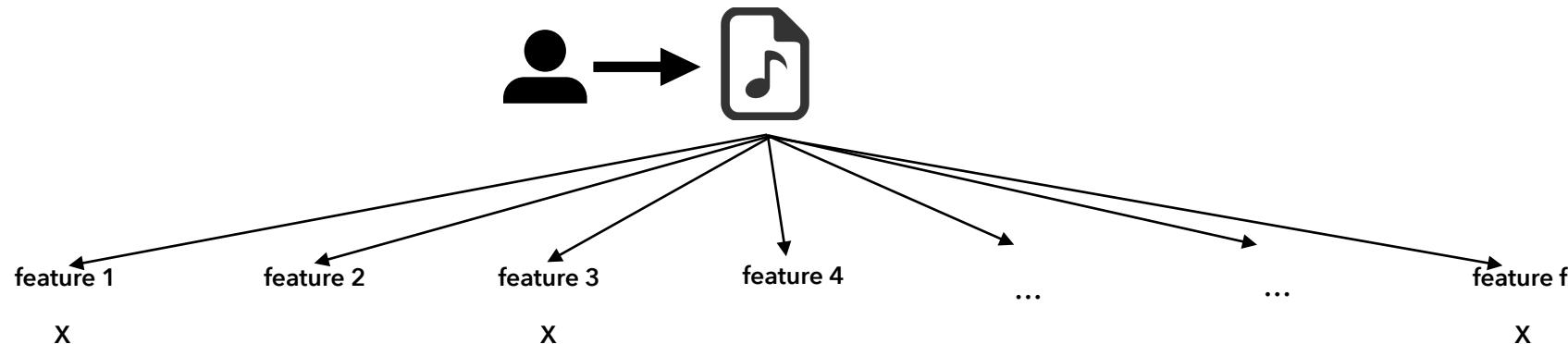
- To improve **recommendation accuracy** of automatic music recommendation systems
- By understanding **what**, **when**, and **where** people listen to music
- By characterizing people's **listening behaviour**
- Performing a **data-centric** instead of ethnocentric **music listening research**

# Music recommendation approaches

- Content-based
- Collaborative filtering

# Music recommendation approaches

Content-based

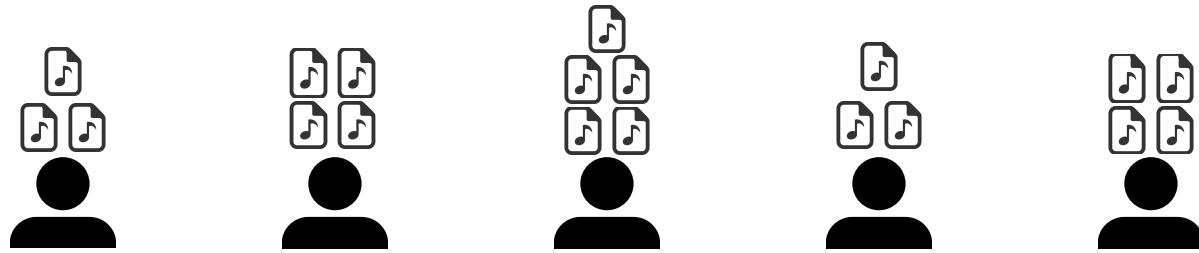


	feature 1	feature 2	feature 3	feature 4	...	...	feature f
music item 1		X					X
music item 2	X	X			X		
music item 3		X			X		X
music item 4			X			X	
...				X			
...		X			X		
music item i	X		X				X



# Music recommendation approaches

## Collaborative filtering



user/artist	beatles	rolling	bsabbath	metallica	miles	coltrane	autechre	dpunk	reich	bartok
a	5	4			3	2	4		4	5
b	5	4		2				2	3	
c	4		3		3		5	4		
d	5			1	5	4				1
e	5				4		1		1	1

# Music recommendation approaches

Collaborative filtering  
User similarity

user/artist	beatles	rolling	bsabbath	metallica	miles	coltrane	autechre	dpunk	reich	bartok
a	5	4	3	3	3	2	4	3	4	5
b	5	4	2	2	5	3	3	2	3	2
c	4	4	3	1	3	3	5	4	5	3
d	5	4	2	1	5	4	3	2	2	1
e	5	3	2	1	4	3	1	1	1	1

Jaccard similarity  
Intersection of sets

	a	b	c	d
b	0.33			
c	0.33	0.25		
d	0.50	0.25	0.25	
e	0.71	0.25	0.43	0.43

Cosine vector similarity  
Angle of vectors in space

	a	b	c	d
b	0.99			
c	0.98	0.92		
d	0.82	0.98	0.99	
e	0.79	0.98	0.81	0.99

Pearson correlation  
Distance of points in space

	a	b	c	d
b	0.93			
c	0.52	0.20		
d	-0.39	0.96	-0.51	
e	-0.06	1.00	-0.30	0.94

# Music recommendation approaches

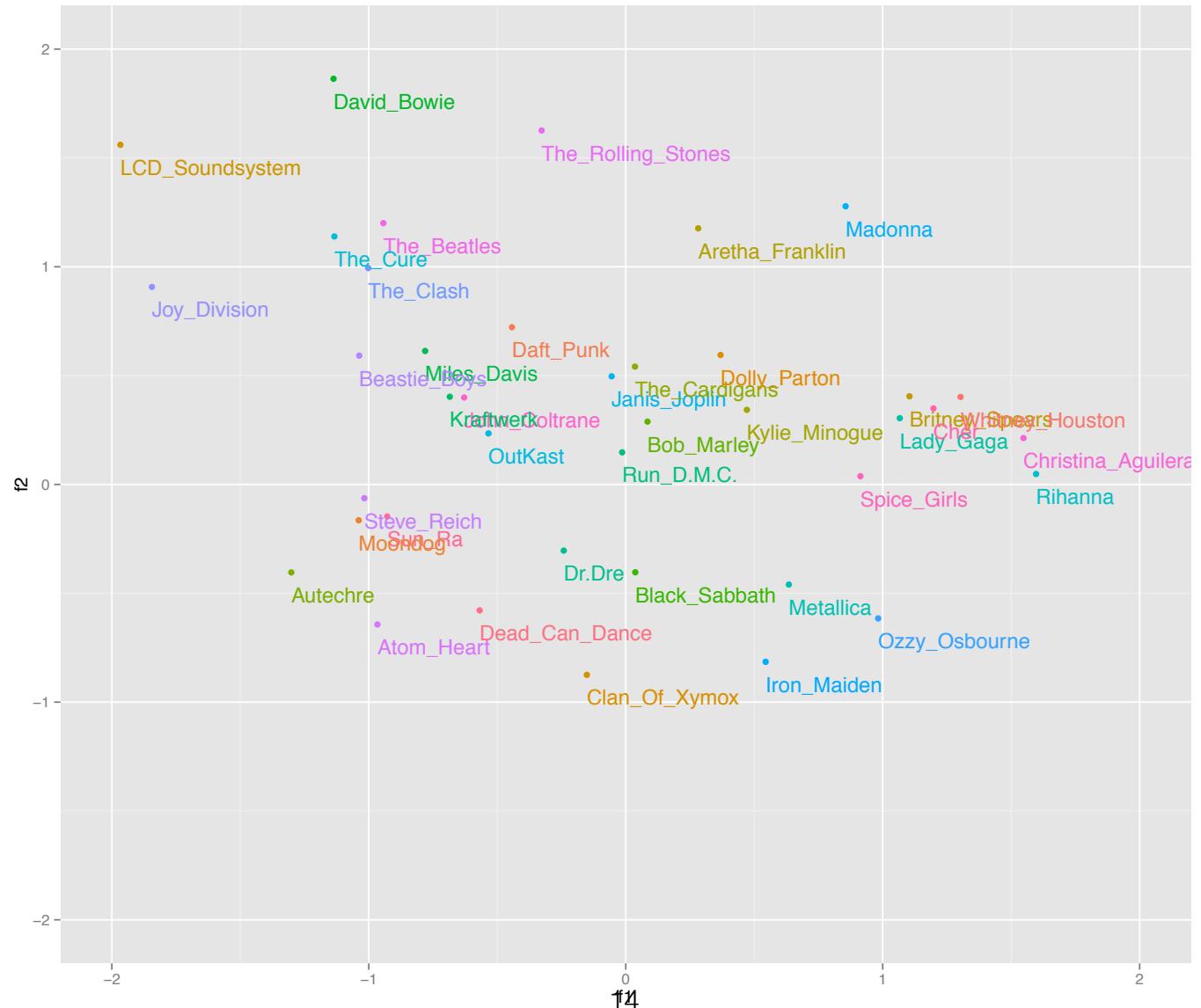
Collaborative filtering

Model-based

		factor 1	-0.188	-0.015	-0.006	0.069	-0.472	-0.353	0.238	0.078	0.168	0.481
		factor 2	-0.074	-0.001	-0.002	-0.014	-0.042	0.036	0.171	0.035	0.083	-0.186
factor 1	factor 2	user/artist	beatles	rolling	bsabbath	metallica	miles	coltrane	autechre	dpunk	reich	bartok
0.440	0.001	a	5	4	3	2	3	2	4	3	4	5
-0.009	-0.010	b	5	4	3	2	4	3	3	2	3	4
0.315	0.118	c	4	4	3	2	3	3	5	4	3	4
-0.634	0.115	d	5	4	3	1	5	4	3	3	2	1
-0.092	-0.229	e	5	3	2	1	4	3	1	2	1	1

