# Diversity by Design in Music Recommender Systems

29/03/2022 Computer Music Group - IME/USP

**Lorenzo Porcaro**
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# Outline

1. Music, diversity, and recommender systems (~15/20 mins)
2. Examples from the Music RS literature (~15/20 mins)
3. Q&A

*Porcaro, L., Castillo, C. and Gómez, E., 2021. Diversity by Design in Music Recommender Systems Transactions of the International Society for Music Information Retrieval, 4(1), pp.114–126. DOI: http://doi.org/10.5334/tismir.106*

# About me

- Background in Applied Mathematics (“La Sapienza” University of Rome)
- Specialized in Sound and Music Computing & Intelligent Interactive Systems (Universitat Pompeu Fabra - UPF , Barcelona)
- Data engineer in Music Industry (SoundCloud, MonkingMe, BMAT)
- PhD in Information and Communication Technology (UPF)

# **Part 1.** Music, diversity, and recommender systems

## Más música de la que te gusta

Sugerencias basadas en lo que te ha gustado o has reproducido


Dekmantel Podcast 285 - ...
Pistas similares

JU$T (feat. Pharrell Willi...
Pistas similares


Midland - Double Feature ...
Pistas similares

## Más cosas que te van

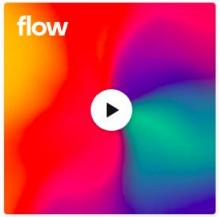
Un poco de todo, pero siempre lo que te gusta.


**Light Academia**
daydreaming, an unfinished book, soft...

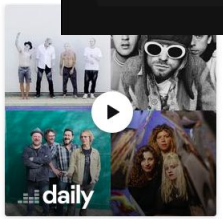

**Sad Classical**
Take comfort in these melancholy masterpieces.


**Minimalism**
Including genre-defining classics (Steve Reich, Phil...

## Solo para ti



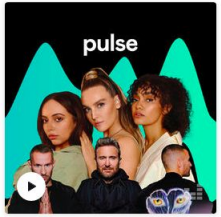

Un mix infinito de favoritos y nuevas canciones




Con Red Hot Chili Peppers, Nirvana, Mudhoney, Babes in Toyland

## Playlists que te gustarán


Vamos a la playa
50 canciones - 81.985 fans



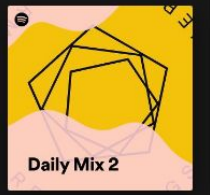

Pulse
50 canciones - 257.818 fans

## Especialmente para ti

Cuanto más escuches, mejores serán las recomendaciones.


**Descubrimiento sem...**
Tu combinado semanal de música fresca. Temas...


**Daily Mix 1**
Lo Stato Sociale, I Cani, Pino Daniele y más



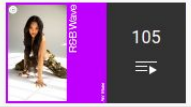

**Daily Mix 2**
Berliner Philharmoniker, Heike Matthiesen, Hélèn...

Todos | Jorja Smith | Música pop | Relacio ›


**anaiis - chuu | A COLORS ENCORE**
COLORS
261.516 visualizaciones • hace 3 semanas


**Black Pumas - Colors (Official Live Session)**
Black Pumas
116 M de visualizaciones • hace 2 años

**Mi mix**
YouTube




**R&B Wave**
YouTube Music
Actualizado hoy

When listening to music...

# Diversity

# Differences

# The MIR perspective

1. [Demographic Diversity] What is the demographic makeup of MIR as a profession?
2. [Cultural Diversity] Whose music and which music gets to be the focus of MIR's influential scientific practices?
3. [Methodological Diversity] How can MIR equip itself with epistemologies and ontologies of music responsive to a greater diversity of musical cultures?
4. [Goal Diversity] Could MIR cultivate a more plural set of orientations and institutional partners so as to include non-commercial, publicly-oriented initiatives aimed at enhancing human musical flourishing?

*Born, G. (2020). Diversifying MIR : Knowledge and Real-World Challenges , and New Interdisciplinary Futures. Transactions of the International Society for Music Information Retrieval, 3, 193–204.*
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# The Media Perspective (1/2)

Deconstructing the diversity principle:

- [Source diversity] The range of information providers
  *e.g. artists and record labels.*
- [Content diversity] The range of information provided
  *e.g. tracks, albums.*
- [Exposure diversity] The range of information accessed by people
  *e.g. what listeners choose to listen.*

*Napoli, P. M. (1999). Deconstructing the diversity principle. Journal of Communication, 49(4), 7–34.* https://doi.org/10.1111/j.1460-2466.1999.tb02815.x

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# The Media Perspective (2/2)

Diversity by design: the creation of an architecture or service that helps people to make diverse choices.

