Stylistic evolution in networks: delayed dynamics in genre emergence

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Mathematical network model of style hybridization and emergence

Motivation: emergence of hybrid musical styles or genres: jazz, Argentine tango...

Style → collection of quantifiable features. (Examples: Typical scales, melodic or rhythmic patterns, etc.)

Style hybridization → interpolation or averaging between features

What were the conditions that favored style hybridization in the origins of jazz or tango?

"Black musicians assimilated exclusively those harmonic-melodic tendencies that permitted the integration of their African traditions" (G. Schuller)

European music and Occidental Africa music easily merged because, differently than other world musics, they are very similar (Marshall Stearns)

Gunther Schuller, *Early Jazz: Its Roots and Musical Development.* Oxford University Press. 1968

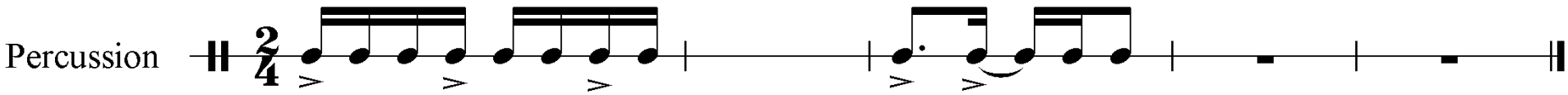
Marshall Stearns *The Story of Jazz*. Oxford University Press, 1956

Style emergence: origins of jazz

Hybridation of European and African music

Rhythm

survival of the simplest rhythmic schemas of African music in jazz (those adaptable to European rhythmic conceptions)



3+3+2 schema (bimetric African schema fitted into 2/4 schema of European marches)

Gunther Schuller, *Early Jazz: Its Roots and Musical Development.* Oxford University Press. 1968

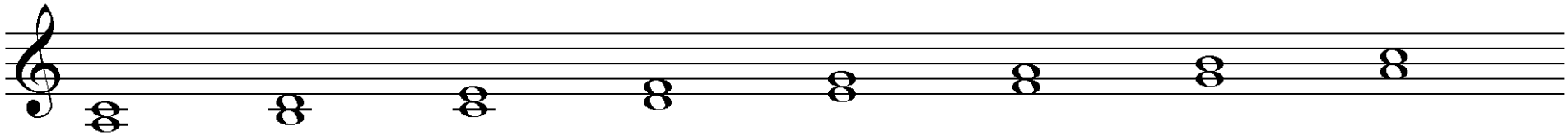
Harmony

Pentatonic African melodies fit easily into diatonic harmonic structures.

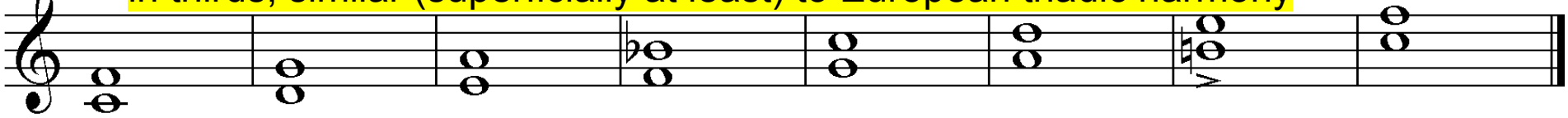
Some African melodies use diatonic scales (with a low sensible).

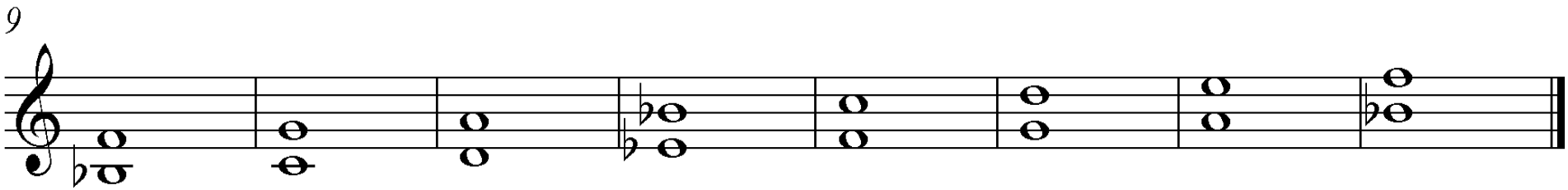
So, African melodic repertory could be retained in the framework of European harmony.

African choral singing is at the unison or diodic. Each tribe had its characteristic intervals.



Triadic intervals. Almost all Occidental Africa tribes sang at the unison or in thirds, similar (superficially at least) to European triadic harmony





Melody

African melodies tend to evolve in "melodic swirls" around a central sound.

This is coincident with the European principle of tonic priority.

Features of style hybridization

Homophily: styles influence each other only when they are sufficiently similar.

Delay: styles interact with each other not just in their present state of evolution, but also their history (the traditions) influence their present interactions.

NETWORK MODEL OF STYLE

We model style hybridization by the evolution of a network of N agents, each of which is identified by its "style" $M_i(t) \in \mathbf{R}^n$

Style is represented by a real number or n-uple of real numbers.