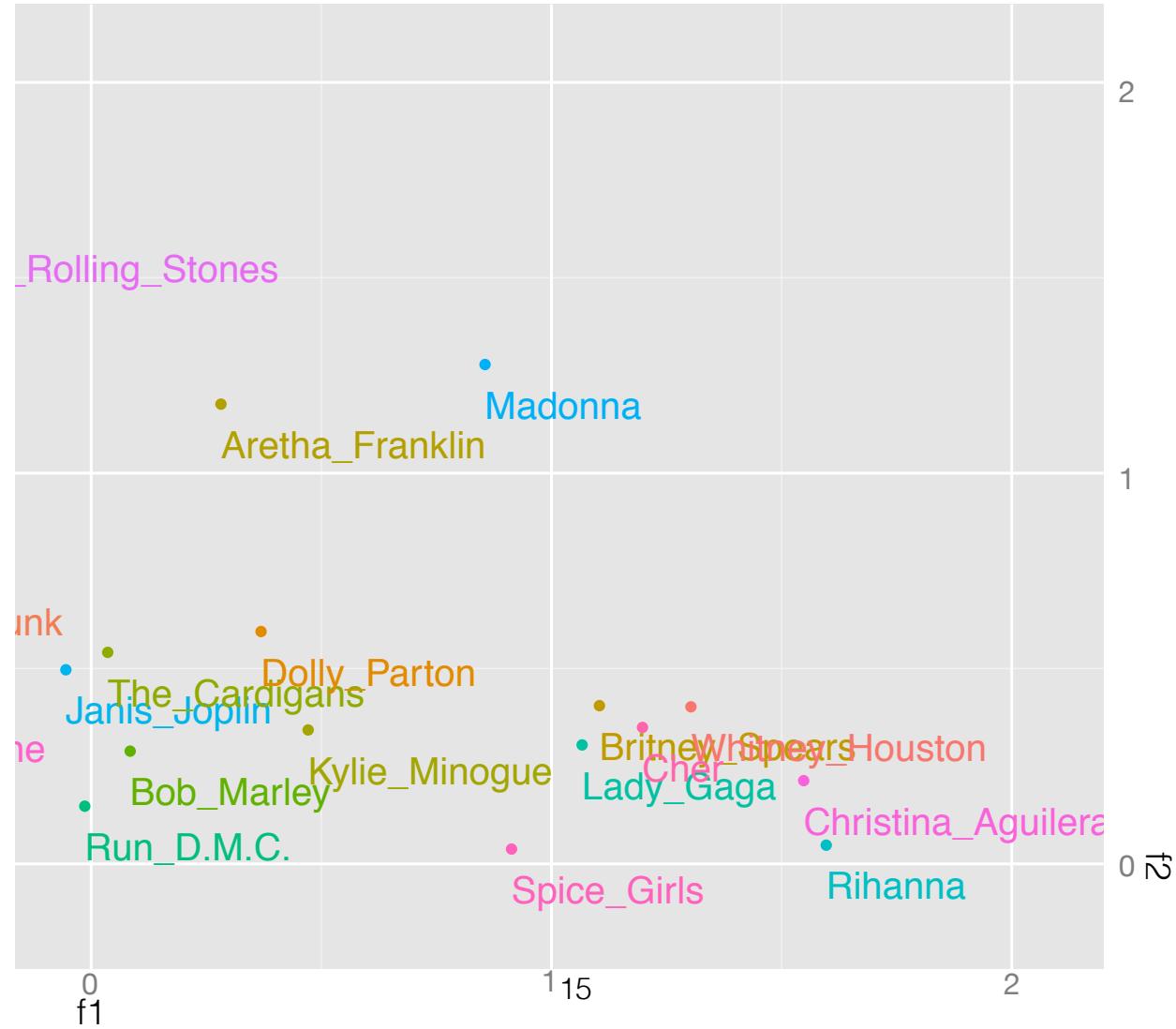
# Music recommendation approaches

## Latent factors models



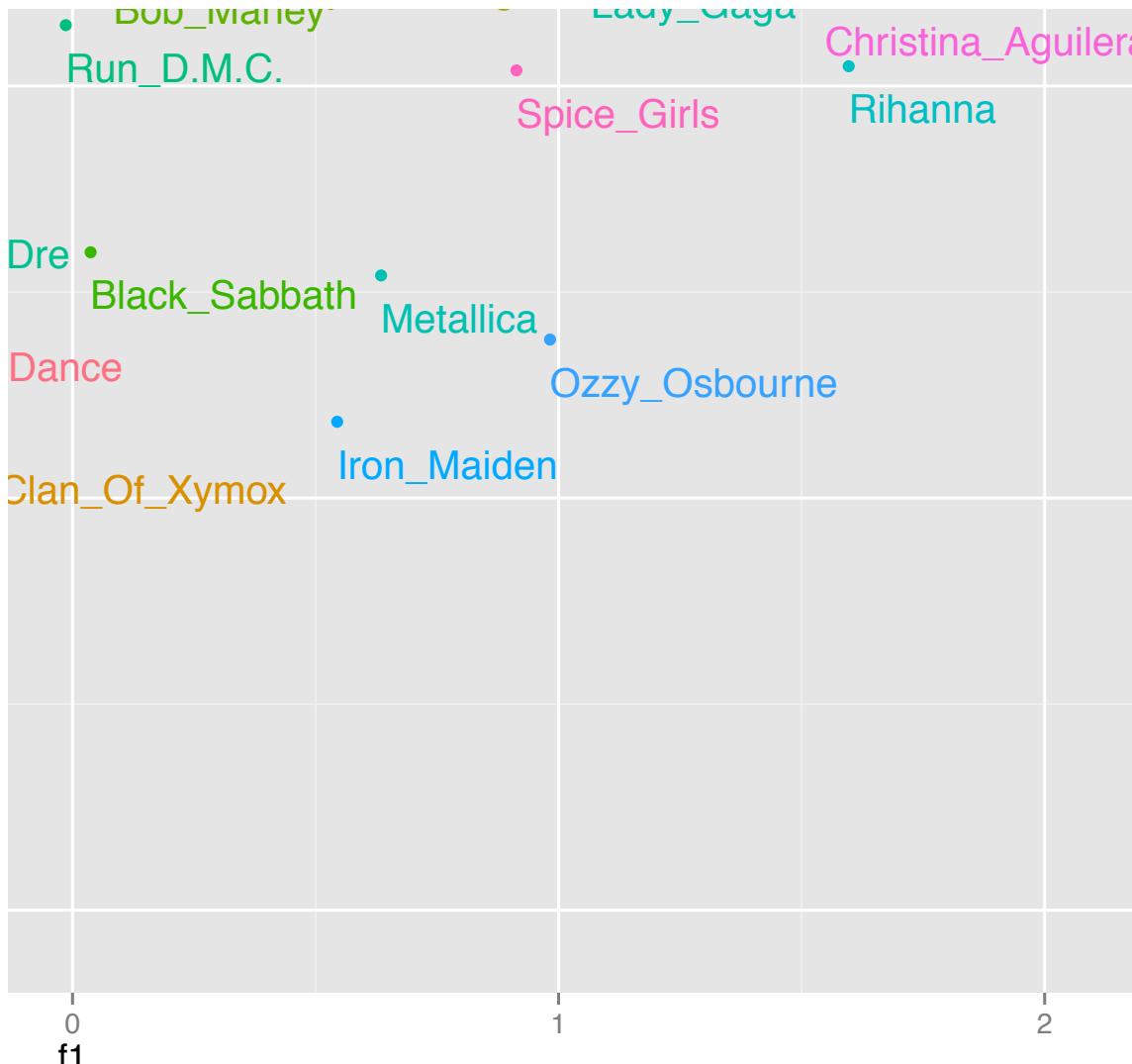
# Music recommendation approaches

## Latent factors models



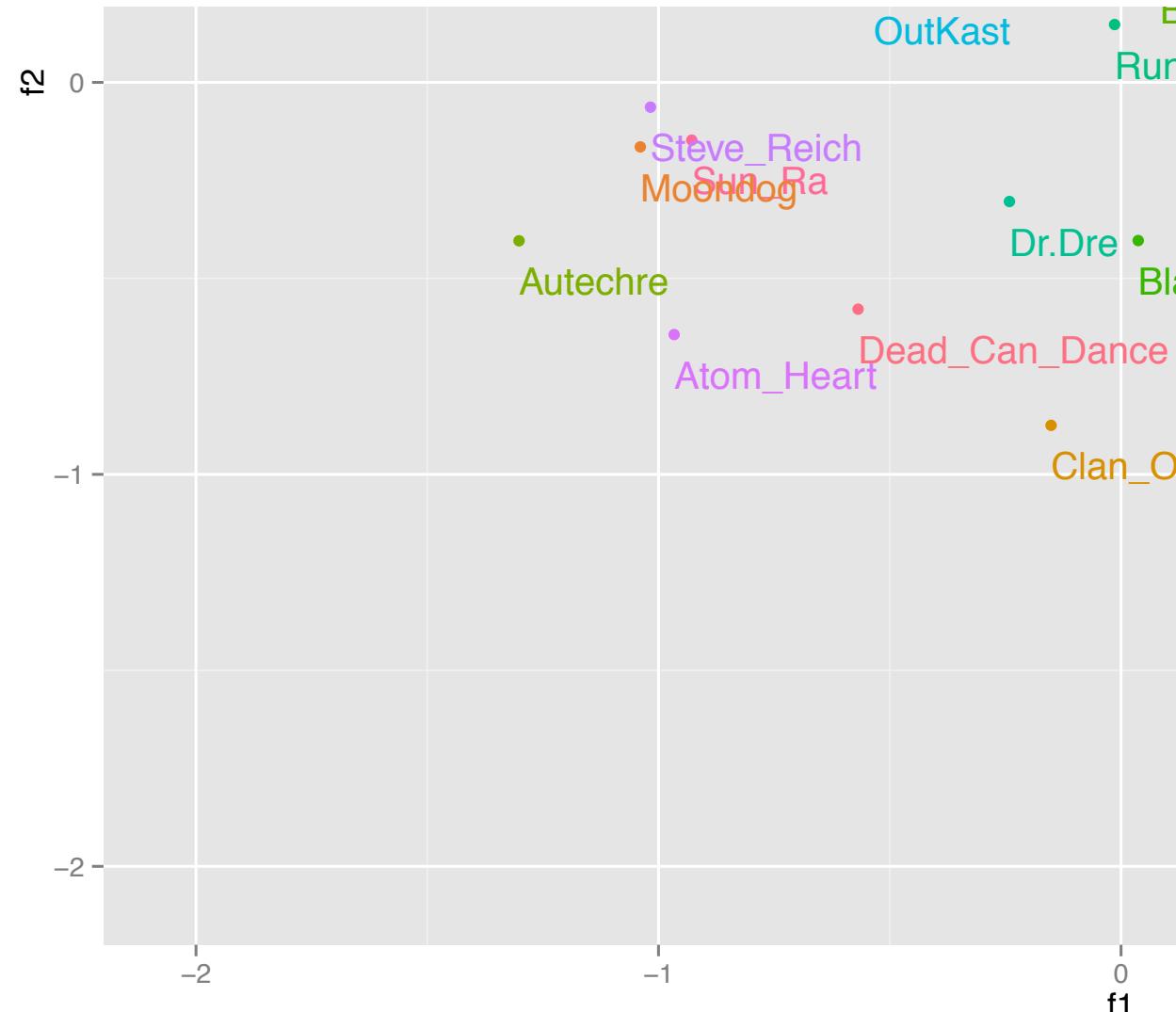
# Music recommendation approaches

## Latent factors models



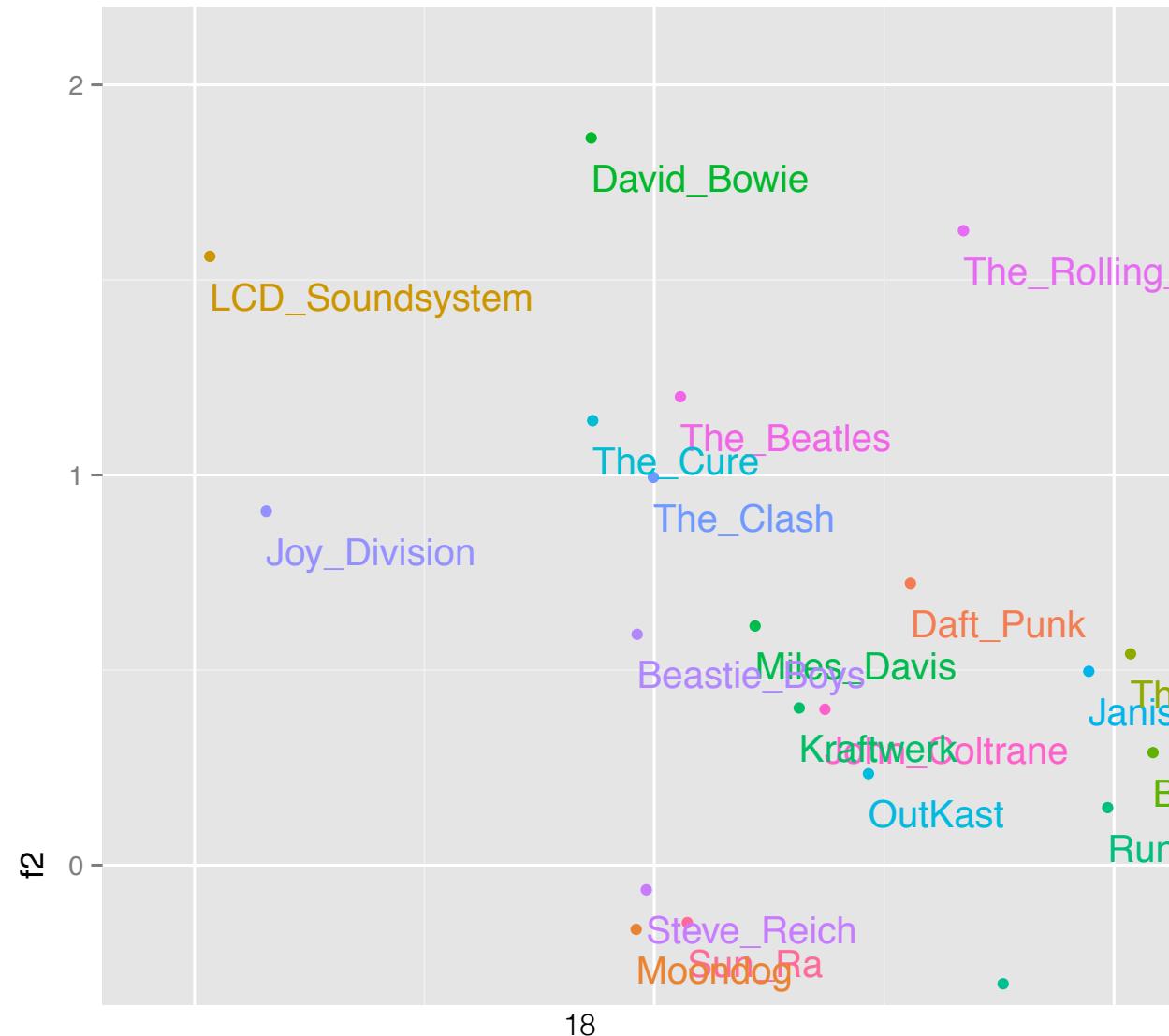
# Music recommendation approaches

## Latent factors models



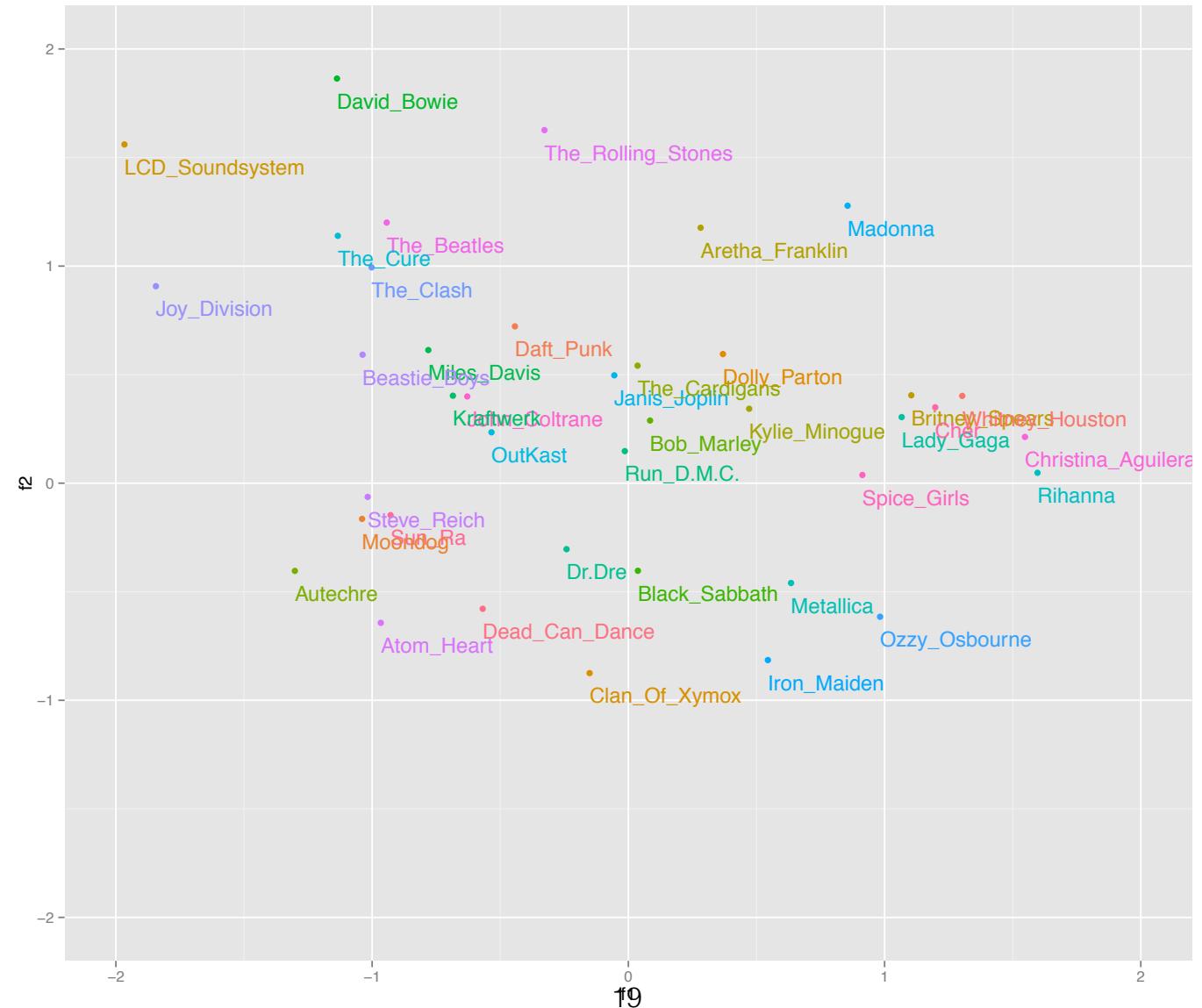
# Music recommendation approaches

## Latent factors models



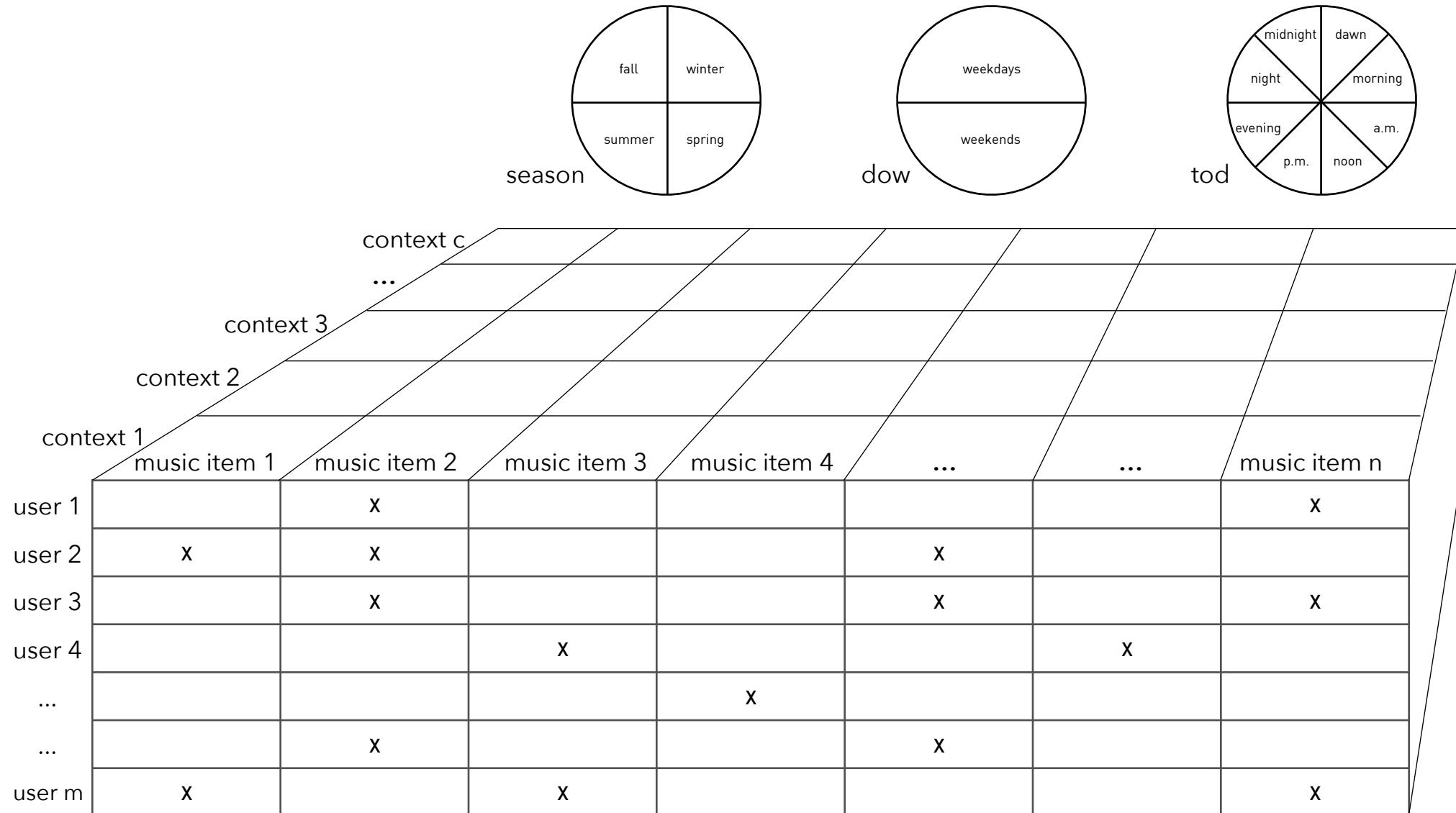
# Music recommendation approaches

## Latent factors models



# Music recommendation approaches

## Incorporating context into the model



# Music recommendation approaches

## Incorporating side features into the model

				<b>factor1</b>	-0.1250	-0.0758	0.2597	-0.4078	0.3469	0.4341	0.8519	0.5257	0.7062	-1.6830
				<b>factor2</b>	0.3663	0.2352	-0.1869	-0.3558	0.9251	0.8393	-0.8159	-1.2368	-0.8491	-0.0734
<b>gender</b>	<b>age</b>	<b>factor1</b>	<b>factor2</b>	<b>user/artist</b>	<b>beatles</b>	<b>rolling</b>	<b>bsabbath</b>	<b>metallica</b>	<b>miles</b>	<b>coltrane</b>	<b>autechre</b>	<b>dpunk</b>	<b>reich</b>	<b>bartok</b>
m	o	-0.7364	-0.5380	a	5	4	3	3	3	2	4	4	4	5
f	o	0.4071	0.3544	b	5	4	3	2	4	3	3	2	3	4
m	y	0.6459	-1.1424	c	4	3	3	1	3	2	5	4	5	1
m	y	0.8063	0.6618	d	5	4	3	1	5	4	4	2	4	1
f	y	-1.0800	0.7037	e	5	4	2	2	4	3	1	0	1	5
m	o	-0.0002	0.0000	f	5	4	2	2	4	3	4	3	4	4

<b>side feature</b>	<b>value</b>	<b>factor 1</b>	<b>factor 2</b>
age	o	-0.3872	-0.1737
age	y	0.1648	0.4031
gender	m	0.3986	-0.1552
gender	f	-0.3539	0.1451

# Research Project

- 1M listeners' listening histories
- Listening history > 2 years
- Average logs per day > 10
- LastFM API

UserID	age	country	gender
playcount	usertype	lifetime	registration time
timestamp	ArtistID	AlbumID	SongID

# Listening histories

1215399979 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab d9b7388e-a155-436c-bdc1-ab0a12567980 230f484e-1d62-4405-8758-f2123864c358  
1215399474 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab d9b7388e-a155-436c-bdc1-ab0a12567980 0771ae03-acb4-43ce-85c9-3602aab736  
1215399033 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab d9b7388e-a155-436c-bdc1-ab0a12567980 0ae30644-0363-4d9d-bf52-2e49939c0fb1  
1215398687 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab d9b7388e-a155-436c-bdc1-ab0a12567980 0c9a06d3-2614-4998-be91-c060aea7bd11  
1215282573 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab e233c4ef-783f-3d1d-b024-daf9076325b 00343efa-29e9-4fc2-91c9-d74e22c0fee4  
1215282230 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab bcce51ff-7fae-4b4d-98f1-771f1c767f14 0366c477-0e8a-4612-8b69-cd73b120b1ec  
1215281947 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab aef5108a-3dc0-3ba7-bfd7-dc95a3b186fe 01a9a99f-1567-4a06-991f-82605adb85b6  
1215281672 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab aef5108a-3dc0-3ba7-bfd7-dc95a3b186fe 01b85e0a-4cd1-49fa-88c4-43ee48d97464  
1215281225 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab fed37cfcc-2a6d-4569-9ac0-501a7c7598eb 00c081da-b833-45db-8899-358ea0cc8509  
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1215280431 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab fed37cfcc-2a6d-4569-9ac0-501a7c7598eb c43d82d1-d998-45e7-9929-ab75e2188802  
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1215279707 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab 009b6f18-2159-4bb9-b74c-a1b140598bb9  
1215224258 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab fed37cfcc-2a6d-4569-9ac0-501a7c7598eb 00c081da-b833-45db-8899-358ea0cc8509  
1215223742 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab fed37cfcc-2a6d-4569-9ac0-501a7c7598eb c43d82d1-d998-45e7-9929-ab75e2188802  
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1215220625 a9044915-8be3-4c7e-b11f-9e2d2ea0a91e baf8b67c-7ca3-484f-ac5a-14c116b7e280 3d9a8a4b-3965-4ec3-873f-9bc117818ead  
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1215139921 65f4f0c5-ef9e-490c-aee3-909e7ae6b2ab d9b7388e-a155-436c-bdc1-ab0a12567980 0771ae03-acb4-43ce-85c9-3602aab736

# Dataset

Dataset	Listeners	Logs	Artists	Albums	Tracks	
	594K	27MM	555K	900K	7M	
Listener's	Min	1st Quartile	Median	Mean	3rd Quartile	Max
Age (years)	0	21	24	25.4	27	113
Number of logs	7K	24K	37K	49K	60K	998K
Logs lifetime (days)	731	1192	1653	1721	2188	3929
Gender	Declared	Non-declared		Female	Male	
(%)	81.6	18.4		28.70	71.30	
User type (number and %)	Alumni 70 (~0%)	Moderator 21 (~0%)	Staff 33 (~0%)	Subscriber 14K (2.4%)	User 580K (97.6%)	

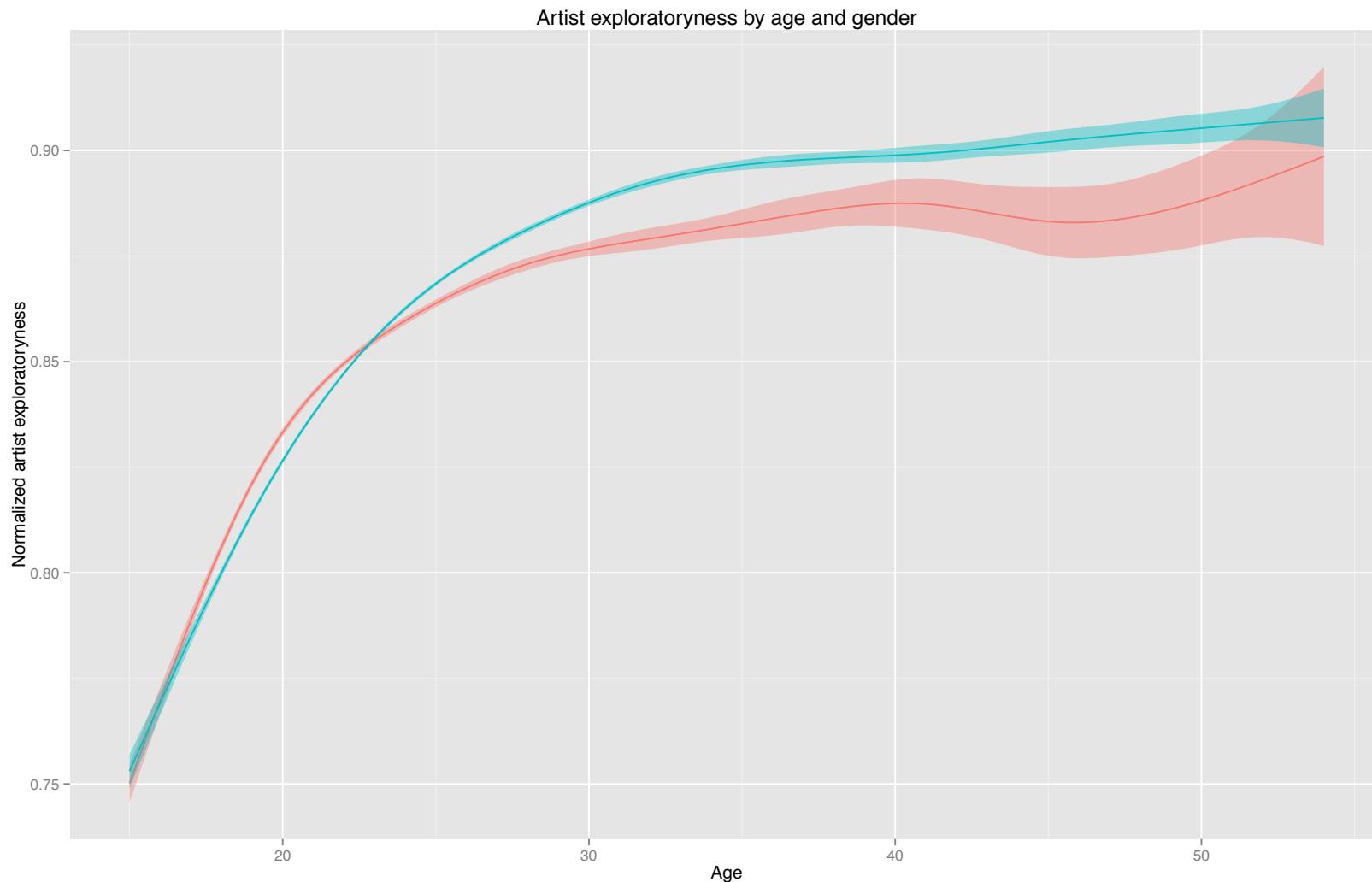
# Profiling features

Exploratoryness



# Profiling features

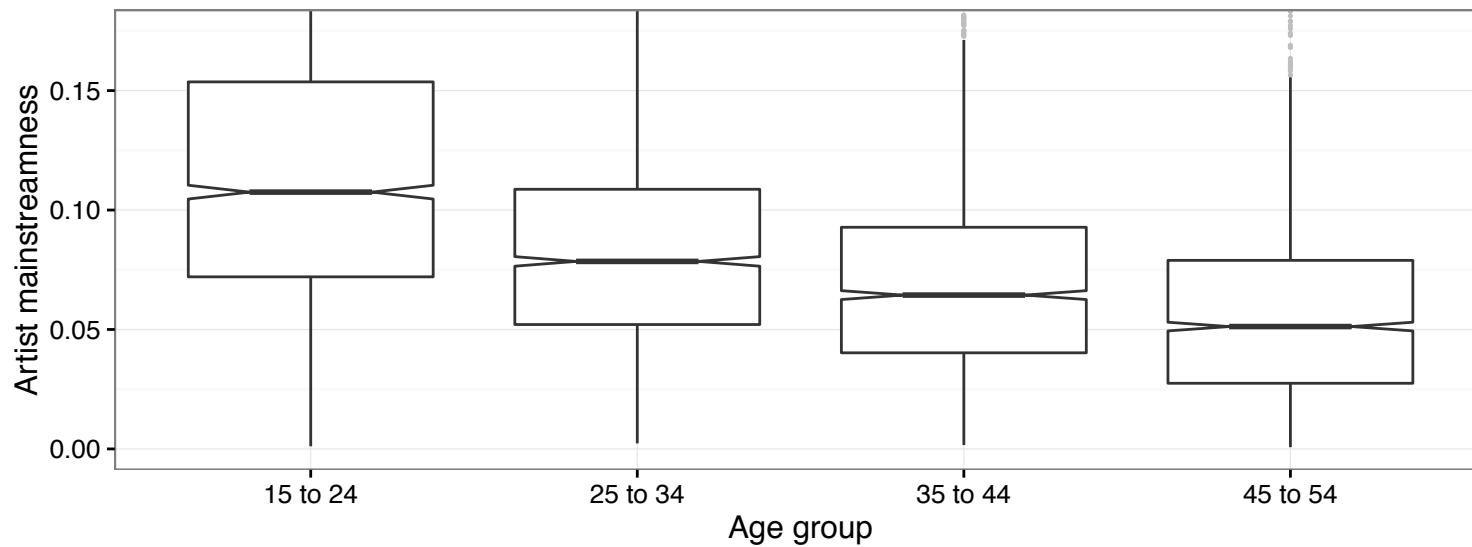
## Exploratoryness



# Profiling features

## Mainstreamness

R	Artist Name	No Logs (M)
1	The Beatles	149
2	Radiohead	140
3	Muse	100
Artist mainstreamness by age group		
4	Coldplay	2000 per factor level