- [Individual autonomy perspective] Provide people with a tool for exploiting their interests
  *e.g. calibrated recommendations.*
- [Deliberative perspective] promote public awareness by showing divergent opinions
  *e.g. make listeners explore music far from their preferences.*
- [Adversarial perspective] enhance the visibility of underrepresented opinions
  *e.g. promote underrepresented groups e.g. subcultures or non-mainstream musical styles.*

*Helberger, N. (2011). Diversity by design. Journal of Information Policy, 1(2011), 441–469.* https://doi.org/10.5325/jinfopoli.1.2011.0441
*Helberger, N., Karppinen, K., & D'Acunto, L. (2018). Exposure diversity as a design principle for recommender systems. Information Communication and Society, 21(2), 191–207. https://doi.org/10.1080/1369118X.2016.1271900*

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# Echo Chambers

# Filter Bubbles

# Cyber balkanization

# Music recommendation algorithms are unfair to female artists, but we can change that

Representation of women & gender minorities in the music industry is low, and streaming services mimic this bias

COUNTRY

## Martina McBride 'Felt Like We'd Been Erased' When Spotify Didn't Recommend a Single Female Country Artist

By **Annie Reuter**
9/16/2019

https://www.billb

# Why Spotify's music recommendations always seem so spot on

**Spotify knows what you like to hear, and isn't afraid to tell you.**

[redacted]

The Youtube algorithm is becoming scarily good at recommending your next listen. I, for one, welcome our new overlord.

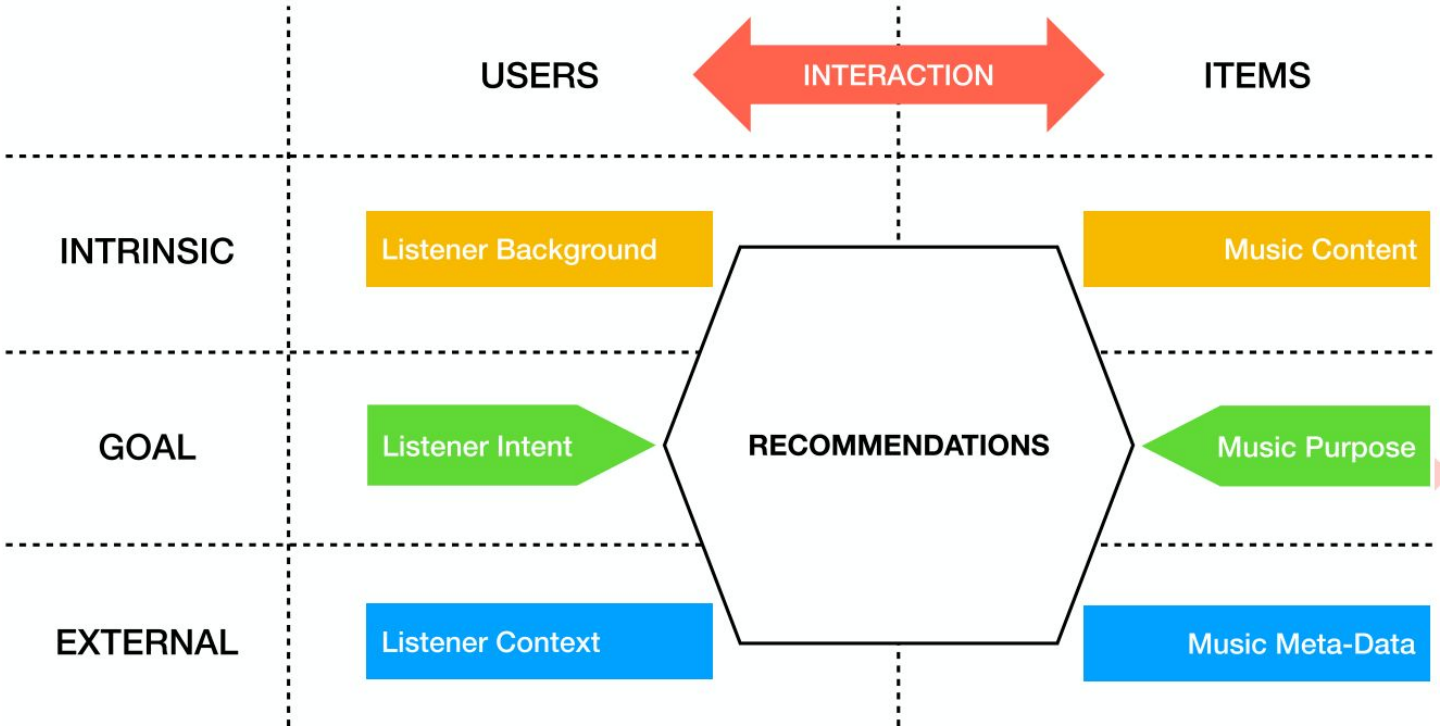
33

Comments 1K

Shout out to the YouTUbe algorithm for bringing us here. We have similar tastes? I think.