16	Foo Fighters	54
17	Daft Punk	52
18	Britney Spears	50
19	Green Day	50
20	Iron Maiden	50

# Side data into recommendation model

Feature combinations

DEMOGRAPHIC  
a: age group  
g: gender  
c: country

PROFILING  
e: exploratoryness  
m: mainstreamness

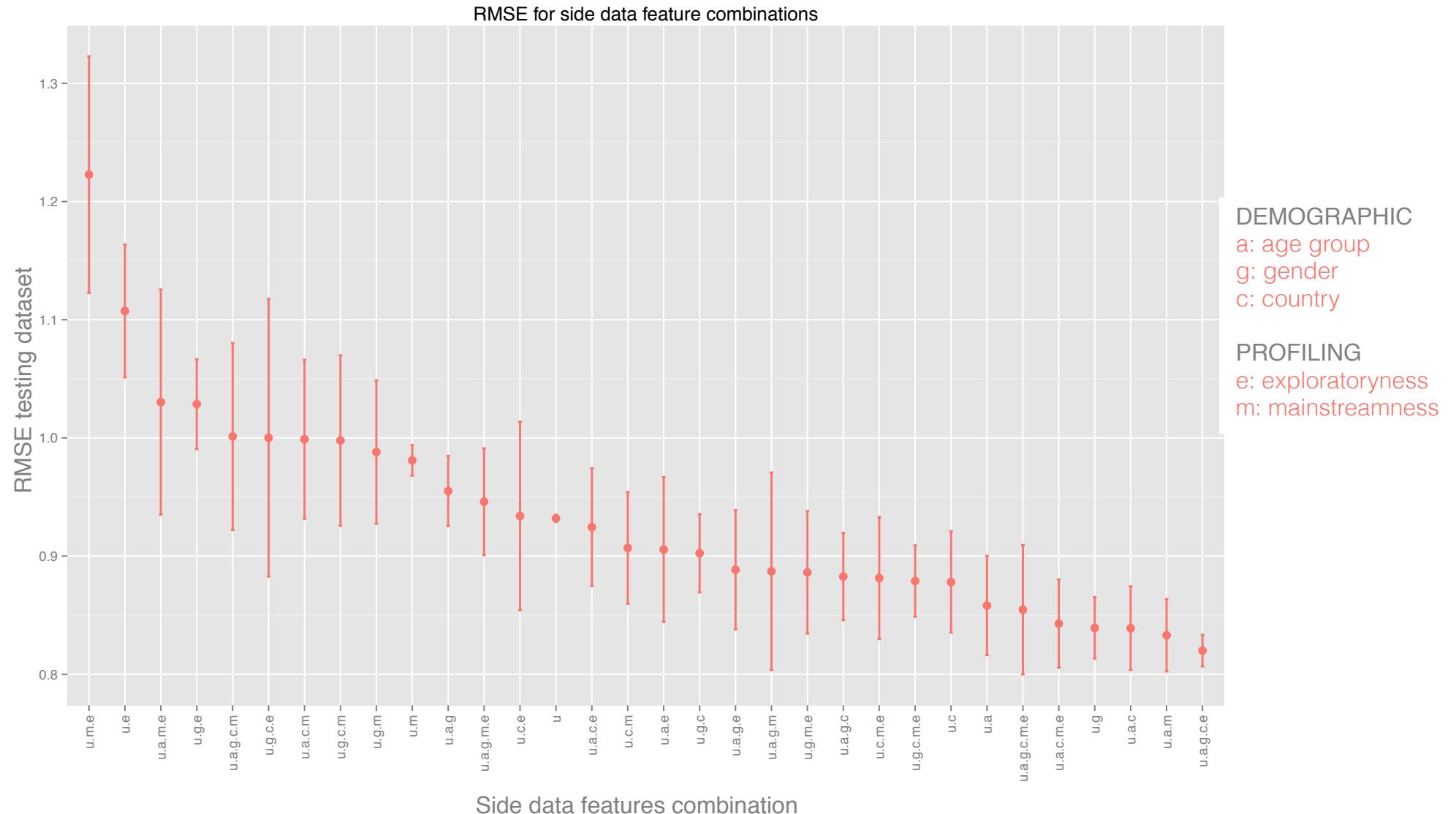


FEATURE  
COMBINATIONS

a  
a,g  
a,c  
a,e  
a,m  
a,g,c  
a,g,e  
a,g,m  
...  
g  
g,c  
g,e  
...  
a,g,c,e,m

# Side data into recommendation model

## Feature combinations



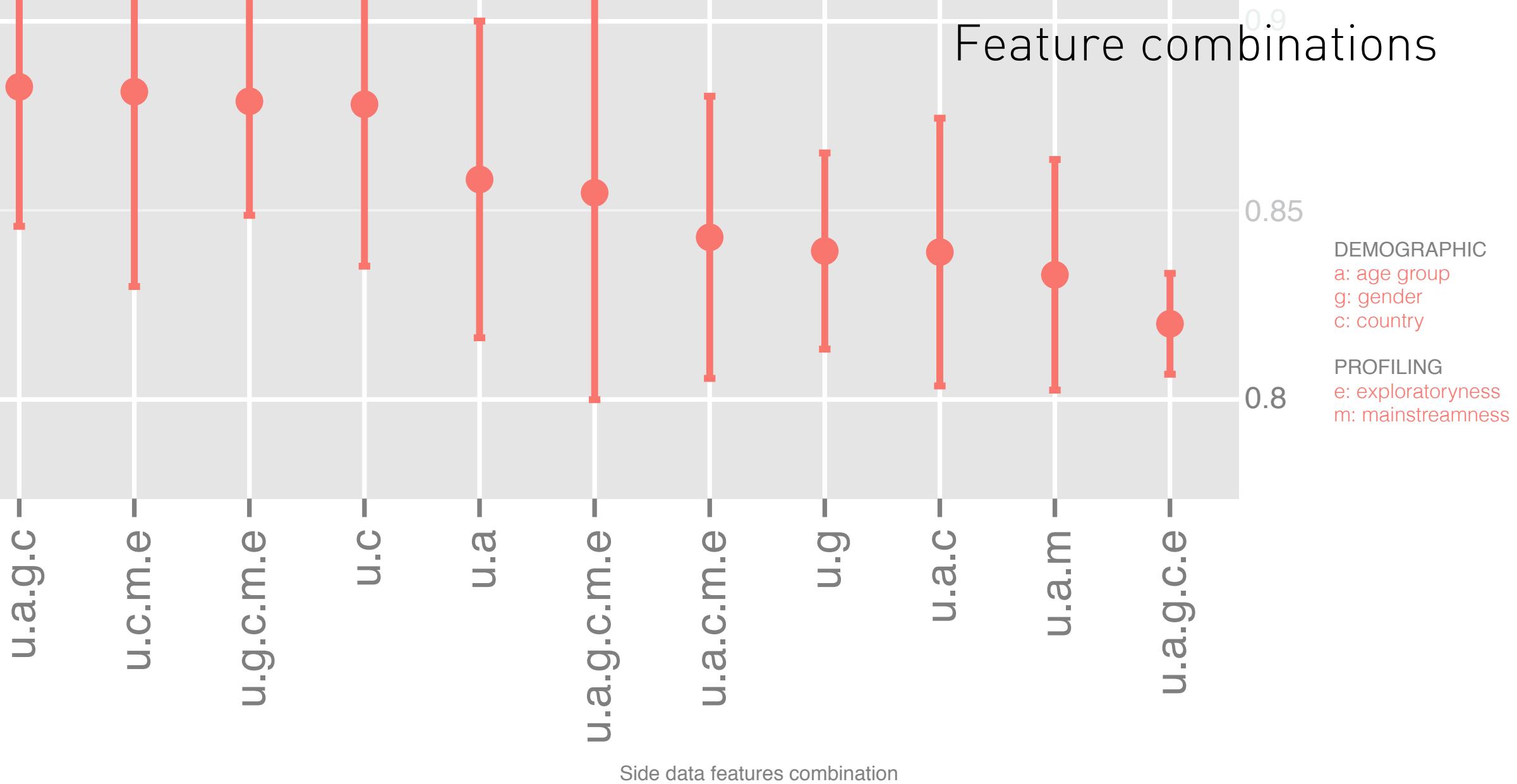
# Side data into recommendation model

Feature combinations



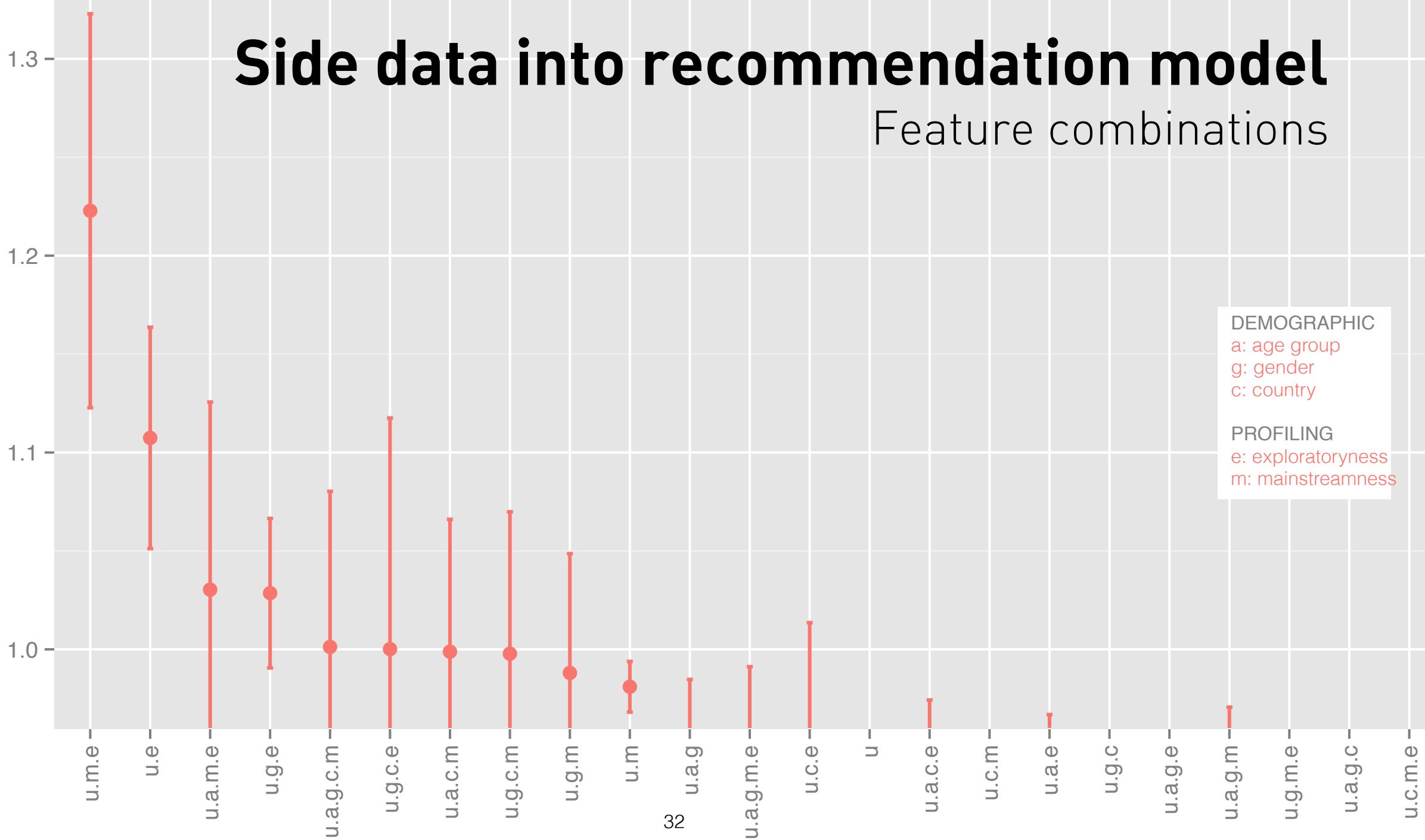
# Side data into recommendation model

Feature combinations



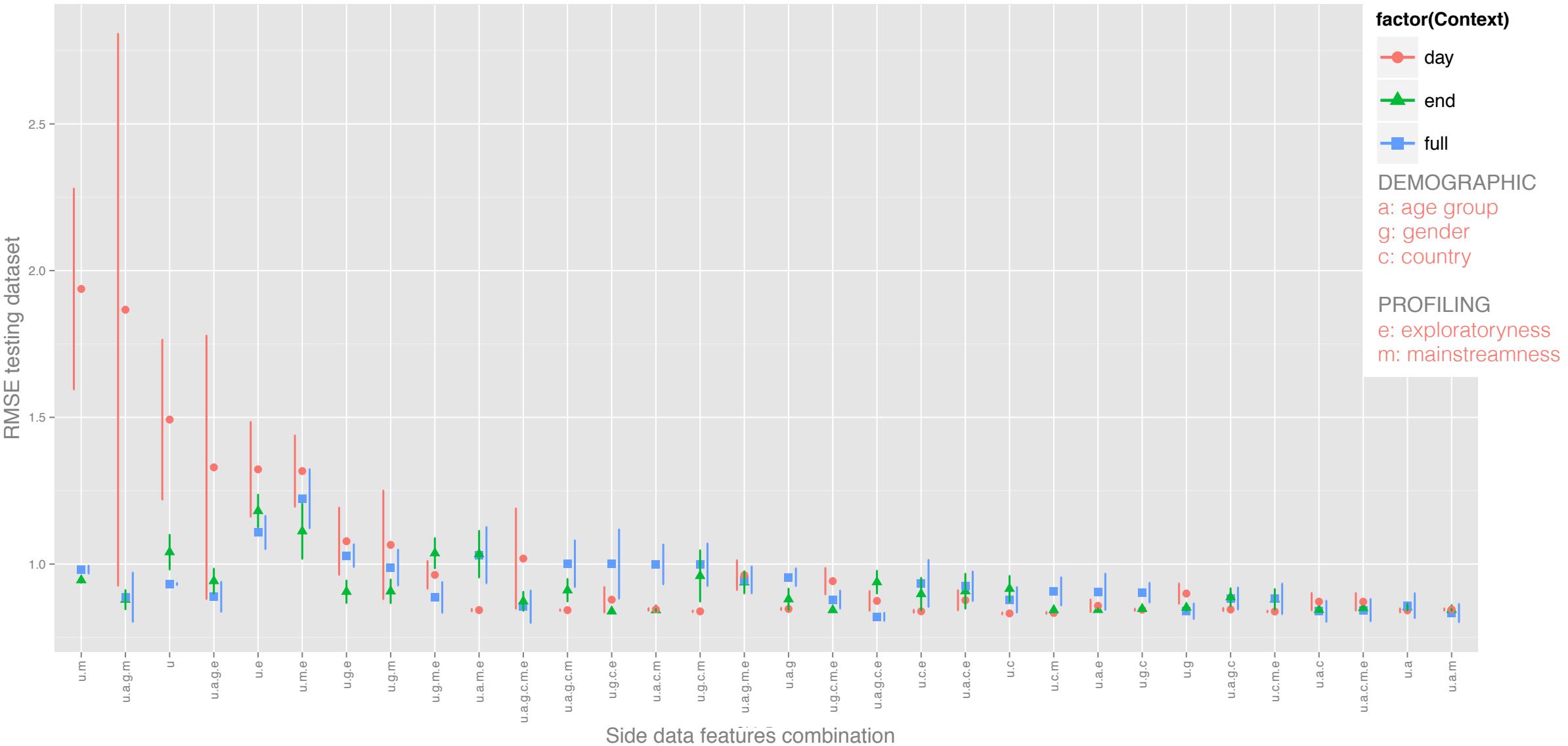
# Side data into recommendation model

Feature combinations



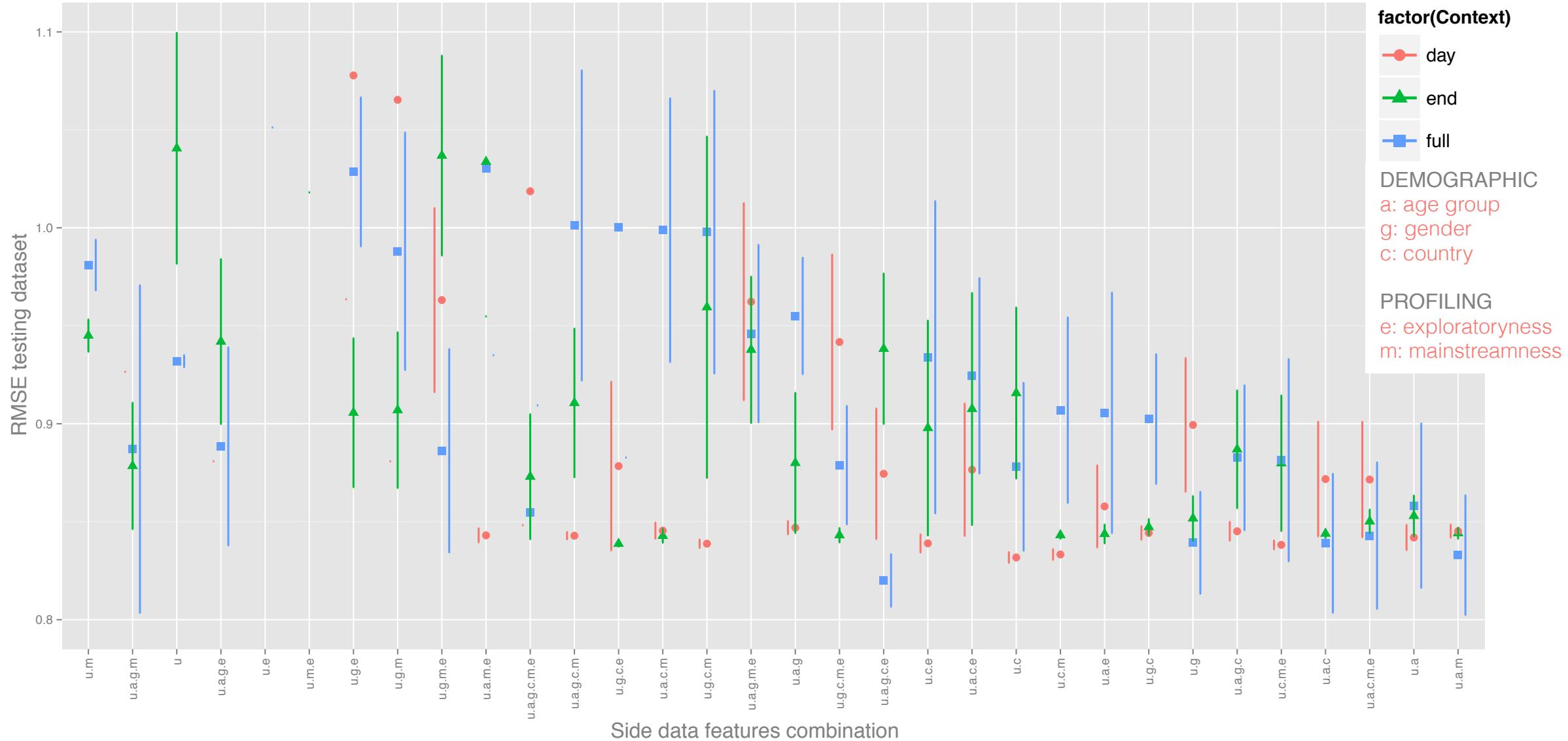
# Side data into recommendation model

Context data: weekdays vs. weekend



# Side data into recommendation model

Context data: weekdays vs. weekend

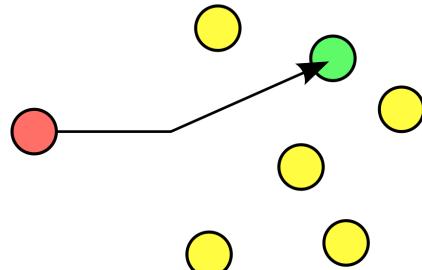
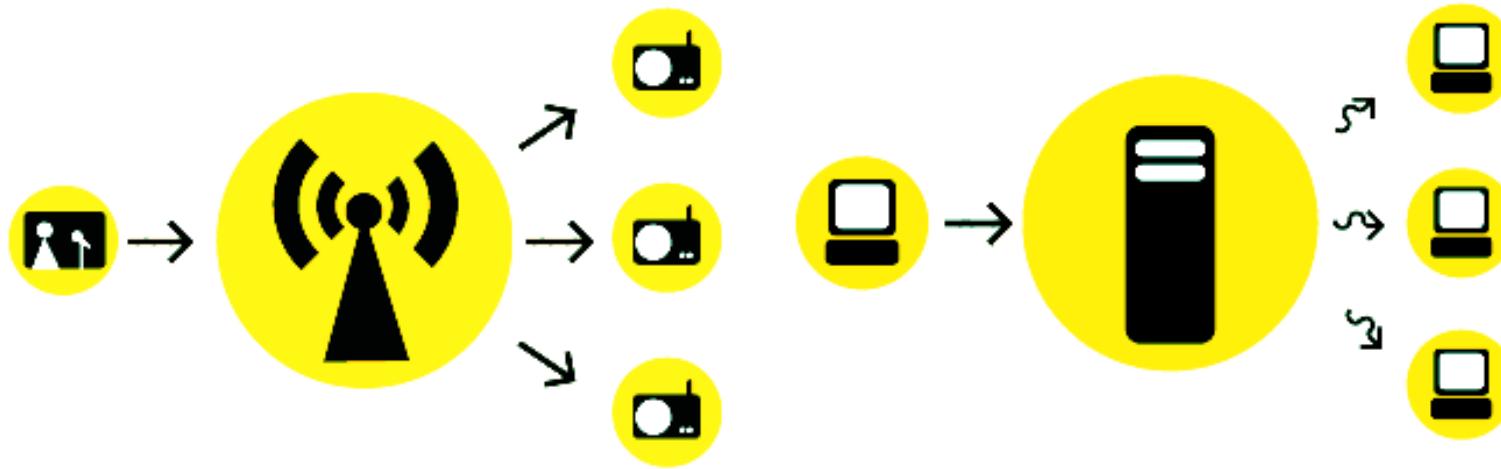


# Experimental results

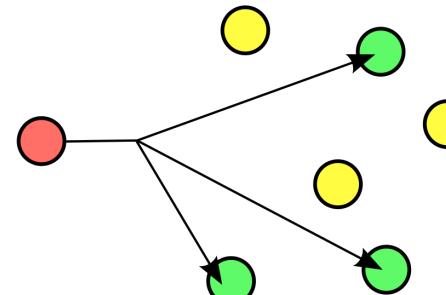
- Artist recommendation model improves by using all **user demographic features** together (5%)
- It improves even more if listener profile of **exploratoryness** is added (12%)
- In general, models with better performance are created if split week data is used. However, the best combination of features achieves the best performance by **using full-week data**
- Demographics and profiling features improve the recommendation accuracy of recommendation model. Further research is needed to determine if listening context improves the recommendation



# Internet radio broadcasting

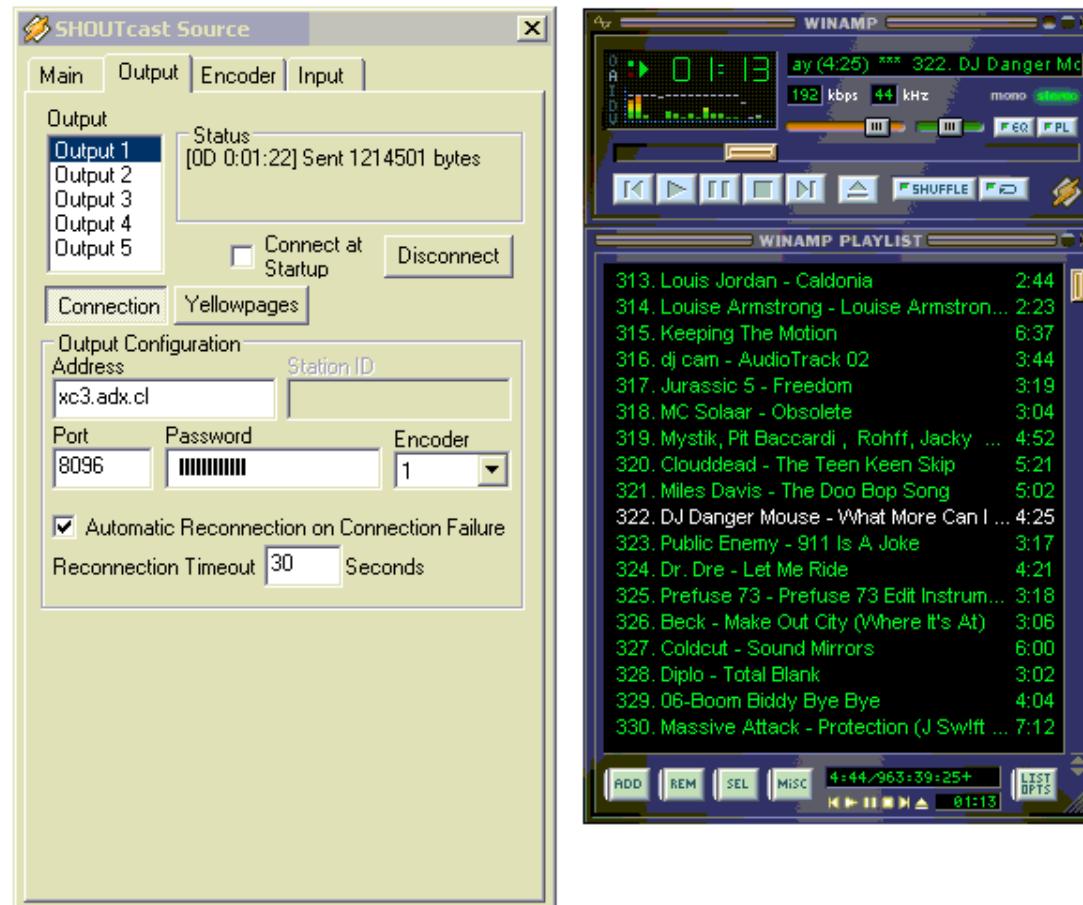


**Unicast:** Sends IP packets to identified recipients on a network, with added bandwidth

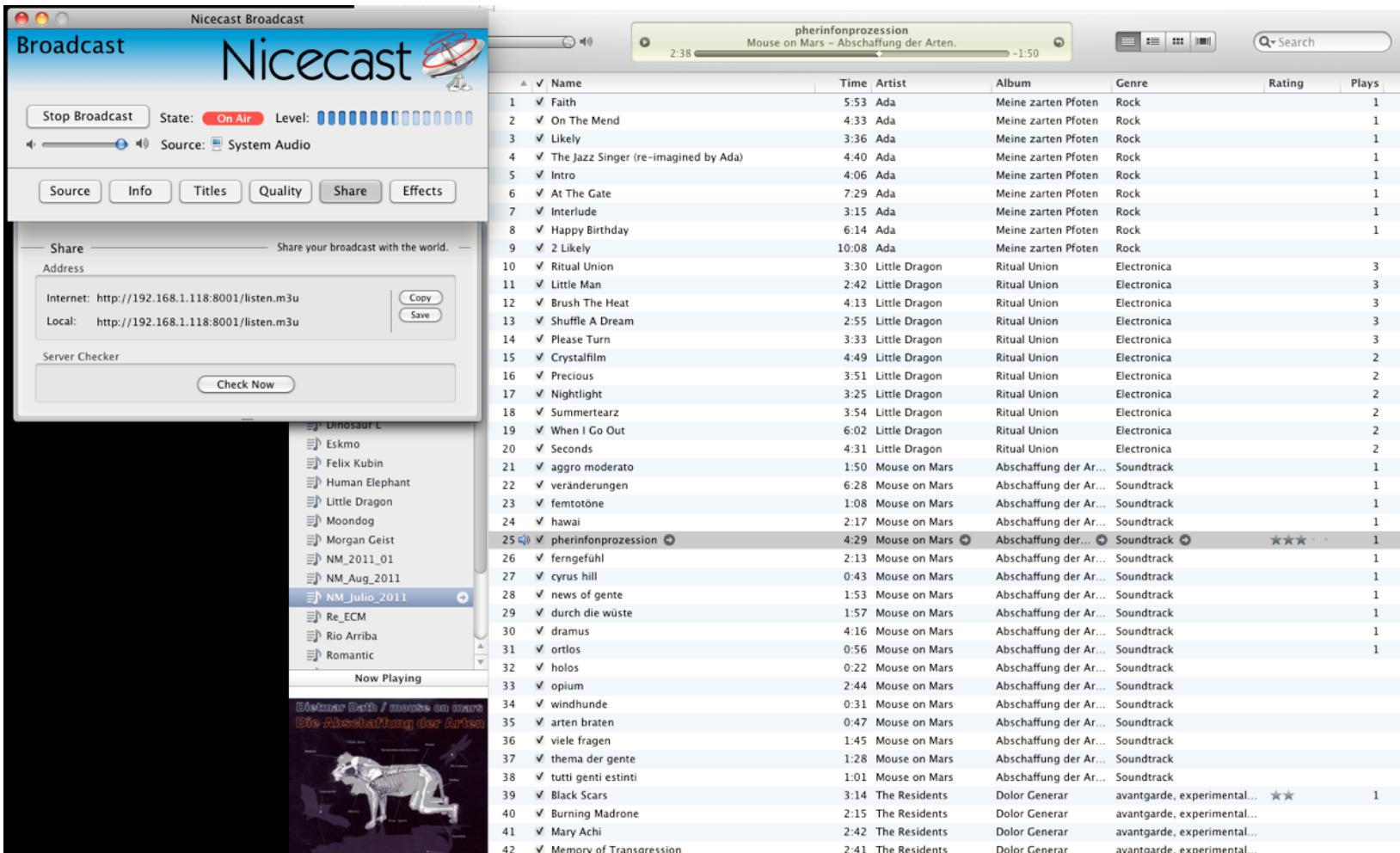


**Multicast:** sends IP packets to a group of hosts on a network, with no added bandwidth, and not requiring prior knowledge of who or how many receivers there are.

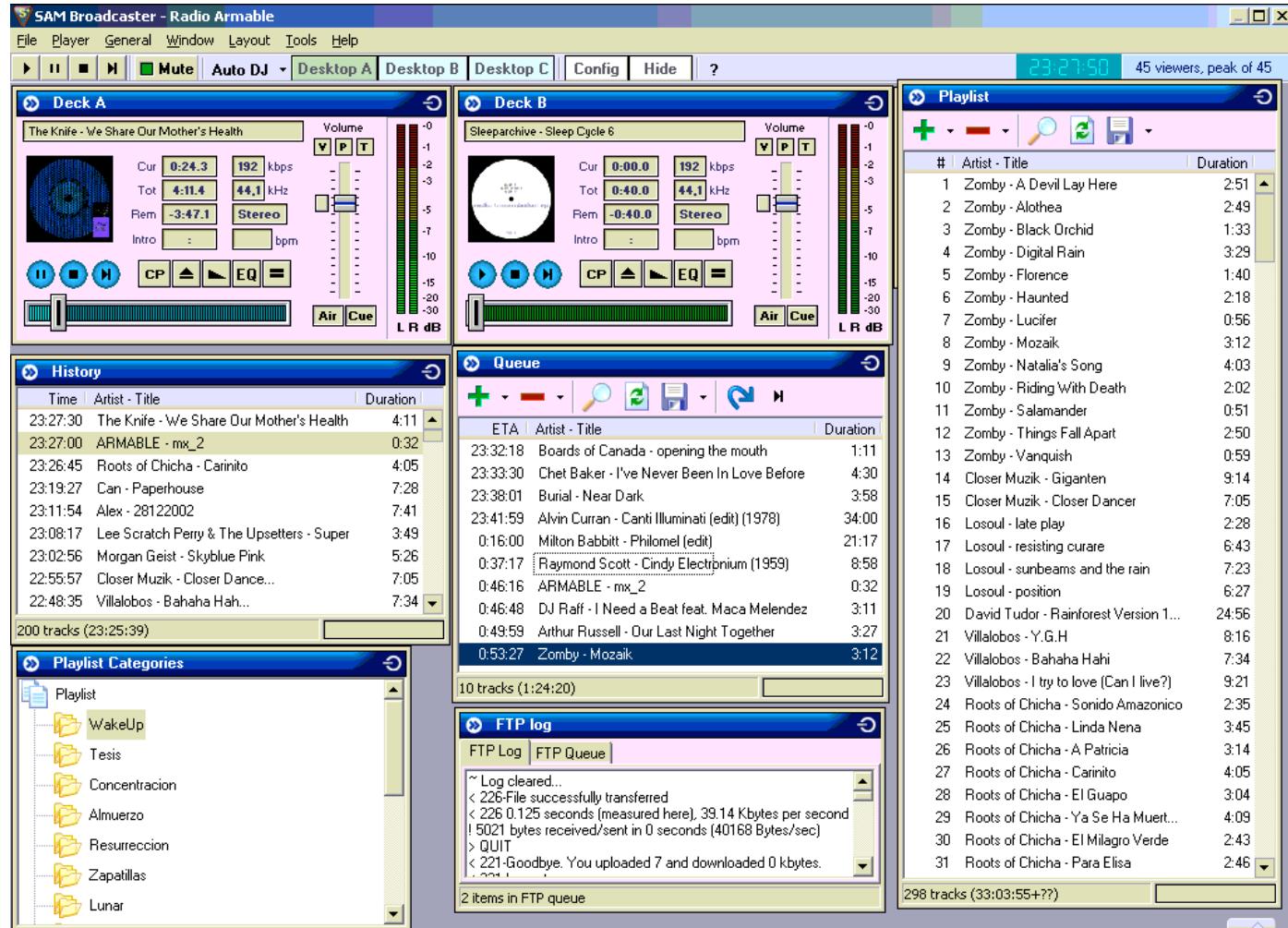
# Playlist creation applications



# Playlist creation applications



# Automated radio broadcasting



# Social radio applications

Radio Armable - Airtime 132.206.14.138/Schedule#

Previous: Autechre - Autriche, 06:55:00  
Autechre - Bronchus 2, 03:33.99 00:37 02:56 GABRIEL MATINAL 08:30 - ON AIR Station time 08:48:51 EDT About

Next: Autechre - Basscadet, 05:24:00 Signed in: gabriel Logout

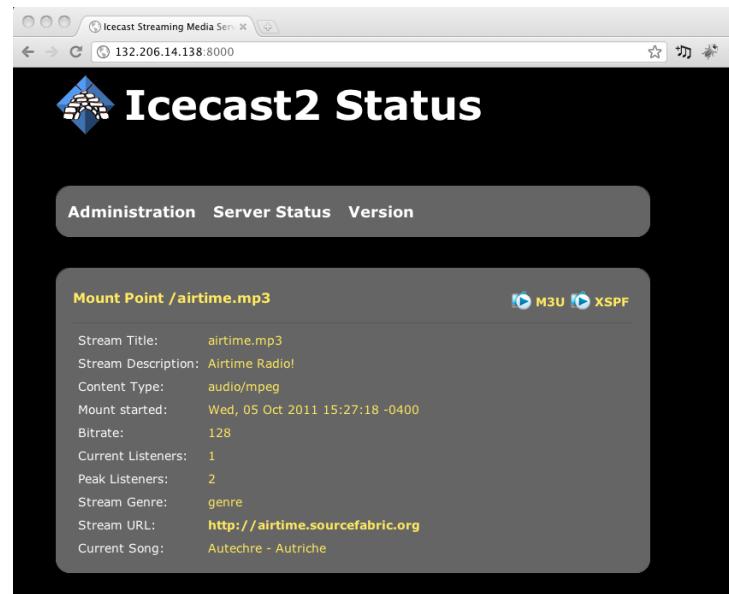
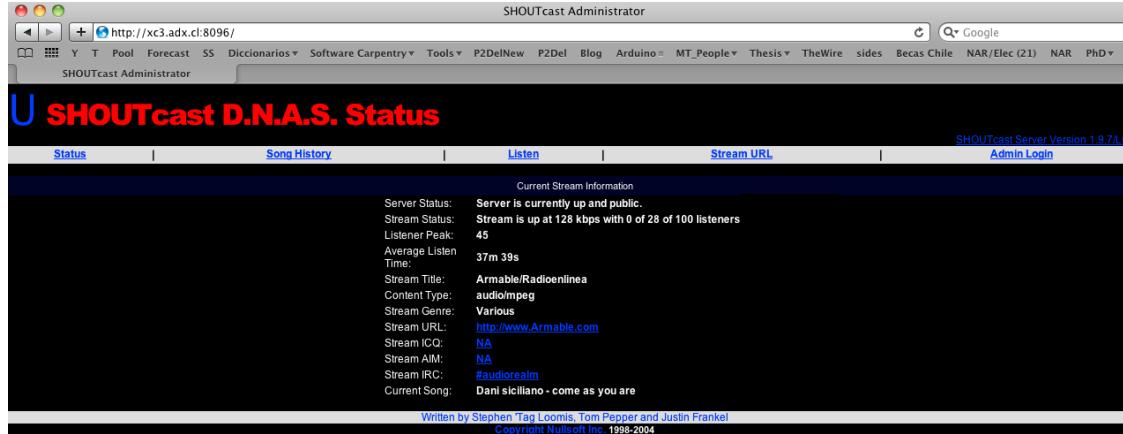
NOW PLAYING ADD MEDIA PLAYLIST BUILDER CALENDAR CONFIGURE HELP Airtime

Oct 16 – 22 2011 day week month

60r Sun 10/16 Mon 10/17 Tue 10/18 Wed 10/19 Thu 10/20 Fri 10/21 Sat 10/22

0:00	21:00 - 6:00 Sábado Noche	0:00 - 7:00 Armable en Random	19:00 - 5:00 Viernes Noche				
1:00							
2:00							
3:00							
4:00							
5:00							
6:00	6:00 - 11:00 Domingo Mañana						5:00 - 12:00 Sábado Mañana
7:00		7:00 - 9:00 WakeUp!					
8:00							
9:00		9:00 - 13:00 Concentración					
10:00							
11:00	11:00 - 18:00 Domingo Amigos						12:00 - 21:00 Sábado Amigos
12:00							
13:00		13:00 - 15:00 Almuerzo					
14:00							
15:00		15:00 - 17:00 Resurrección					
16:00							
17:00		17:00 - 19:00 Zapatillas					
18:00	18:00 - 0:00 Domingo Noche						21:00 - 6:00 Sábado Noche
19:00		19:00 - 22:00 Lunar	19:00 - 22:00 Lunar	19:00 - 22:00 Lunar	19:00 - 22:00 Lunar	19:00 - 5:00 Viernes Noche	
20:00							
21:00							
22:00		22:00 - 0:00 Tesis	22:00 - 0:00 Tesis	22:00 - 0:00 Tesis	22:00 - 0:00 Tesis		
23:00							

# Streaming media servers



# The Infinite Dial 2017



# THE INFINITE DIAL

2017

#infinitedial





# Study Overview

- The Infinite Dial is the longest-running survey of digital media consumer behavior in America.
- The annual reports in this series have covered a wide range of digital media and topics since 1998.
- For 2017, The Infinite Dial tracks and covers new research on mobile behaviors, Internet Radio, Podcasting, Social Media, Smart Speakers and more.





# Study Methodology

- In January/February 2017, Edison Research conducted a national telephone survey of 2000 people aged 12 and older, using random digit dialing techniques
- Interviews were 51% landline and 49% cell phone
- Survey offered in both English and Spanish languages
- Data weighted to national 12+ population figures