# **Part 2.** Examples from the Music RS literature

# The (Music) Recommender Systems Framework




*Knees, P., Schedl, M., Ferwerda, B., & Laplante, A. (2019). 9. User awareness in music recommender systems. In Personalized Human-Computer Interaction (pp. 223–252). De Gruyter Oldenbourg. https://doi.org/doi:10.1515/9783110552485-009*

**Semiology ("study of signs")** →Discipline that studies the phenomena of signification and communication.

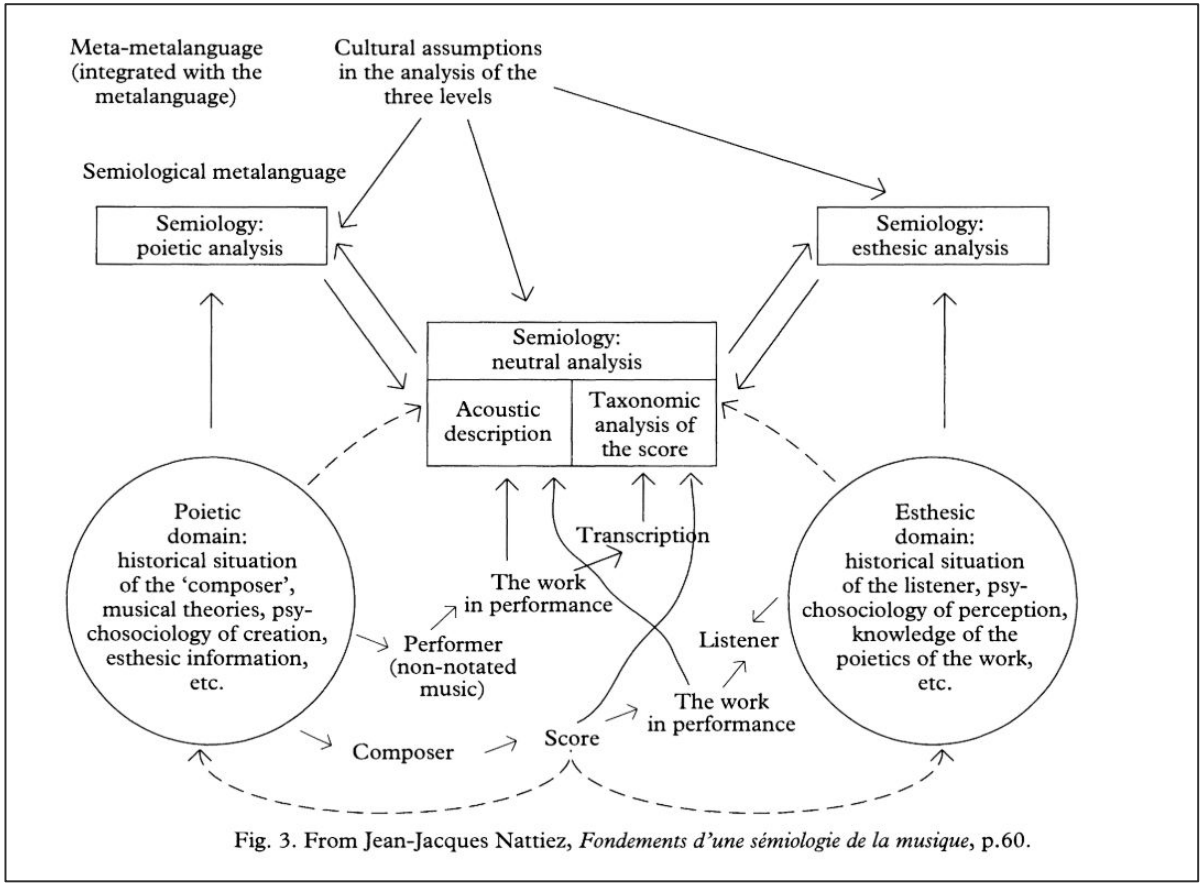
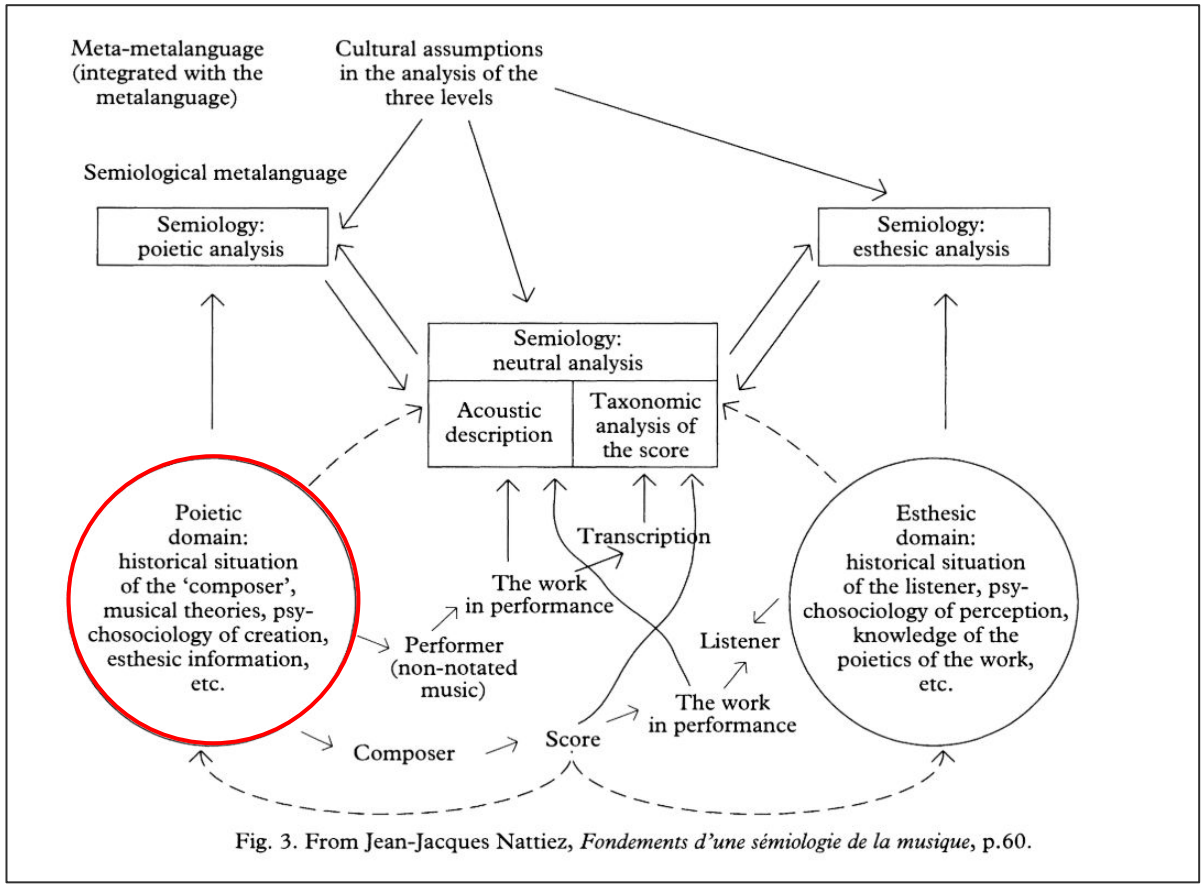