# MEDIA & TECHNOLOGY

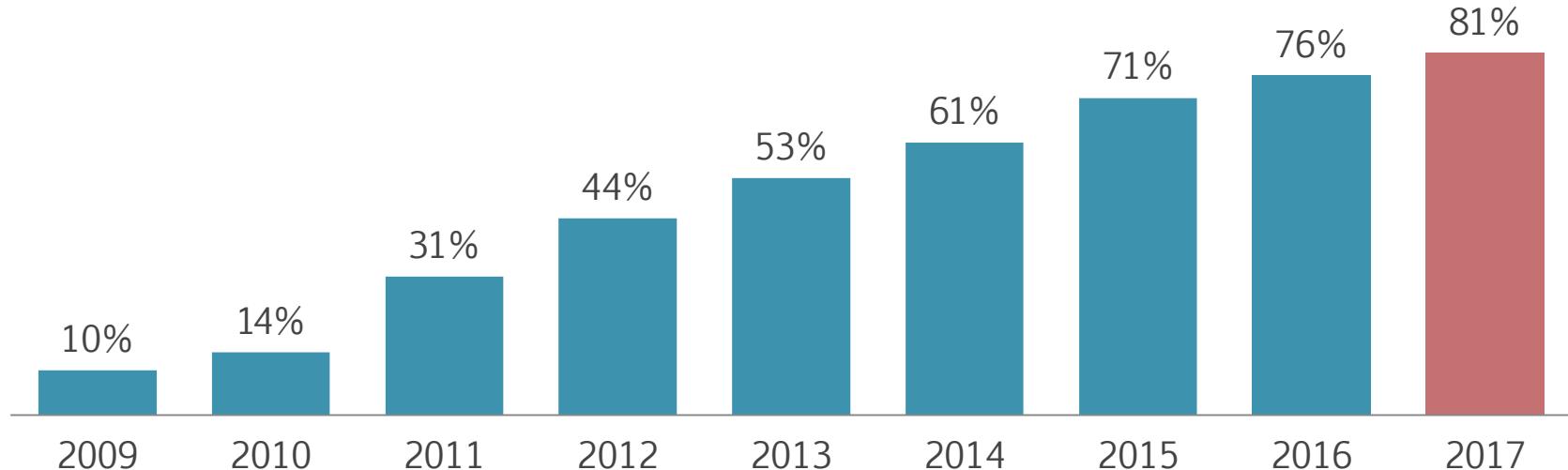




# Smartphone Ownership

Total Population 12+

Estimated  
226 Million

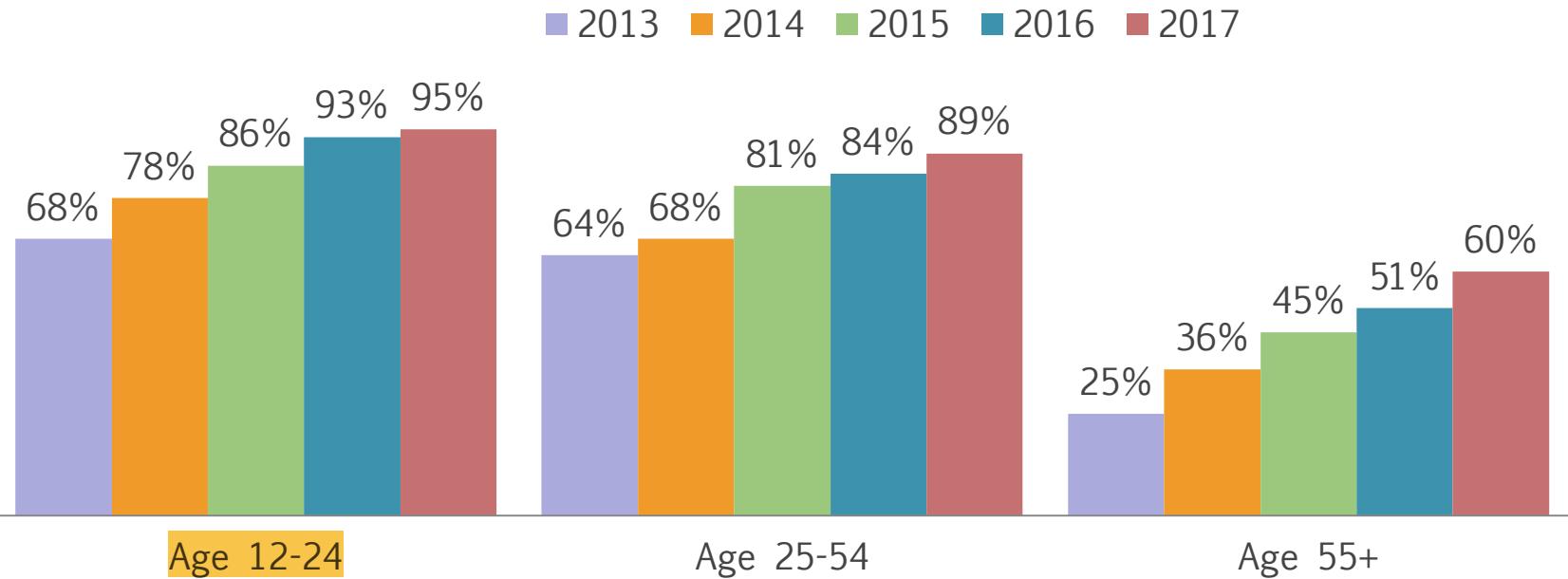


% owning a smartphone





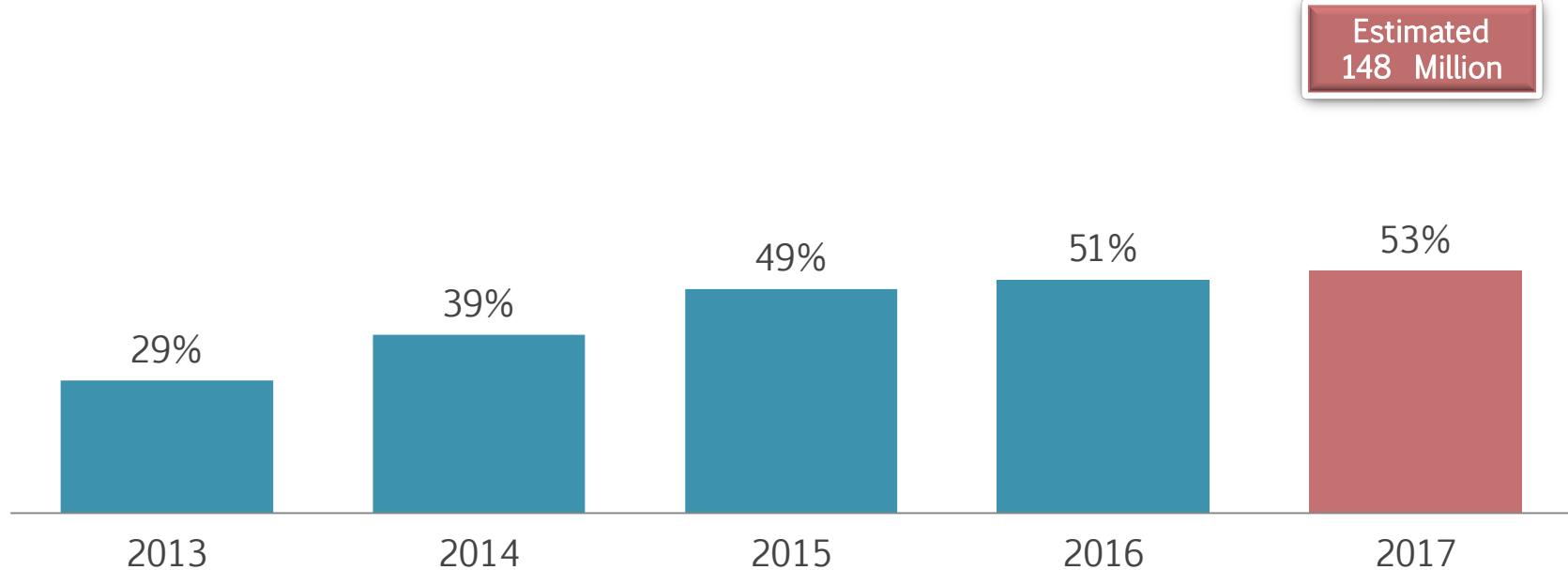
# Smartphone Ownership





# Tablet Ownership

Total Population 12+

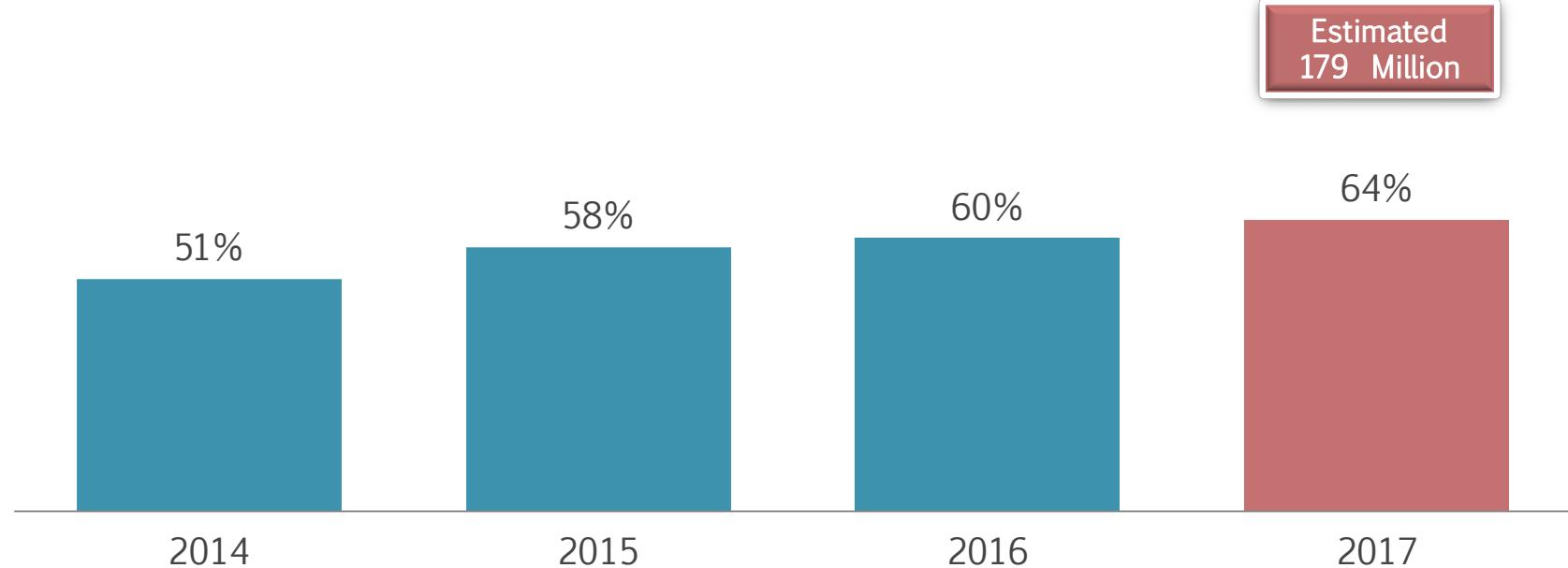


% owning a tablet



# Internet-Connected TV Ownership

Total Population 12+

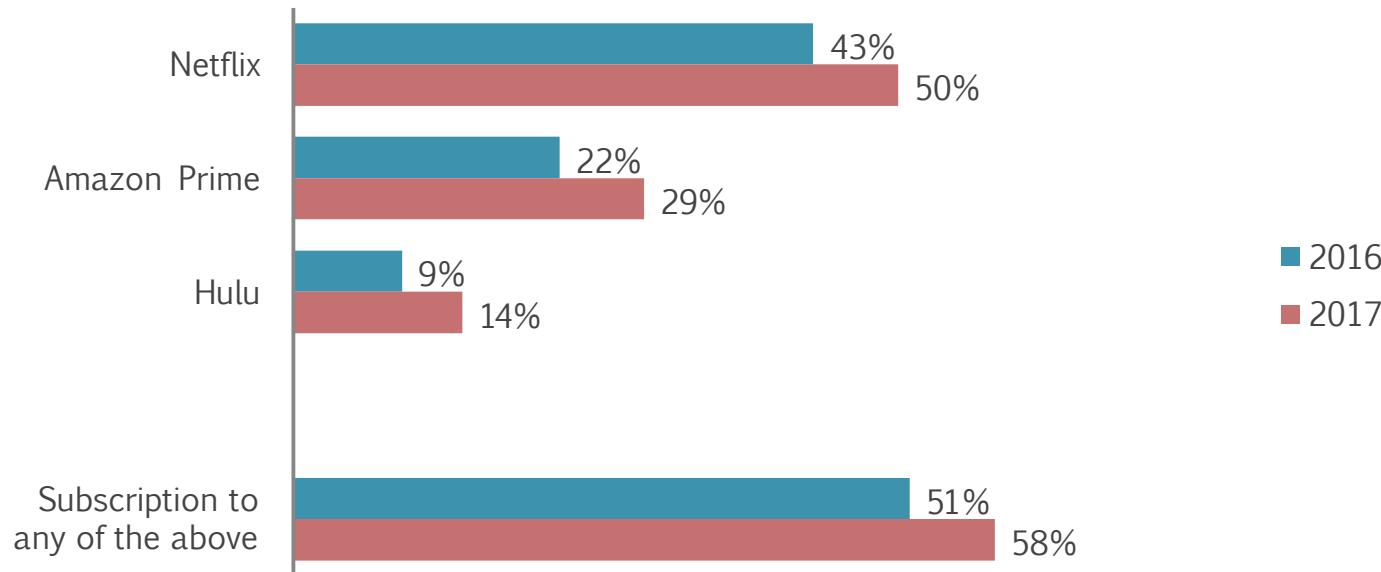


% owning an Internet-connected TV



# On-Demand Video Service Subscription

Total Population 12+



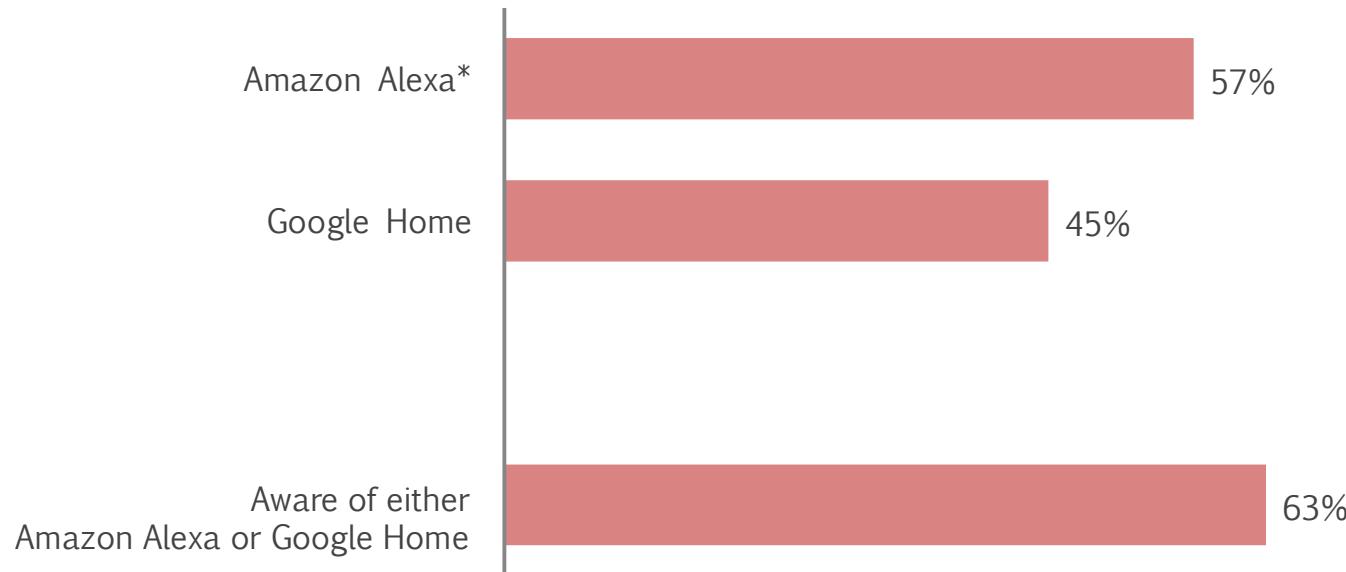
% having a subscription





# Smart Speaker Awareness

Total Population 12+



\*Asked as "Amazon Echo or Amazon Dot, which uses the Alexa voice service"

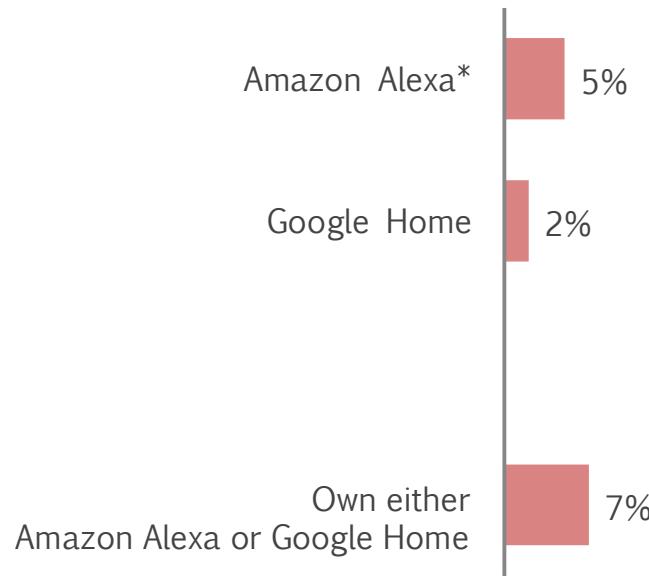
% aware of smart speaker





# Smart Speaker Ownership

Total Population 12+



\*Asked as "Amazon Echo or Amazon Dot, which uses the Alexa voice service"

% owning smart speaker





# ONLINE RADIO



The Infinite Dial © 2017 Edison Research and Triton Digital

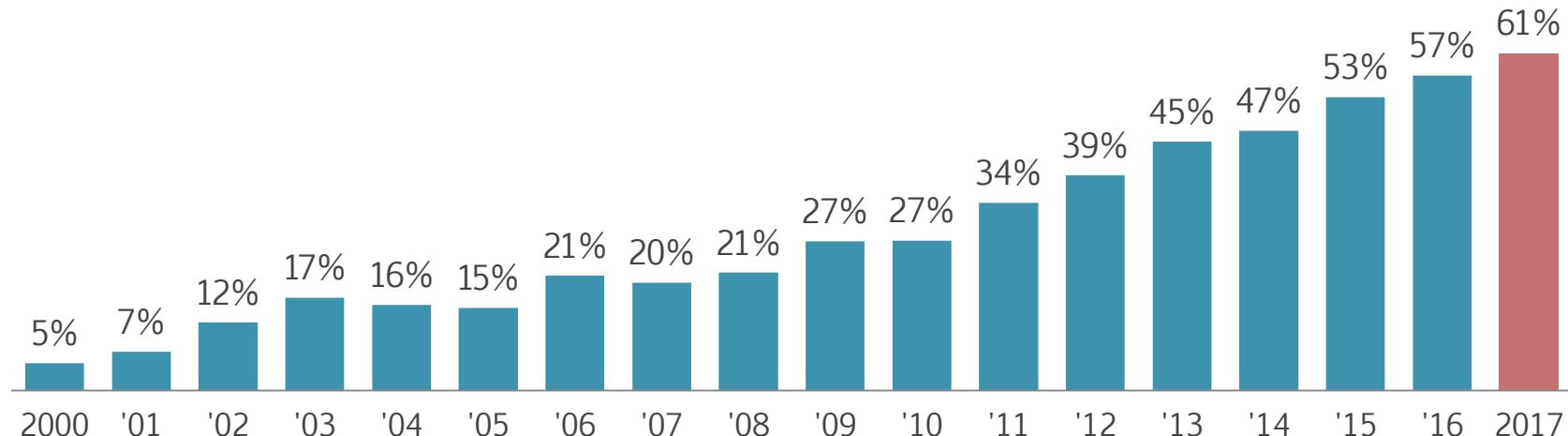




# Monthly Online Radio Listening

Total Population 12+

Estimated  
170 Million



% listening to Online Radio in last month

Online Radio = Listening to AM/FM radio stations online and/or listening to streamed audio content available only on the Internet

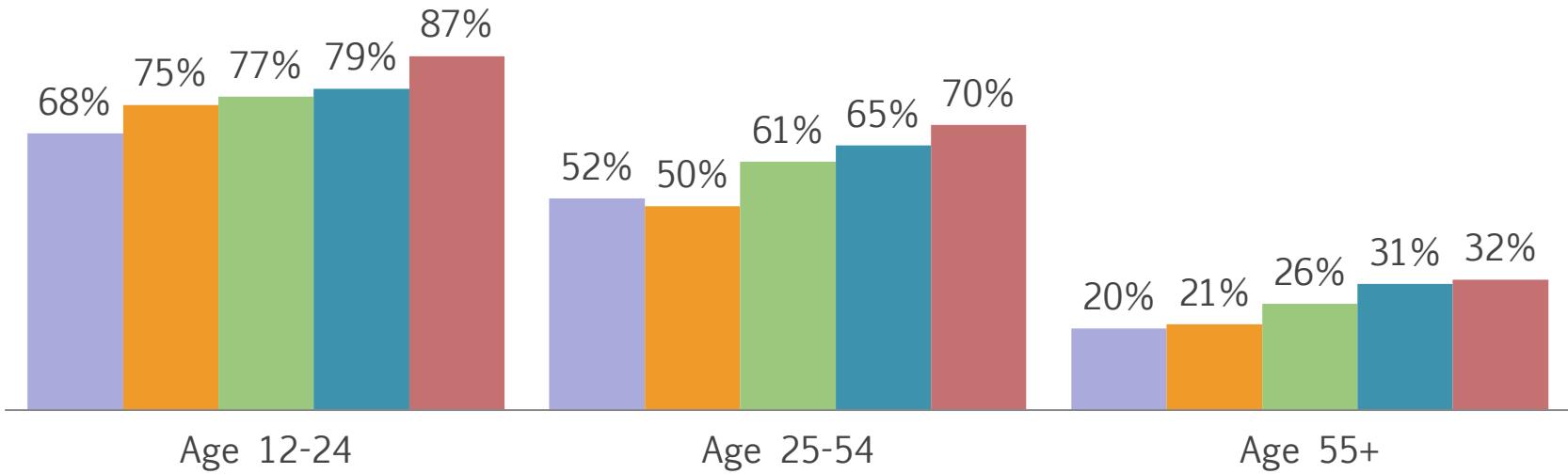
The Infinite Dial © 2017 Edison Research and Triton Digital





# Monthly Online Radio Listening

■ 2013 ■ 2014 ■ 2015 ■ 2016 ■ 2017



% listening to Online Radio in last month

Online Radio = Listening to AM/FM radio stations online and/or listening to streamed audio content available only on the Internet



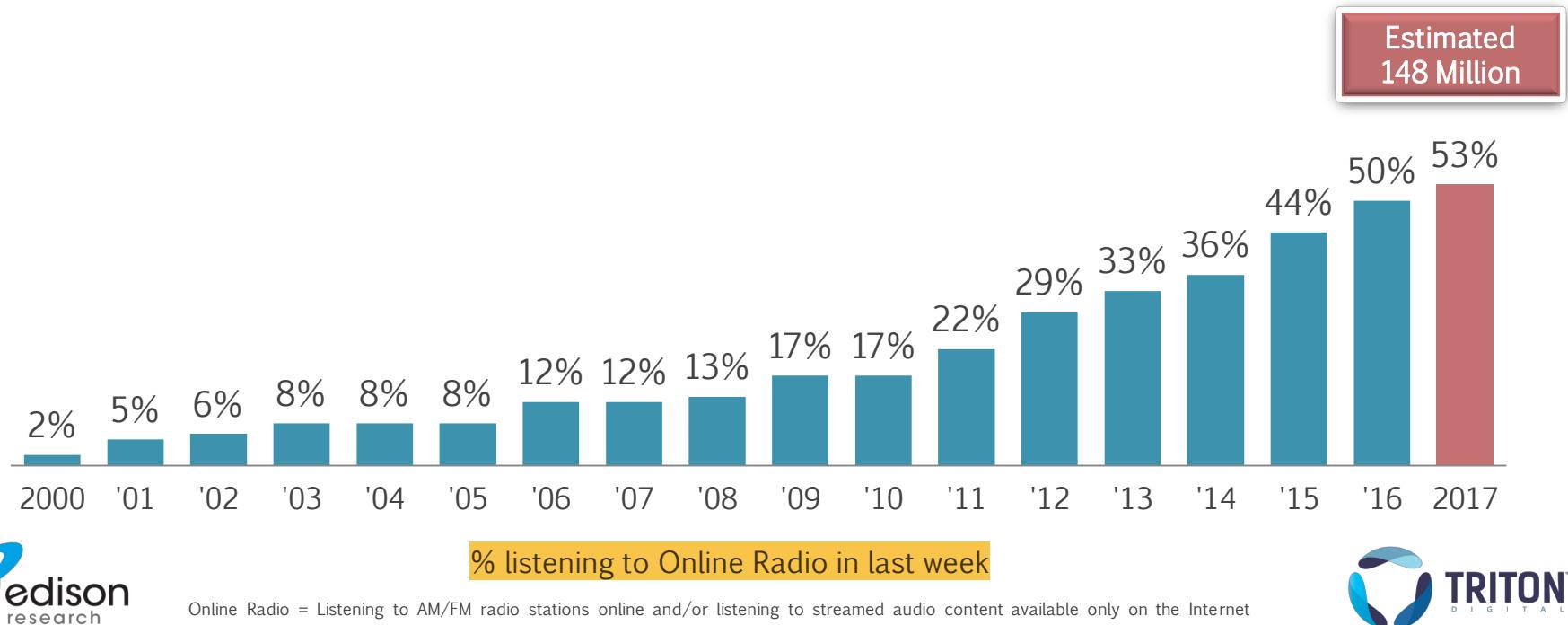
The Infinite Dial © 2017 Edison Research and Triton Digital





# Weekly Online Radio Listening

Total Population 12+



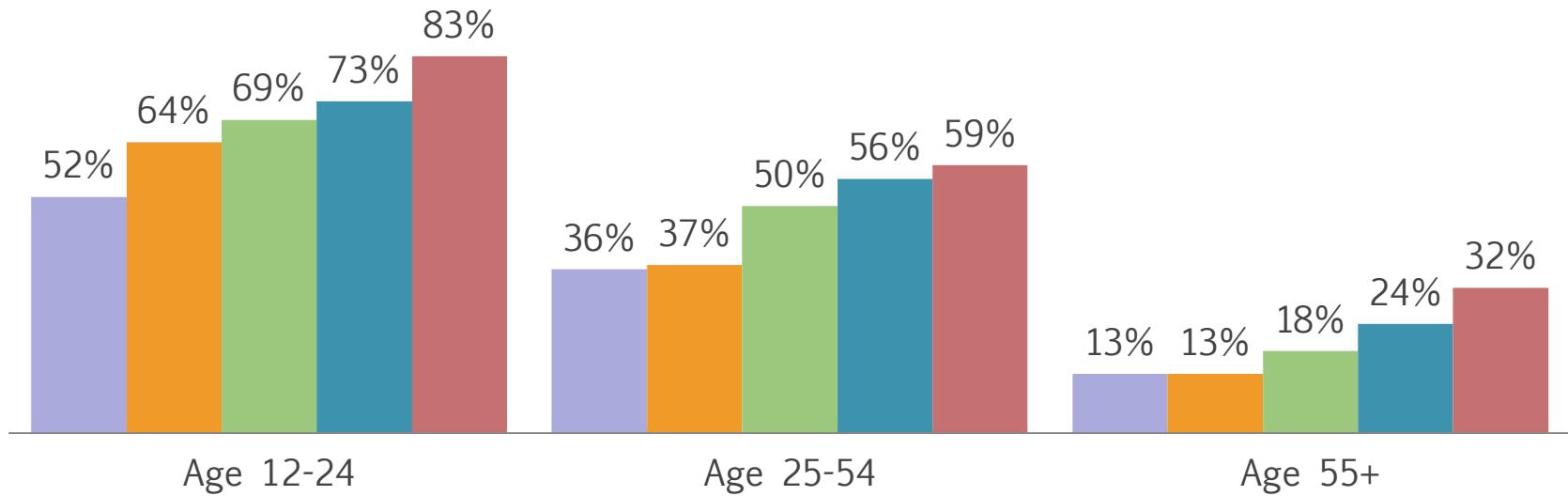
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# Weekly Online Radio Listening

■ 2013 ■ 2014 ■ 2015 ■ 2016 ■ 2017



% listening to Online Radio in last week

Online Radio = Listening to AM/FM radio stations online and/or listening to streamed audio content available only on the Internet



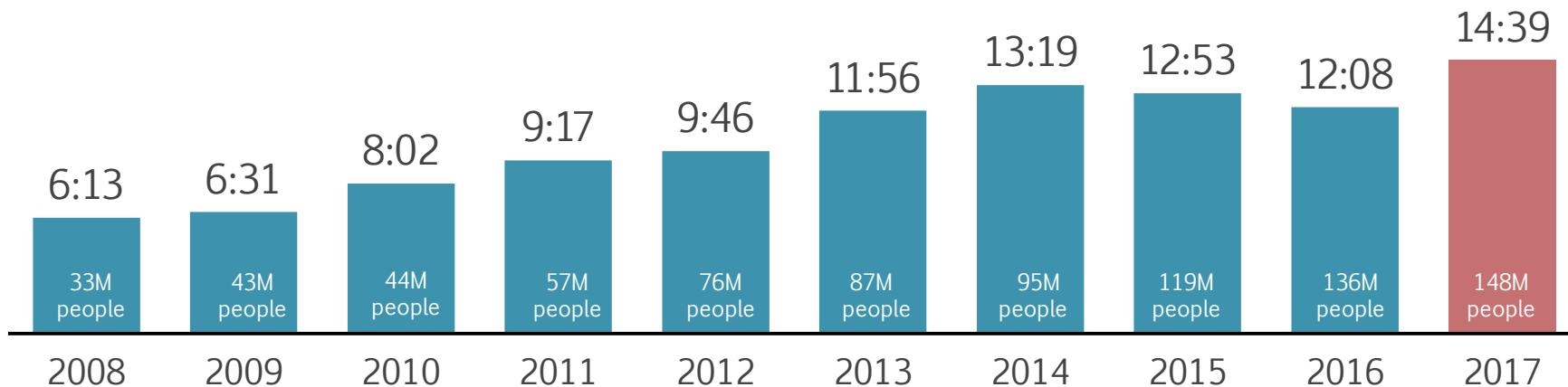
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# Average Time “Weekly Online Radio Listeners” Spend Listening to Online Radio

Base: Weekly Online Radio Listeners



Online Radio = Listening to AM/FM radio stations online and/or listening to streamed audio content available only on the Internet