Fig. 3. From Jean-Jacques Nattiez, *Fondements d'une sémiologie de la musique*, p.60.

*Molino, J., & Ayrey, C. (1990). Musical Fact and the Semiology of Music. Music Analysis, 9(2), 105–111; 112–156.*

# Poietic Domain (from Greek: poiētikós, 'creative') - The Item Side

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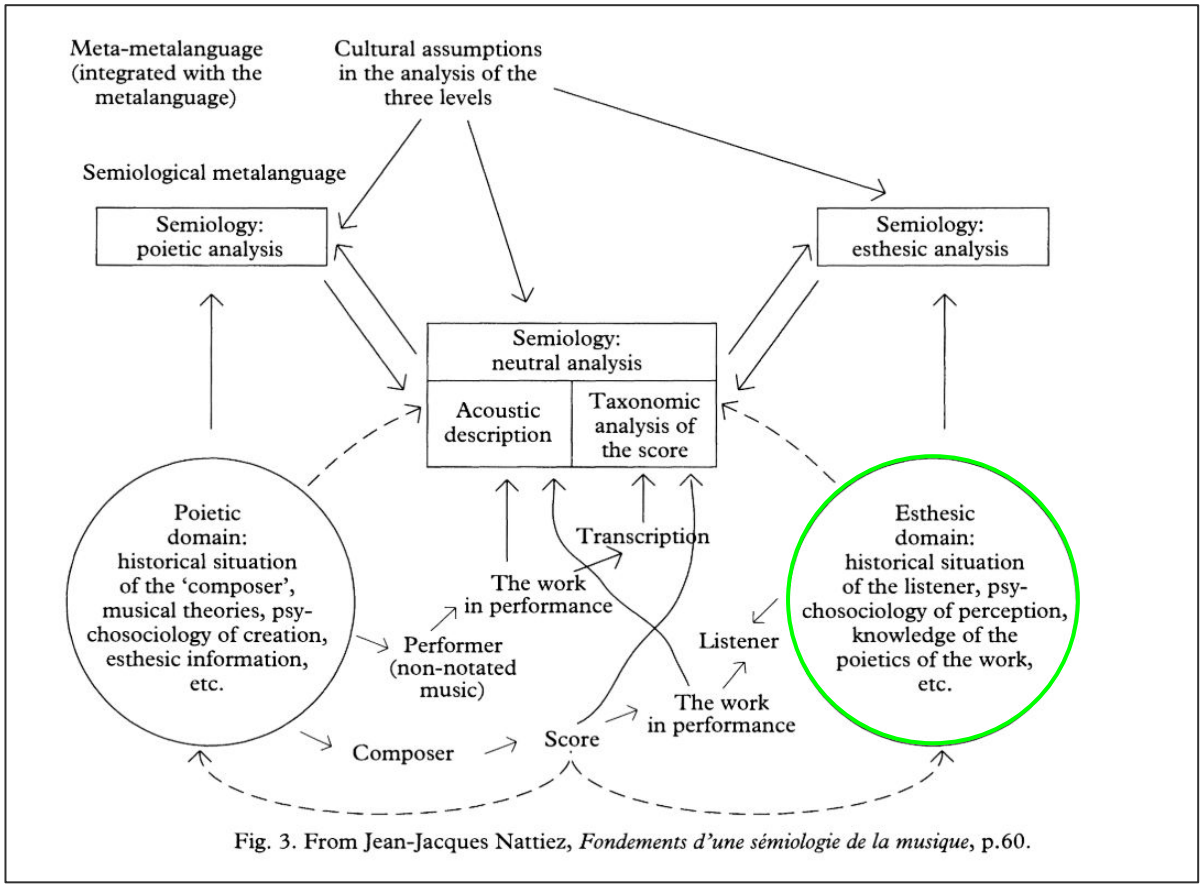
# Esthesic domain (from Greek: aísthēsis, 'perception') - The User side

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# Poietic Domain - the Item side

Diversity as the count of different items with which users interact.

$$diversity_u = \frac{total\ number\ of\ playcounts\ of\ u}{|unique\ items\ u\ listened\ to|}$$

$$diversity_u = |unique\ genre\ tags\ that\ describes\ u\ music\ taste|$$

*Schedl, M., & Hauger, D. (2015). Tailoring Music Recommendations to Users by Considering Diversity, Mainstreaminess, and Novelty. Proceedings of the 38th International ACM SIGIR Conference on Research and Development in Information Retrieval, 947–950. https://doi.org/10.1145/2766462.2767763*

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**Pro: Not complex formulation and relatively simple implementation.**

**Cons: No use  of any additional features to differentiate between items.**

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# Poietic Domain - the Item side

Diversity as distribution of the user-item interactions + distance spaces containing additional information.

*Rao-Stirling Index:*

- *$p_i$ and $p_j$ := fraction of streams from genres i and j*
- *d(i, j) := dissimilarity of the two genres*
- *K := genres listened to by a user*

$$d_{RS}(p) = \sum_{i,j \in K} p_i \times p_j \times d(i,j)$$

*Stirling, A. (2007). A general framework for analysing diversity in science, technology and society. Journal of The Royal Society Interface, 4(15), 707–719. https://doi.org/10.1098/rsif.2007.0213*

*Way, S. F., Gil, S., Anderson, I., & Clauset, A. (2019). Environmental Changes and the Dynamics of Musical Identity. Proceedings of the International AAAI Conference on Web and Social Media, 1–10. http://arxiv.org/abs/1904.04948*

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**Pro: Items' fine-grained features for estimating diversity.**

**Cons: Expensive in terms of data and computational resources.**

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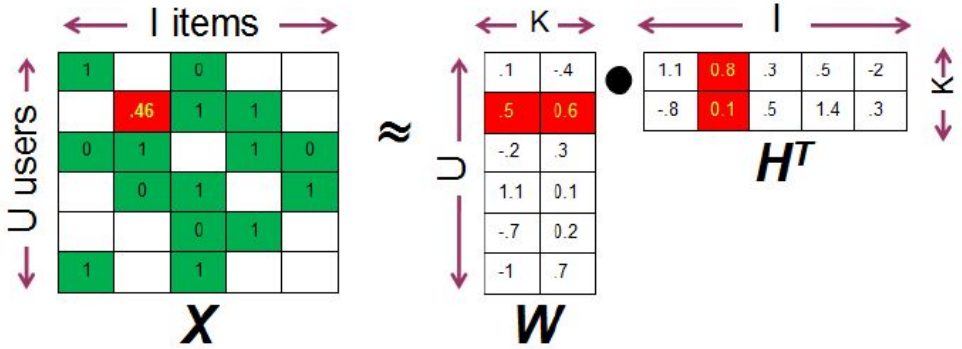
# Poietic Domain - the Item side

Diversity as the distance between item vectors in the Matrix Factorization space.

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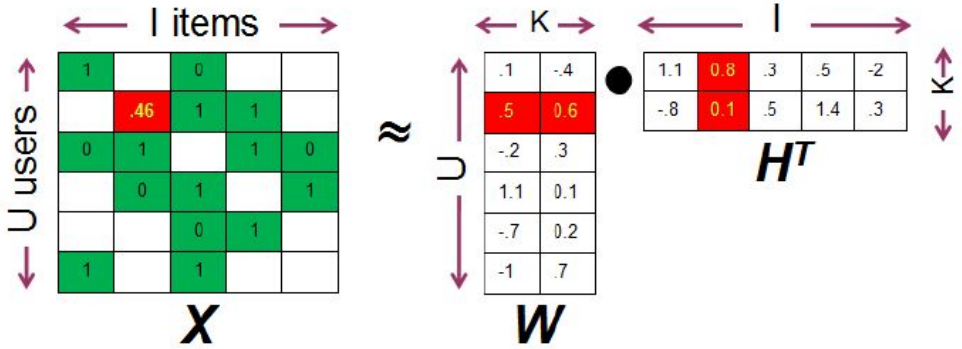


**Pro: Required only the user-item interaction matrix.**

**Cons: Little interpretability of the latent space.**

*Ferwerda, B., Graus, M. P., Vall, A., Tkalcic, M., & Schedl, M. (2017). How item discovery enabled by diversity leads to increased recommendation list attractiveness. Proceedings of the ACM Symposium on Applied Computing, 1693–1696. https://doi.org/10.1145/3019612.3019899*

# Poietic Domain - the Item side

- Measuring item diversity connected with the users' behaviours (*exposure diversity*).
- *Content* and *source diversity* considered in works centered on music lists (e.g. playlists).
- *The user is left aside*!
  Grouping users by their diversity = grouping them by the diversity of the items they consumed.

# Esthetic domain – the User side *(Individual aspects)*

**Personality traits** → Big Five personality traits (OCEAN):

- **O**penness to Experience
- **C**onscientiousness
- **E**xtraversion
- **A**greeableness
- **N**euroticism

*McCrae, R. R., and John, O. P. (1992). An introduction to the five-factor model and its applications. Journal of Personality, 60(2): 175–215. DOI: https://doi.org/10.1111/j.1467-6494.1992.tb00970.x*

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"conscientious participants are increasingly satisfied when provided a higher degree of diversity"

*Ferwerda, B., Graus, M., Vall, A., Tkalcic, M., & Schedl, M. (2016). The influence of users' personality traits on satisfaction and attractiveness of diversified recommendation lists. Proceedings of the 4th Workshop on Emotions and Personality in Personalized Systems (EMPIRE), at the 10th Conference on Recommender Systems (RecSys), 1680, 43–47.*

*McCrae, R. R., and John, O. P. (1992). An introduction to the five-factor model and its applications. Journal of Personality, 60(2): 175–215. DOI: https://doi.org/10.1111/j.1467-6494.1992.tb00970.x*

# Esthetic domain – the User side *(Individual aspects)*

## Personal values

Conservation (*caring about one's safety in every aspects of one's life*)
Openness to Change (*caring about independence and discovery*)
Self-Transcendence (*caring for the world*)
Self-Enhancement (*caring for oneself*)
Hedonism