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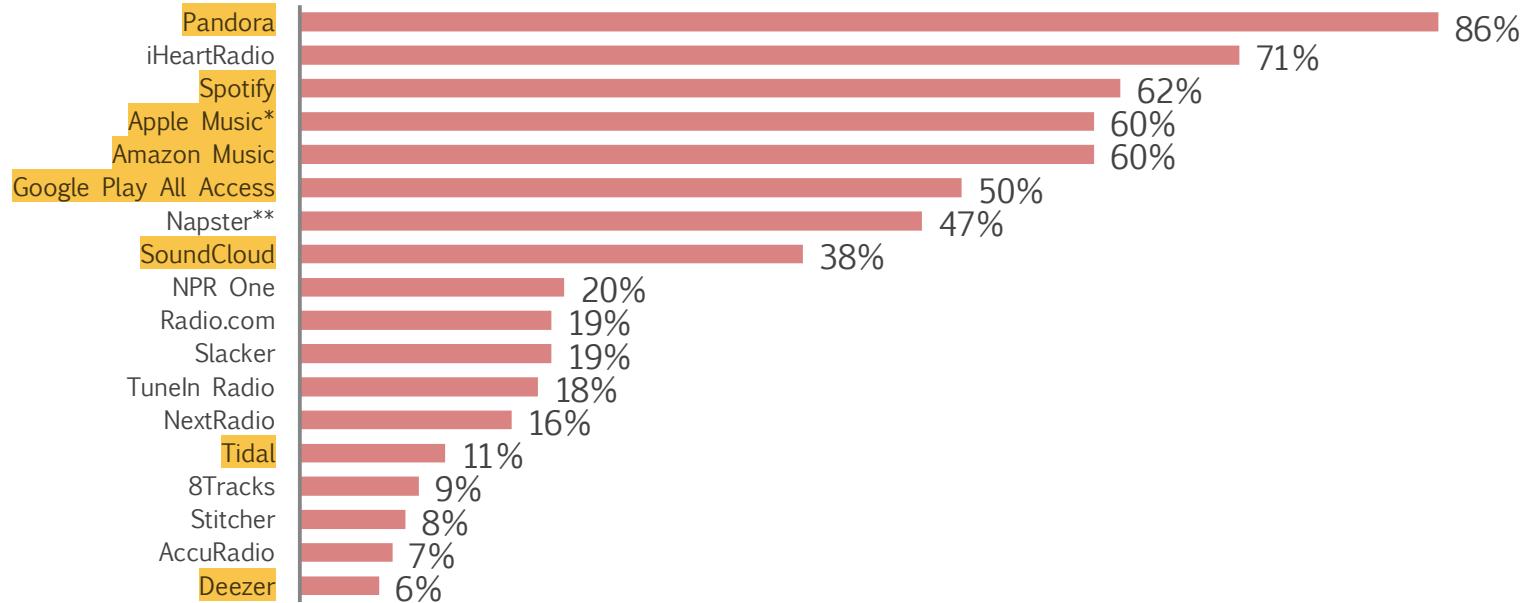
# AUDIO BRANDS





# Audio Brand Awareness

Total Population 12+



\*Asked as "Apple Music, the paid music subscription from Apple"

\*\*Asked as "Rhapsody, now known as Napster"

% aware of audio brand

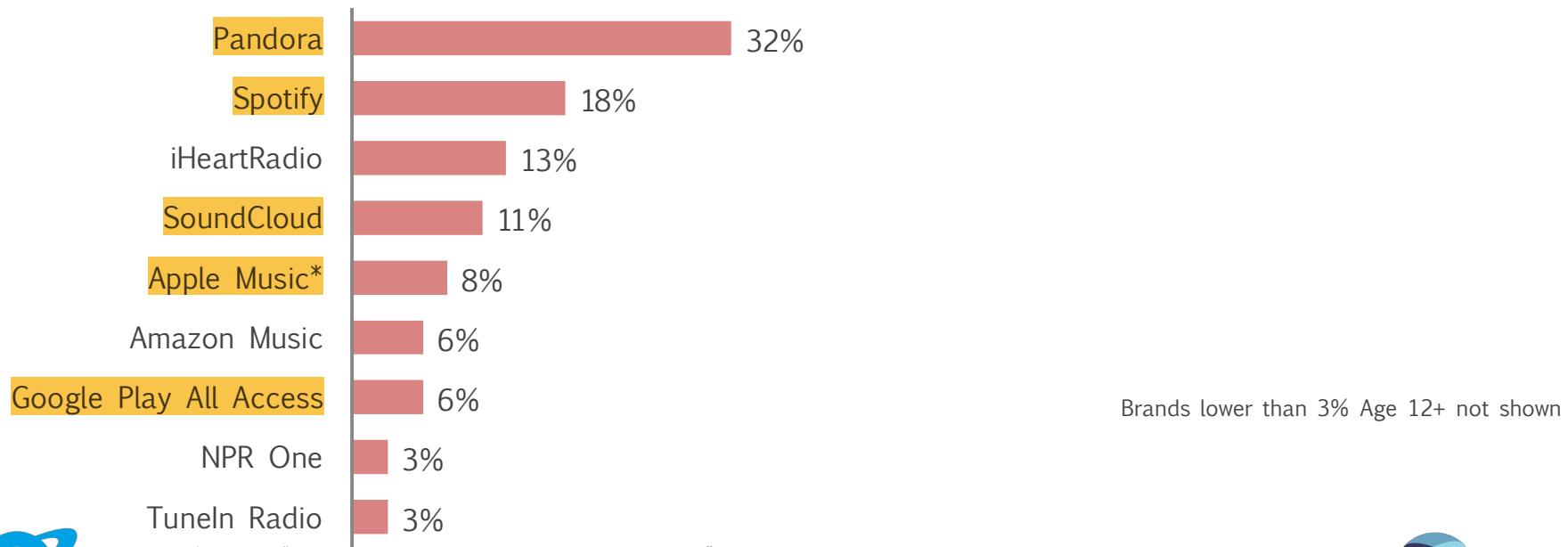
The Infinite Dial © 2017 Edison Research and Triton Digital





# Listened in the last month to...

Total Population 12+



\*Asked as "Apple Music, the paid music subscription from Apple"

% listened in last month

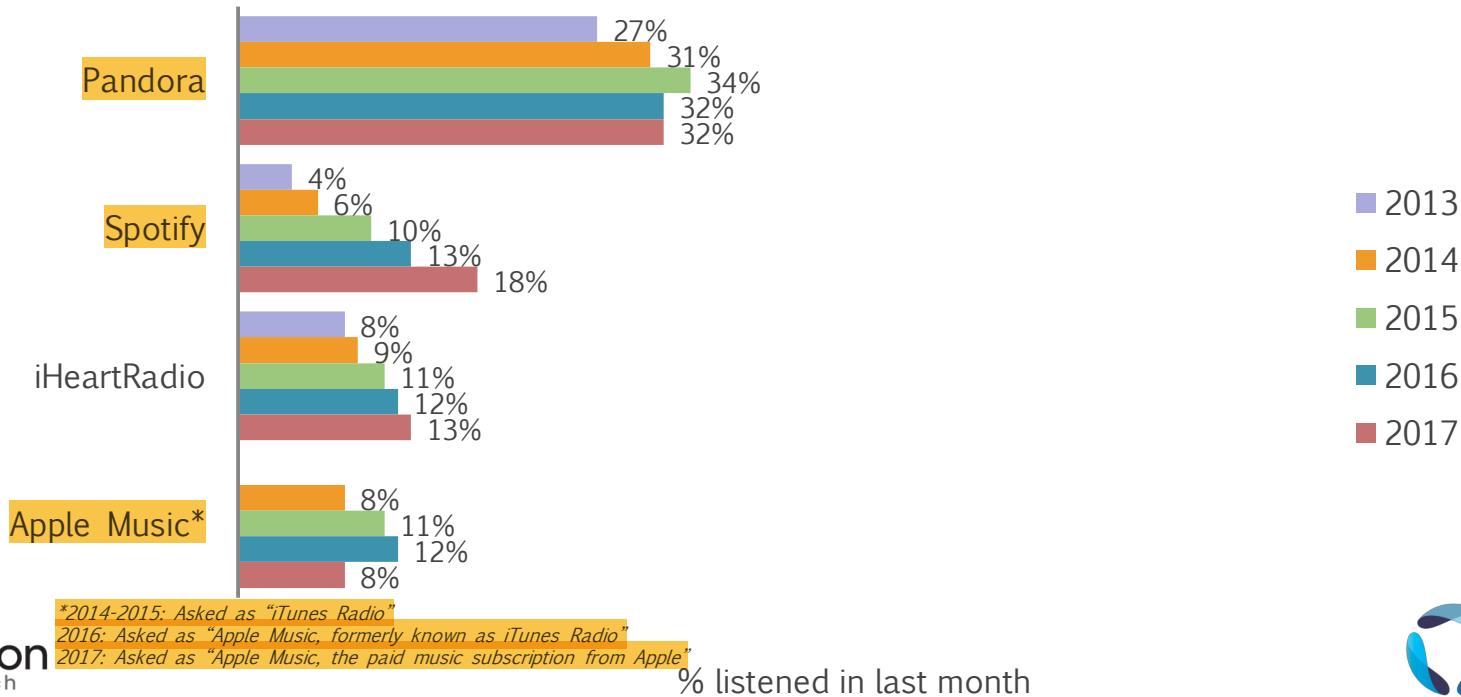
The Infinite Dial © 2017 Edison Research and Triton Digital





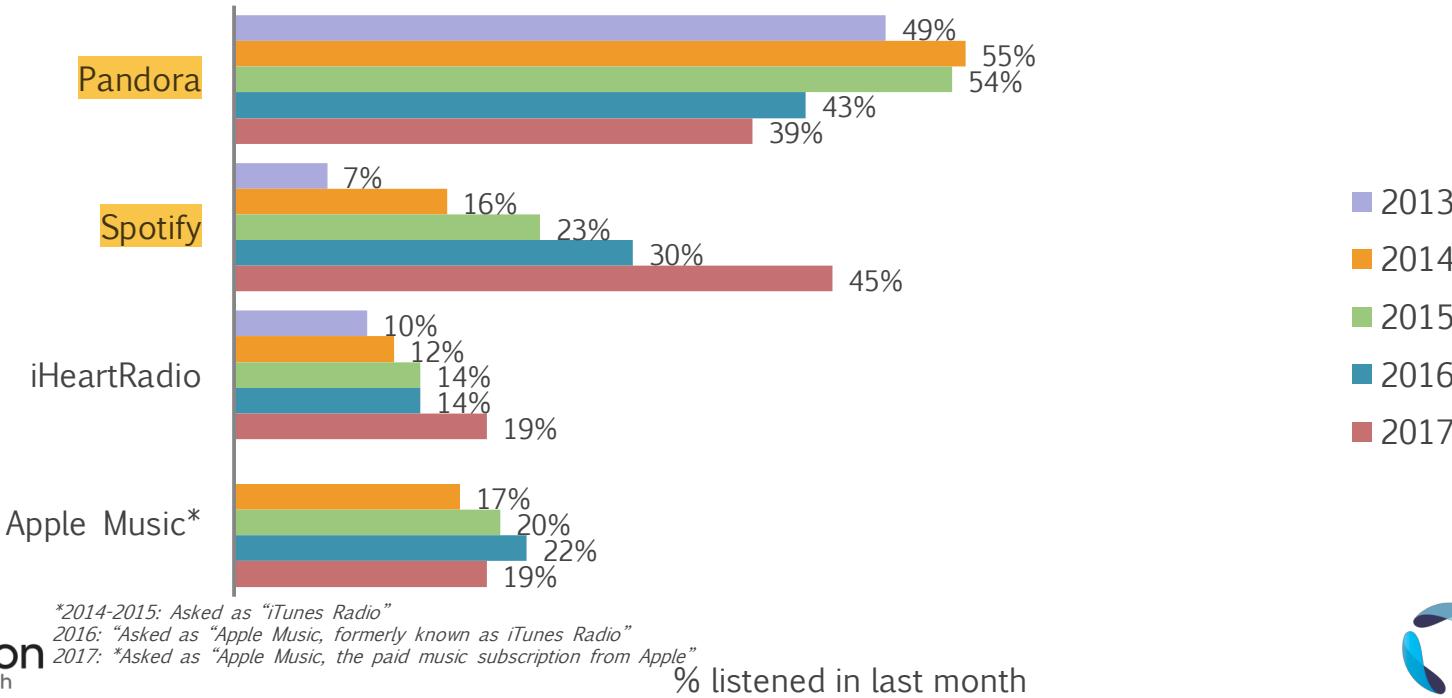
# Listened in the last month to...

Total Population 12+



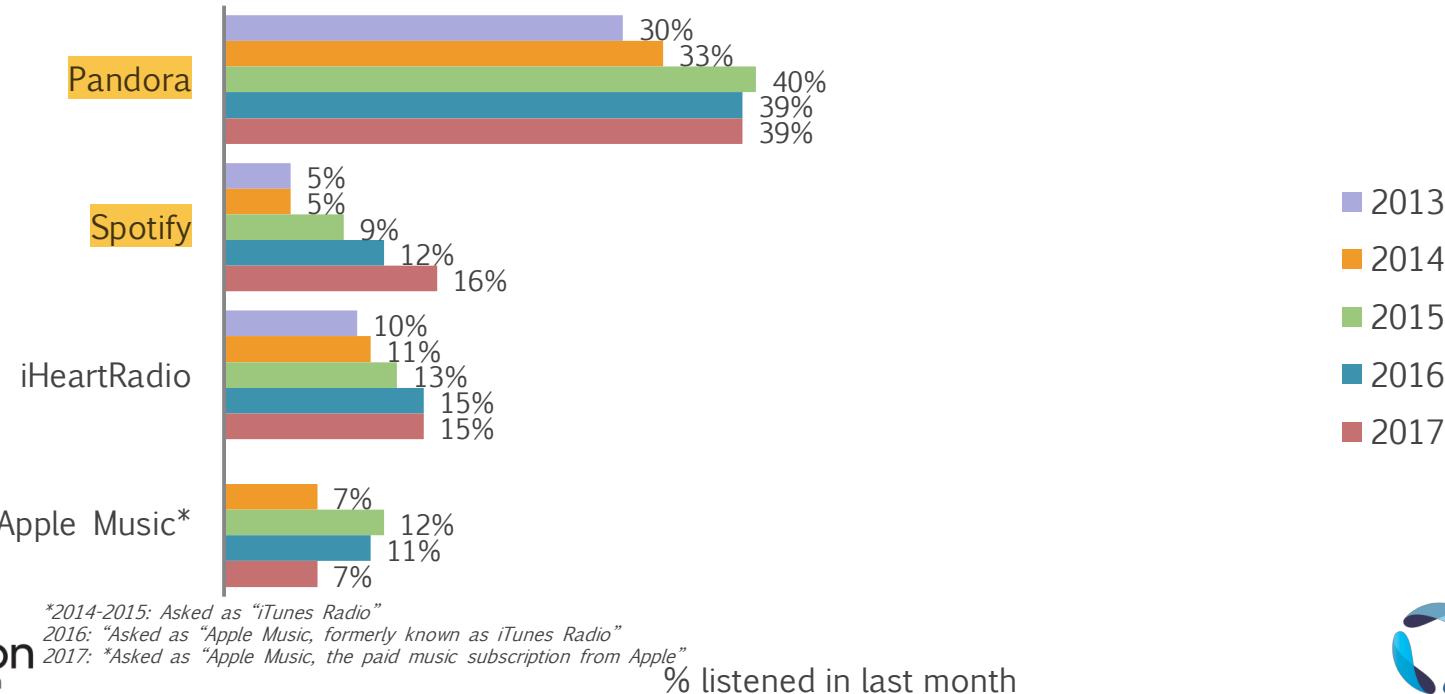


# Listened in the last month to... (Age 12-24)





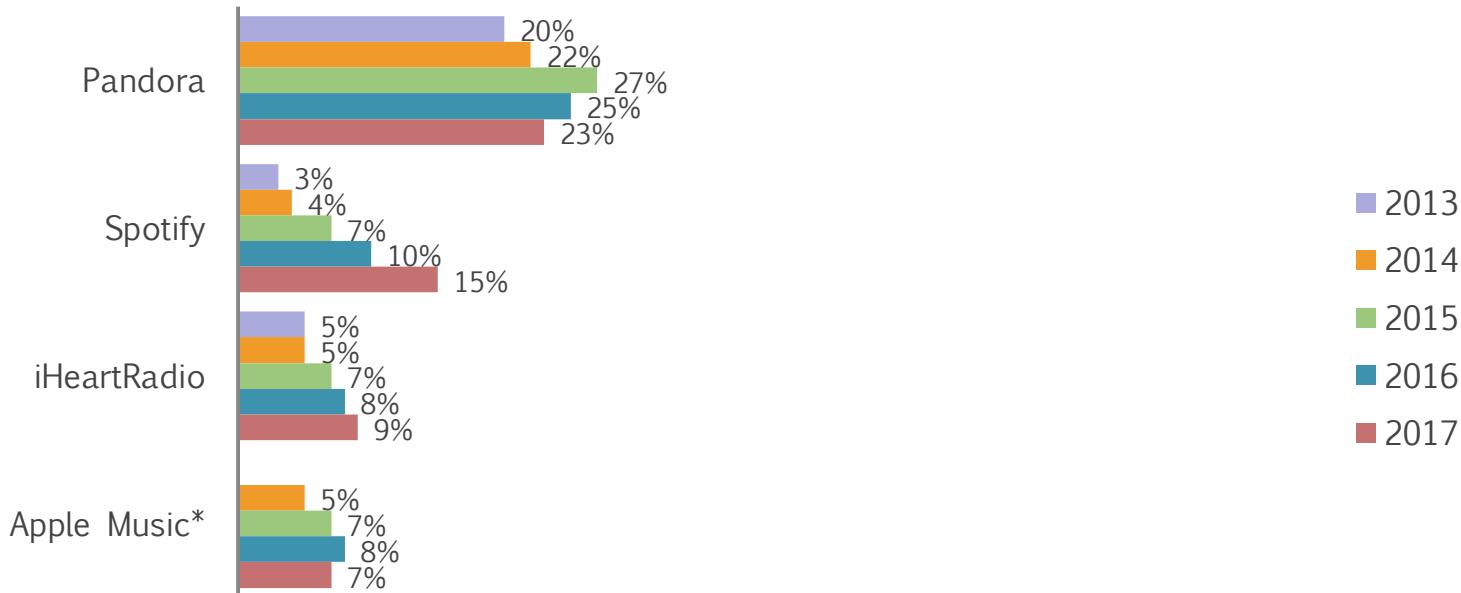
# Listened in the last month to... (Age 25-54)





# Listened in the last week to...

Total Population 12+



\*2014-2015: Asked as "iTunes Radio"

2016: "Asked as "Apple Music, formerly known as iTunes Radio"

2017: \*Asked as "Apple Music, the paid music subscription from Apple"

% listened in last week

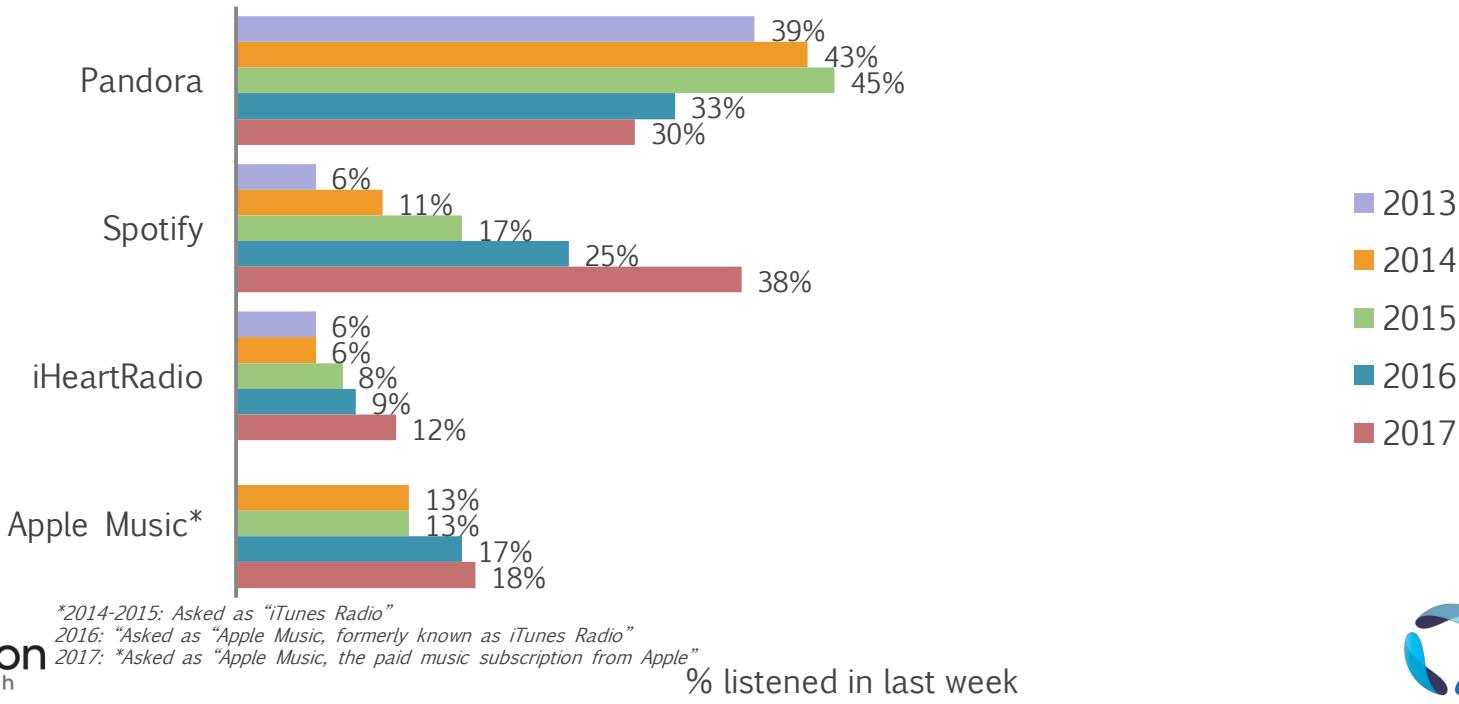


The Infinite Dial © 2017 Edison Research and Triton Digital



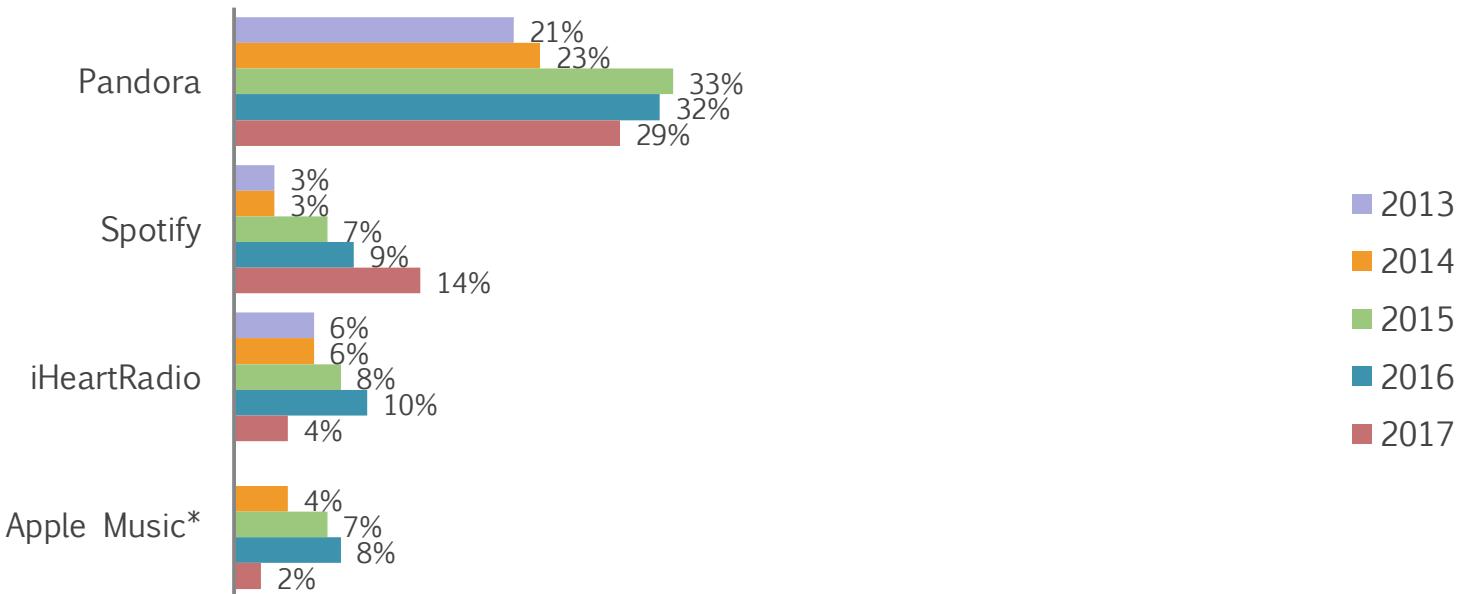


# Listened in the last week to... (Age 12-24)





# Listened in the last week to... (Age 25-54)



\*2014-2015: Asked as "iTunes Radio"