*Manolios, S., Hanjalic, A., & Liem, C. C. S. (2019). The influence of personal values on music taste: Towards value-based music recommendations. Proceedings of the 13th ACM Conference on Recommender Systems (RecSys), September 2019, 501–505. https://doi.org/10.1145/3298689.3347021*

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## Musical Sophistication

Active Musical Engagement (*how much time and money resources spent on music*)
Self-reported Perceptual Abilities (*accuracy of musical listening skills*)
Musical Training (*amount of formal musical training received*)
Self-reported Singing Abilities (*accuracy of one's own singing*)
Sophisticated Emotional Engagement with Music (*ability to talk about emotions that music expresses*)

*Ferwerda, B., & Tkalčič, M. (2019). Exploring online music listening behaviors of musically sophisticated users. ACM UMAP 2019 Adjunct - Adjunct Publication of the 27th Conference on User Modeling, Adaptation and Personalization, 33–37. https://doi.org/10.1145/3314183.3324974*

# Esthetic domain – the User side *(Individual aspects)*

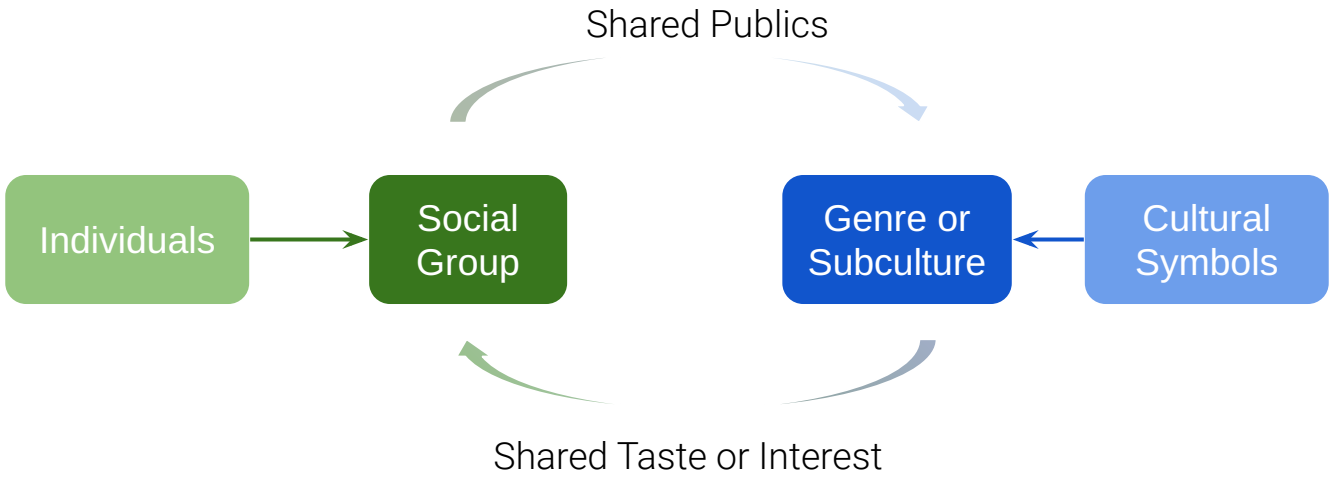
**metric-based diversity**

*extractable by algorithmic processes*

**perceived diversity**

*how people evaluate a degree of diversity*

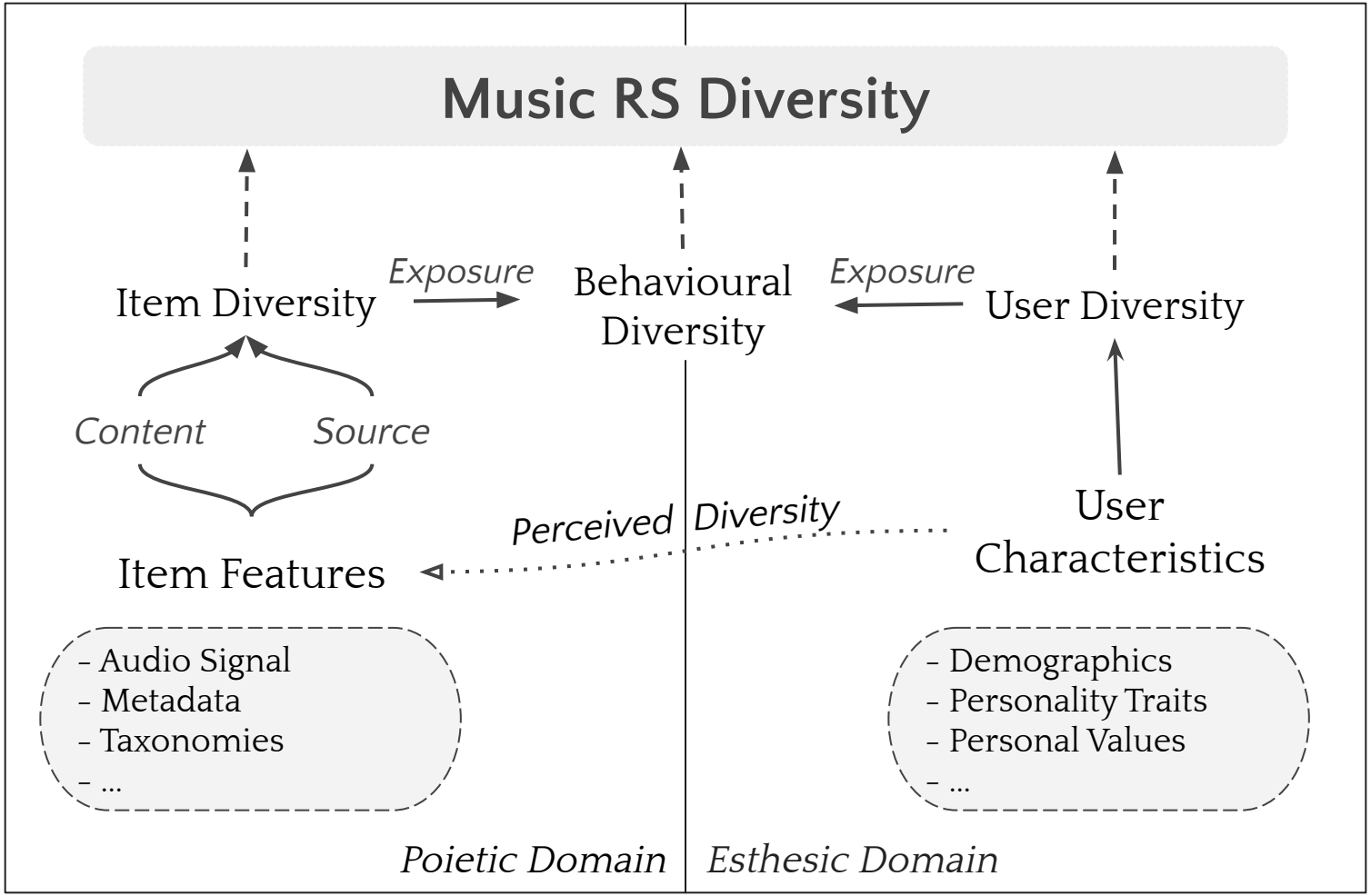
# Esthetic domain – the User side *(Collective aspects)*




*DiMaggio, P. (2011). Cultural networks. In Scott, J. and Carrington, P. J., editors, The Sage Handbook of Social Network Analysis, pages 286–310. SAGE Publications. DOI: https://doi.org/10.4135/9781446294413.n20*