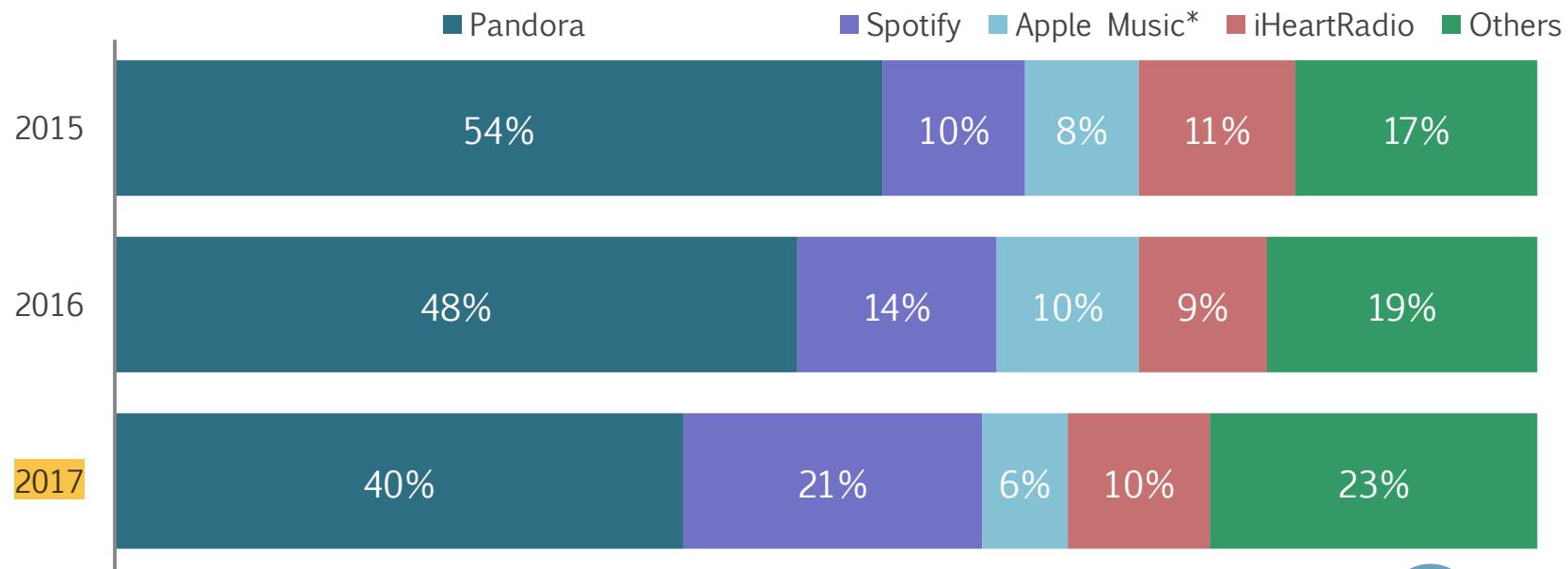
2016: "Asked as "Apple Music, formerly known as iTunes Radio"

2017: \*Asked as "Apple Music, the paid music subscription from Apple"



# Audio Brand Used Most Often

Base: Currently ever use any audio brand



\*2015: Asked as "iTunes Radio"

2016: Asked as "Apple Music, formerly known as iTunes Radio"



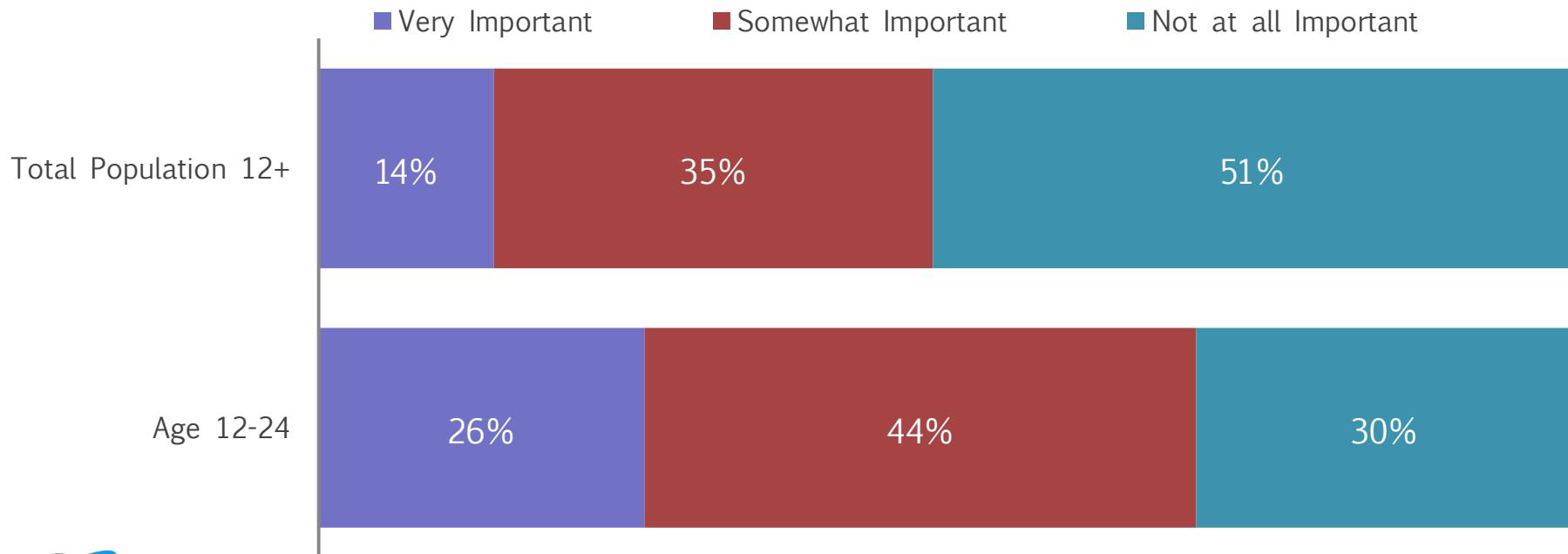


# MUSIC DISCOVERY





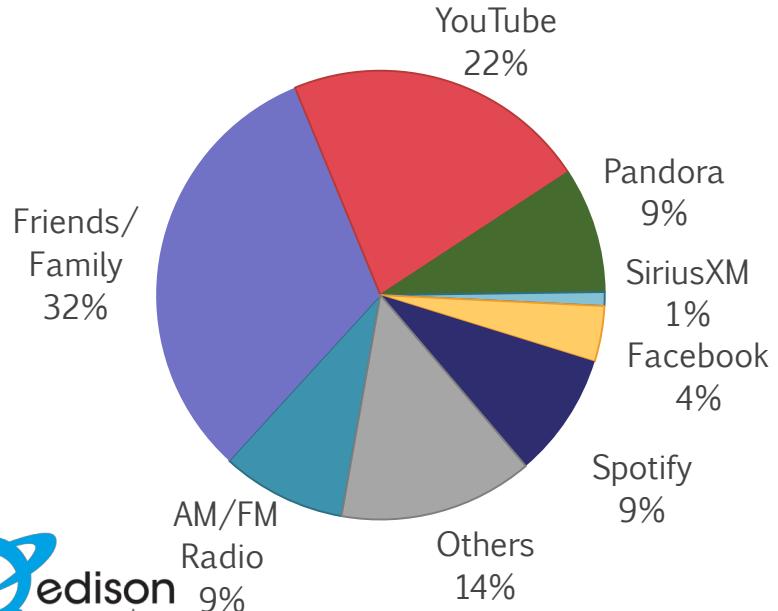
# Importance of Keeping Up-To-Date with Music



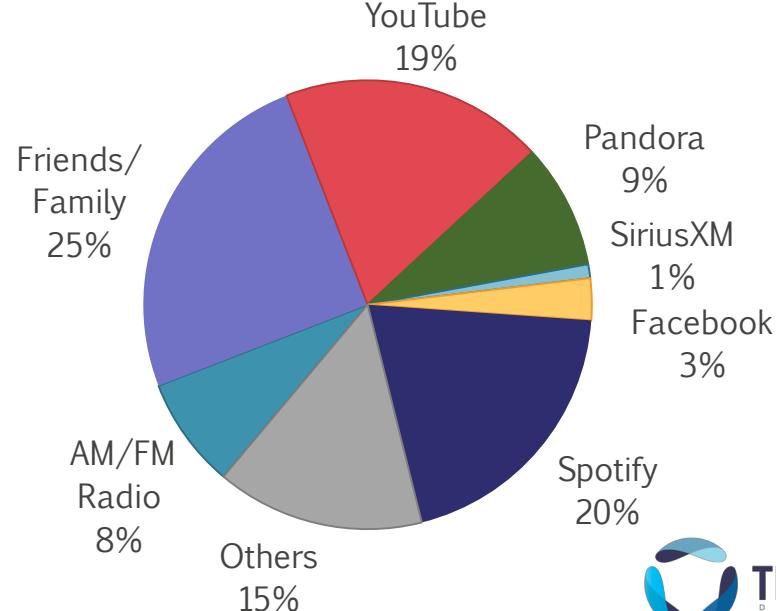
# Source Used Most Often for Keeping Up-to-Date with Music (Age 12-24)

Base: Those saying it is “Very Important” or “Somewhat Important” to keep up-to-date with music

2016



2017



# Intellectual property

Compiled from <http://www.cipo.ic.gc.ca/>

- Copyright Act: **any original** literary, dramatic, musical (musical compositions with or without words) or artistic work is **automatically protected by copyright the moment it is created**
- In the simplest terms, “**copyright**” means “**the right to copy**”: the right to reproduce a work, or a substantial part of it, in any form
- In the case of music or sound:
  - **a recording consisting of sounds**
  - **a performance of a musical work**
  - **an improvisation of a musical work**
- Copyright in Canada

# Intellectual property

Compiled from <http://www.cipo.ic.gc.ca/>

- The **work's creator** is usually the **copyright owner**
  - Exceptions: an employer has copyright for works created by employees unless there is an agreement to the contrary
- When you own copyright on a work you can **control how it is used**
  - **Selling the right** to use the work, or **getting a permission** to use it
  - You can **limit its use** to protect the value of the copyrighted work.
- Even though copyright protection is automatic, **registration** gives you evidence of ownership
  - **Certificate of registration of copyright:** evidence that copyright exists and that the person registered is the owner of the copyright

# Intellectual property

Compiled from <http://www.cipo.ic.gc.ca/>

- Application in Canada for a **registration of a copyright** in a
  - Work
  - Performer's performance or sound recording
- Copyright generally exists for the **life of the author/s plus an amount of time after their death**
- This amount of **time varies per country**
  - Canada: 50 years after the death of the author
  - US: 70 years after the death of the author
- **After that, the work becomes part of the public domain** and anyone can use it.

# Canada and Copyright

- Why there are just a few on-demand music services in Canada?
  - Canada is a party to the **Berne Convention of 1886**
    - aspects of modern copyright law were set
    - copyright exists the moment a work is “fixed”
    - countries recognize copyrights held by the citizens of all other signatory countries.
  - Canada **signed but did not ratify** both the WIPO Copyright Treaty of 1996, and the WIPO Performances and Phonograms Treaty of 1996
  - File sharing in Canada
  - That changed three years ago! -> Bill C-11

# Fair use

<http://fairuse.stanford.edu/overview/fair-use/what-is-fair-use/>

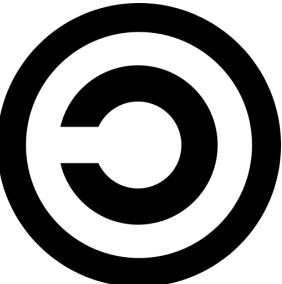
- Fair Use
  - copying of copyrighted material done for a **limited and “transformative” purpose**
  - based on the belief that the public is entitled to **freely use portions** of copyrighted materials for purposes of **commentary** and **criticism**
  - such uses can be done **without permission** from the copyright owner
  - if your use qualifies as fair use, then it would not be considered an illegal infringement
- The **Four Factors** are used to measure fair use:
  - the **purpose and character** of usage (the transformative factor)
  - the **nature** of copyrighted work
  - the **amount and substantiality** of the portion taken
  - the **effect of the use** upon the potential market
- What If You Acknowledge the Source Material?
  - **Acknowledgment of the source** material (such as citing a photographer) may be a **consideration** in a fair use determination, but **it will not protect** against a claim of infringement.
- E.g.,
  - Text: limited copying for educational purposes
  - Audio/visual content: limited performance for educational purposes
  - Graphical content: limited display for educational purposes

# Fair use

<http://fairuse.stanford.edu/overview/fair-use/what-is-fair-use/>

- Fair use music cases
  - A television film crew, covering an Italian festival in Manhattan, recorded a **band playing a portion of a copyrighted song** “Dove sta Zaza.” The music was replayed during a news broadcast.
  - A woman was sued for copyright infringement for **downloading 30 songs using peer-to-peer file sharing software**. She argued that her activity was a **fair use because she was downloading the songs to determine if she wanted to buy them later**.
  - Campbell v. Acuff-Rose Music Inc. (AKA 2 Live Crew vs. Roy Orbison)
  - WAY
  - Danger Mouse's The Grey album
    - Jay-Z and Macca reaction

# Copyright alternatives



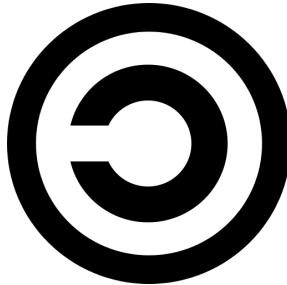
# Public Domain

<http://fairuse.stanford.edu/overview/fair-use/what-is-fair-use/>



- “Creative materials that are not protected by intellectual property laws such as copyright, trademark, or patent laws.”
- **Four common ways** that works arrive in the public domain
  - the copyright has **expired**
  - the owner failed to follow copyright **renewal rules**
  - the owner deliberately **places it in the public domain**
  - copyright law does not protect this type of work

# Copyleft



- Practice of using copyright law to offer **the right to distribute copies and modified versions of a work**, requiring that **the same rights be preserved in modified versions of the work**
- Copyleft can be characterized as a copyright licensing scheme in which an **author surrenders some, but not all rights** under copyright law
- **Instead of allowing a work to fall completely into the public domain** (where no ownership of copyright is claimed), **copyleft allows an author to impose some restrictions** on those who want to engage in activities that would more usually be reserved by the copyright holder
- Four **types of freedom**:
  - Freedom 0 – the freedom to use the work
  - Freedom 1 – the freedom to study the work
  - Freedom 2 – the freedom to copy and share the work with others
  - Freedom 3 – the freedom to modify the work, and the freedom to distribute modified and therefore derivative works
- Under copyleft, **derived works may be produced** provided they are released under the compatible copyleft scheme

# Creative Commons

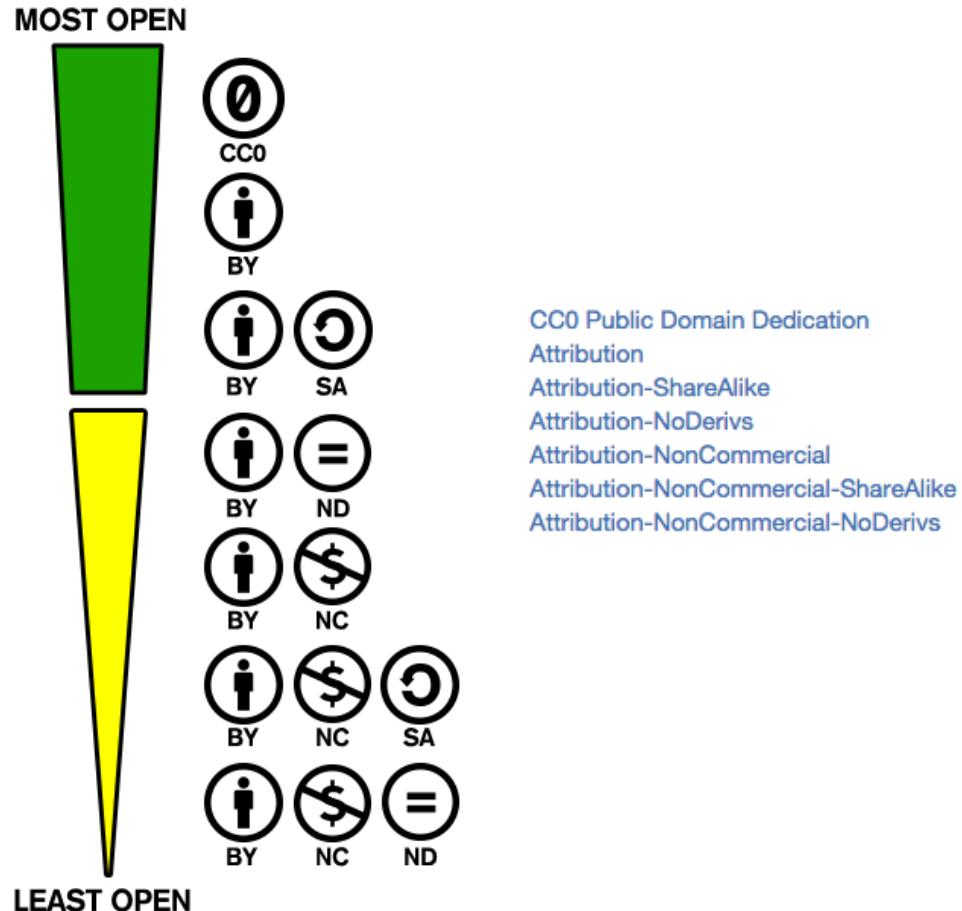


- “Reasonable, flexible copyright” at [www.creativecommons.org](http://www.creativecommons.org)
- Copyleft-like licenses for creative work
- Four main variables
  - Attribution
  - Non-commercial
  - No derivative works
  - Share alike



CC licenses

# Creative Commons



# CC Music

- [A new public domain score and studio recording of Bach's Goldberg Variations - set the Goldbergs free!. The link!](#)
- [Chris Zabriskie, on CC](#)
- [Creative Common Music Communities](#)
- [Creative Commons Record Labels](#)
- [Freesound](#)
- [Kompoz](#)
- [iBeat](#)
- [Musopen](#)
- [InternetArchive](#)
- [IMSLP](#)



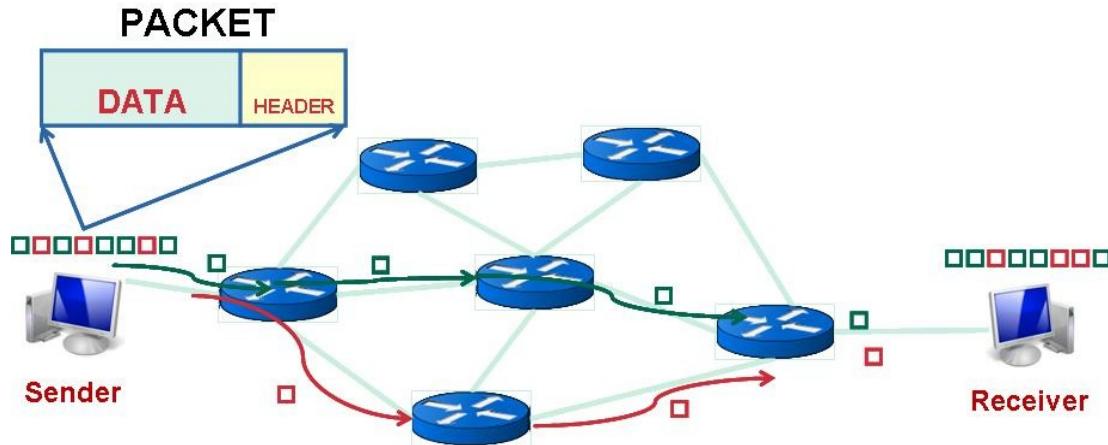
BREAK

# Mid-term review

# New music economy

- Three dimensions (tensions) between the old music economy (OME) and the new music economy (NME)
  - Connectivity vs. control
  - Service vs. product
  - Amateur vs. professional