# Esthetic domain – the User side *(Collective aspects)*

- Lack of data publicly available:
  - Demographic information (Cross-country analysis)
    *e.g. Ferwerda, B., Vall, A., Tkalcic, M., & Schedl, M. (2016). Exploring Music Diversity Needs Across Countries. Proceedings of the 2016 Conference on User Modeling Adaptation and Personalization (UMAP '16), 287–288. https://doi.org/10.1145/2930238.2930262*
  - Socio-economic factors (Sociological-informed analysis)
    *e.g. Park, M., Weber, I., Naaman, M., & Vieweg, S. (2016). Understanding Musical Diversity via Online Social Media. Proceedings of the 10th International AAAI Conference on Web and Social Media (ICWSM'16). http://arxiv.org/abs/1604.02522*


Music RS Diversity
Item Diversity
Exposure
Behavioural Diversity
Exposure
User Diversity
Content
Source
Perceived Diversity
Item Features
User Characteristics
- Audio Signal
- Metadata
- Taxonomies
- ...
- Demographics
- Personality Traits
- Personal Values
- ...
Poietic Domain
Esthesic Domain

Those who study music should be concerned about the loss of cultural diversity for the same reason that biologists worry about the loss of biodiversity: we don't yet know what the loss will mean, but we do know that the loss will be irreversible.

*Huron, D. (2004). Issues and Prospects in Studying Cognitive Cultural Diversity. Proceedings of the 8th International Conference on Music Perception & Cognition.*

# Diversity by Design in Music Recommender Systems

29/03/2022 Computer Music Group - IME/USP

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