# Packet switching



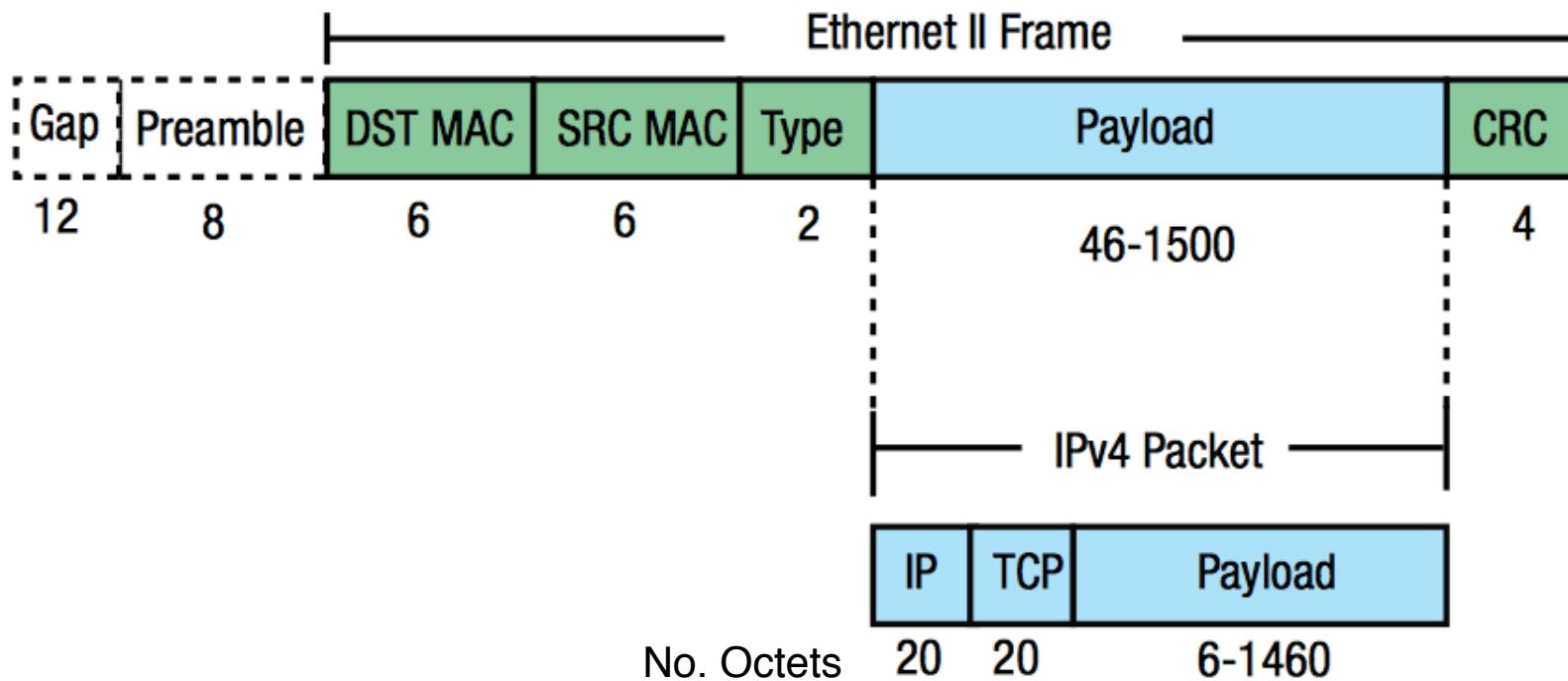
Taken from <http://computernetworkingsimplified.com/physical-layer/overview-circuit-switching-packet-switching/>

# Internet technologies

- Ethernet
- TCP/IP
- OSI Model
- IP Addresses
- DNS
- Ports
- DHCP
- FTP
- SSH
- HTTP

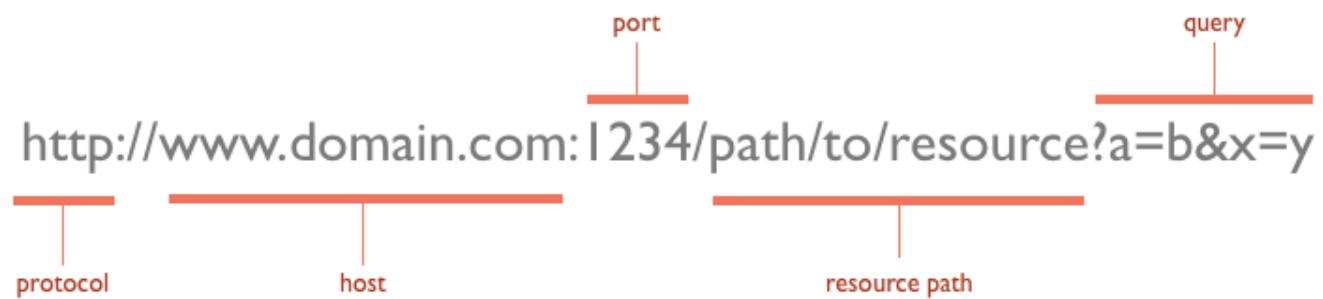
# Complete Ethernet Packet

Taken from [openmicrolab.com](http://openmicrolab.com)



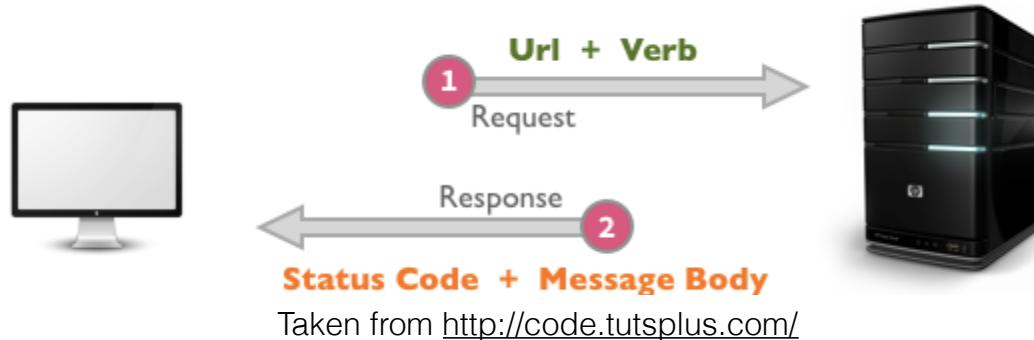
# HTTP requests

- Request messages are at the heart of web communications using HTTP
- These messages are sent using URLs (Uniform Resource Locators)



# HTTP

- “The first version of the protocol had only one method, namely GET, which would request a page from a server. The response from the server was always an HTML page.” (T. Berners-Lee)



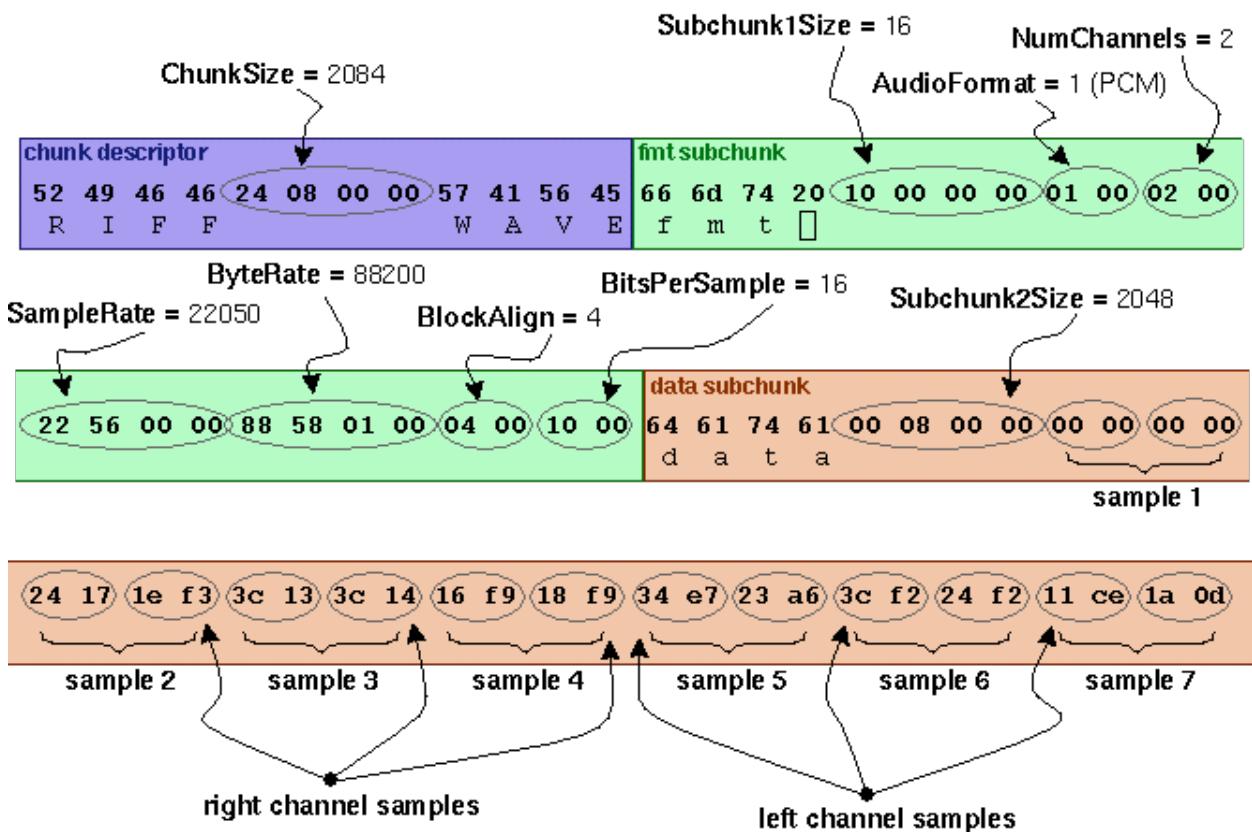
- However, these days there are some other HTTP “verbs” that allow us to perform other actions on resources:
  - GET: fetch an existing resource
  - POST: create a new resource
  - PUT: update an existing resource
  - DELETE: delete an existing resource

# Sound file formats

- Broadly speaking, sound content is delivered in two format categories:
  - As **structured audio**
    - Sounds are generated in a dynamic manner at runtime
    - MIDI, MODs (e.g., trackers)
  - As **recorded sound**:
    - often called *waveform* sound
    - audio data can be stored in
      - **uncompressed** formats
      - **compressed** formats
        - **Lossy** formats
        - **Lossless** formats

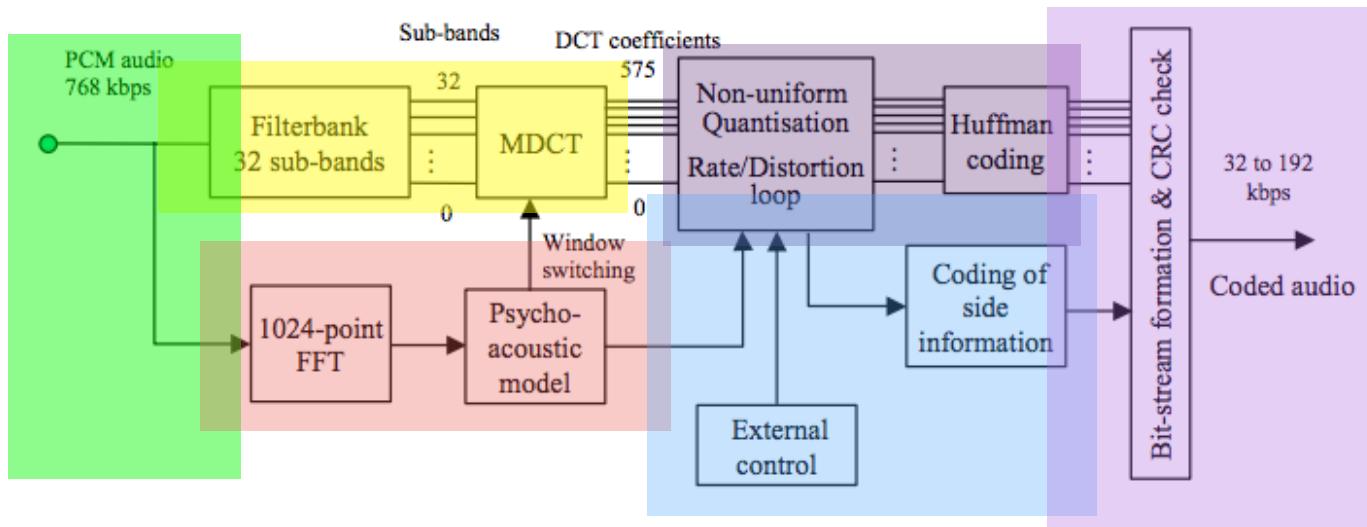
# Uncompressed formats

## The Canonical WAVE file format



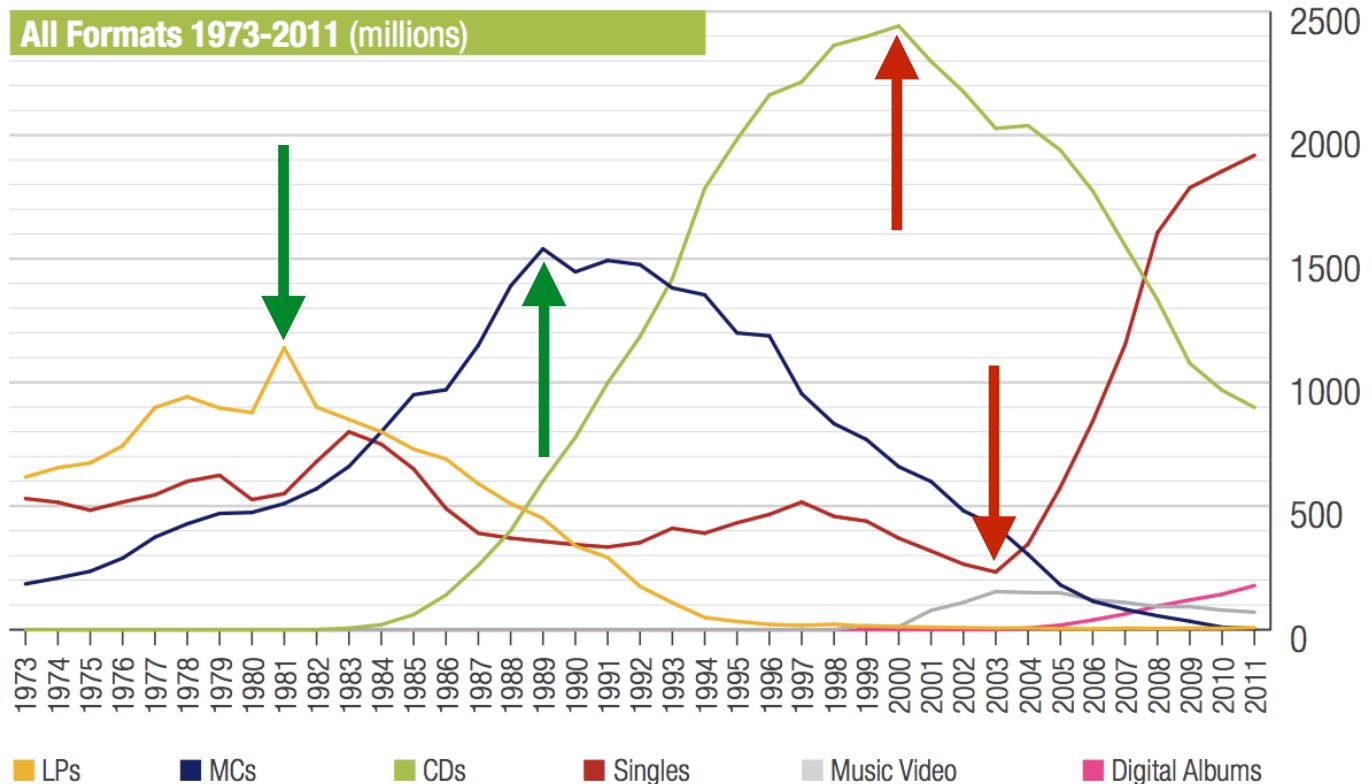
Taken from <http://soundfile.sapp.org/doc/WaveFormat/>

# MPEG-1 Layer-3 encoder diagram



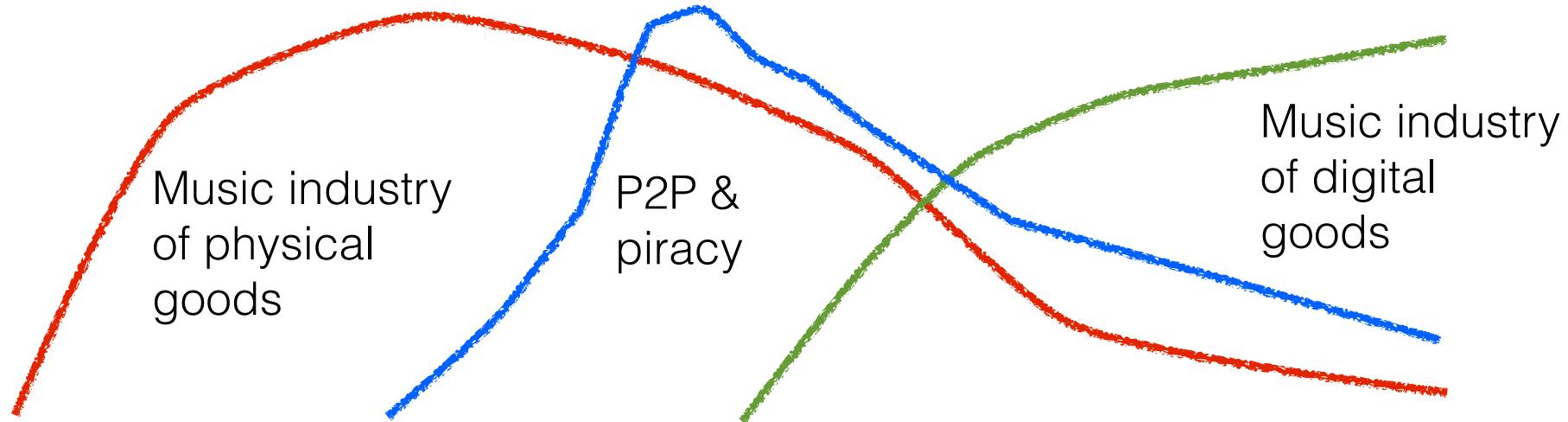
Taken from [Brandeburg, K. 1999. MP3 and AAC explained. In Proceedings of the AES 17th International Conference on High Quality Audio Coding](#)

# Global music sales by format



Taken from [Record Industry in Numbers 2011 \(IFPI\)](#)

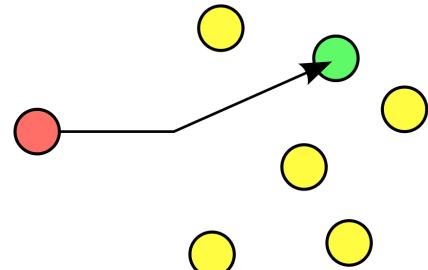
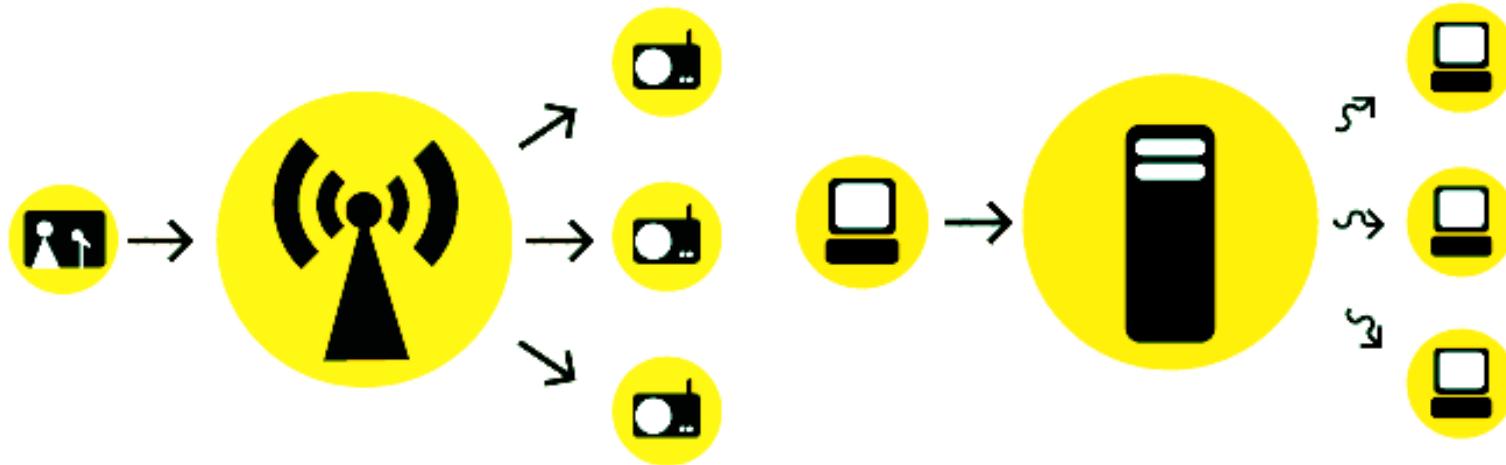
# Music industry



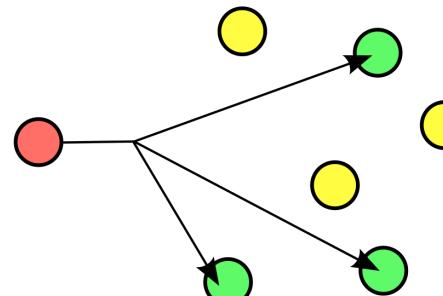
# Digital music distribution models

- Music stores (buy to own)
- Music tracks are delivered online
- Music locker (cloud based)
- Music streaming via subscription

# Internet Radio broadcasting



Unicast: Sends IP packets to identified recipients on a network, with added bandwidth



Multicast: sends IP packets to a group of hosts on a network, with no added bandwidth, and not requiring prior knowledge of who or how many receivers there are.

# Mid-term potential questions

## Class 7

- Music recommendation systems
  - How does content-based recommendation work?
  - How does collaborative filtering recommendation work?
- Internet radio:
  - Differences between unicast and multicast streaming?

## Class 6

- Music streaming services
  - Differences and similarities between music streaming services.

## Class 5

- Music distribution
  - In the context of music sales, the year 2000 has been established as an inflection point, in which the ever-growing music industry stop its growth. Explain what happened year, and how the music industry changed.
  - How the music industry recovered from the inflection point established in the year 2000?
- Digital music distribution models
  - Provide the characteristics of the different current models of digital music distribution

## Class 4

- Sound file formats
  - What is the main difference between "structured audio" and "recorded sound." Provide at least one name of a structured audio file format.
  - What are the main differences between lossy and lossless compression?
  - Provide an explanation about the perceptual model in which MPEG-3 Layer 1 is based

## Class 3

- Internet technologies
  - Explain briefly how does Ethernet work
  - What is the Internet Protocol Suite (TCP/IP)
  - What is a port in the context of computer networking?
  - Can you explain the five constituent parts in this URL:
    - <http://www.domain.com:1234/path/to/resource?a=b&x=y>

## Class 2

- Internet, WWW, and HTML
  - Explain the difference between the Internet and the web (WWW)
  - Explain what is HTML

## Class 1

- The old and the new music industry
  - Explain the tensions between the new and the old music industry in terms of
    - connectivity vs. control
    - service vs. product

# Potential final projects

- History of the recording industry in the age of the Internet
- Statistical / historical analysis of music industry based on web-based data
- Study of international music copyright laws
- Substantial music composition (20-30 min) strictly using web resources with substantial write up (2-3 pages)
- Comprehensive comparison of on-demand music streaming services
- Music recommendation site
- Music playlist maker