We assume that in a network of inter-acting agents, each agent assimilates features from their neighbors' styles. (homophily)

We will say that two agents are neighbors when their styles are numerically close to each other. Assimilation (influence, hybridization) drives them still closer.

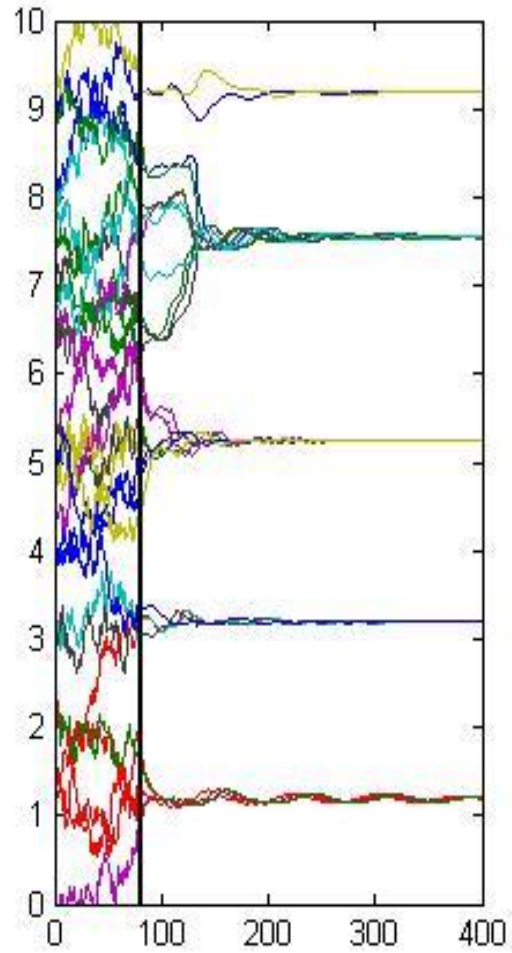
"Style" may be any quantified musical feature, one-dimensional or multidimensional. For instance, a typical scale or pitch interval, a typical rhythm pattern, the timbre of a musical instrument, or a bundle of such features.

One-dimensional model

The style of each agent is initialized randomly with uniform distribution in the interval [0,10].

The values of each agent are allowed to evolve randomly and independently during a certain time before the beginning of interactions.

After that lapse, each agent replaces its own style with an average of the styles of its neighbors.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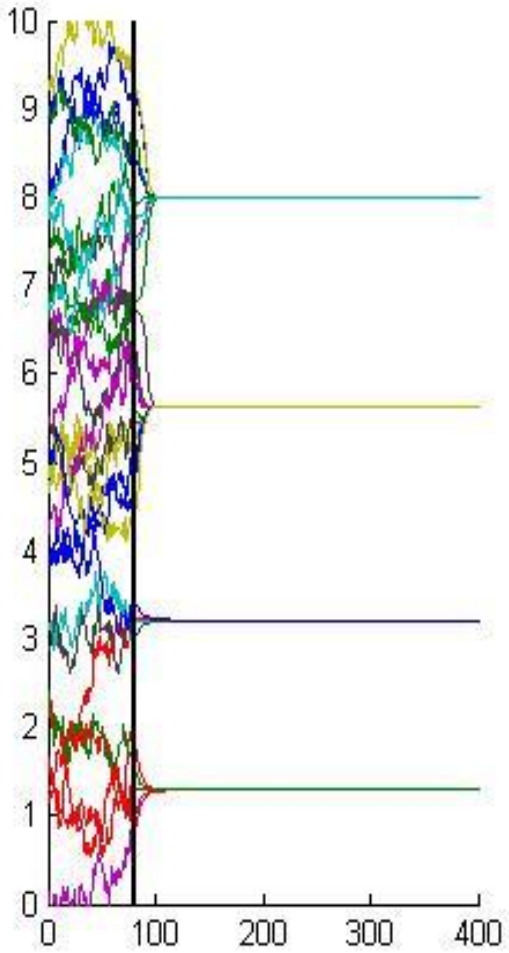
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d=80; % delay

N=90; % agent number

T=400; % evolution steps

M(i,t) is the "style" of agent i at time t

M(:,1)=10*rand([N,1]); % uniform random initialization in the range [0 10]

D=randi([0 d],N,1); %variable delays, a different delay for each agent (many delay options here)

(at each interaction, each agent uses elements from different epochs (or the whole) of its tradition)

initialization

```
for t=2:d;
    M(:,t)=max(0,min(M(:,t-1)+(rand([N,1]) -0.5)./(N^(0.3)),10));
end
%random trajectory with normal distribution of steps

MM=M;
```

```
for t=d+1:T;
for i=1:N;
    for j=1:N;
%model with delay
if abs(M(i,t-1)-M(j,t-1))<=1
          G(i,j)=(M(j,t-D(j,t))-M(i,t-1));
        end
%model without delay
if abs(MM(i,t-1)-MM(j,t-1))<=1
GG(i,j)=(MM(j,t-1)-MM(i,t-1));
         end
```

→ homophily

```
for k=1:N;
            M(k,t)=M(k,t-1)+(sum(G(k,:)))/N;
               MM(k,t)=MM(k,t-1)+(sum(GG(k,:)))
/N;
   end
```

Stylistic clusters

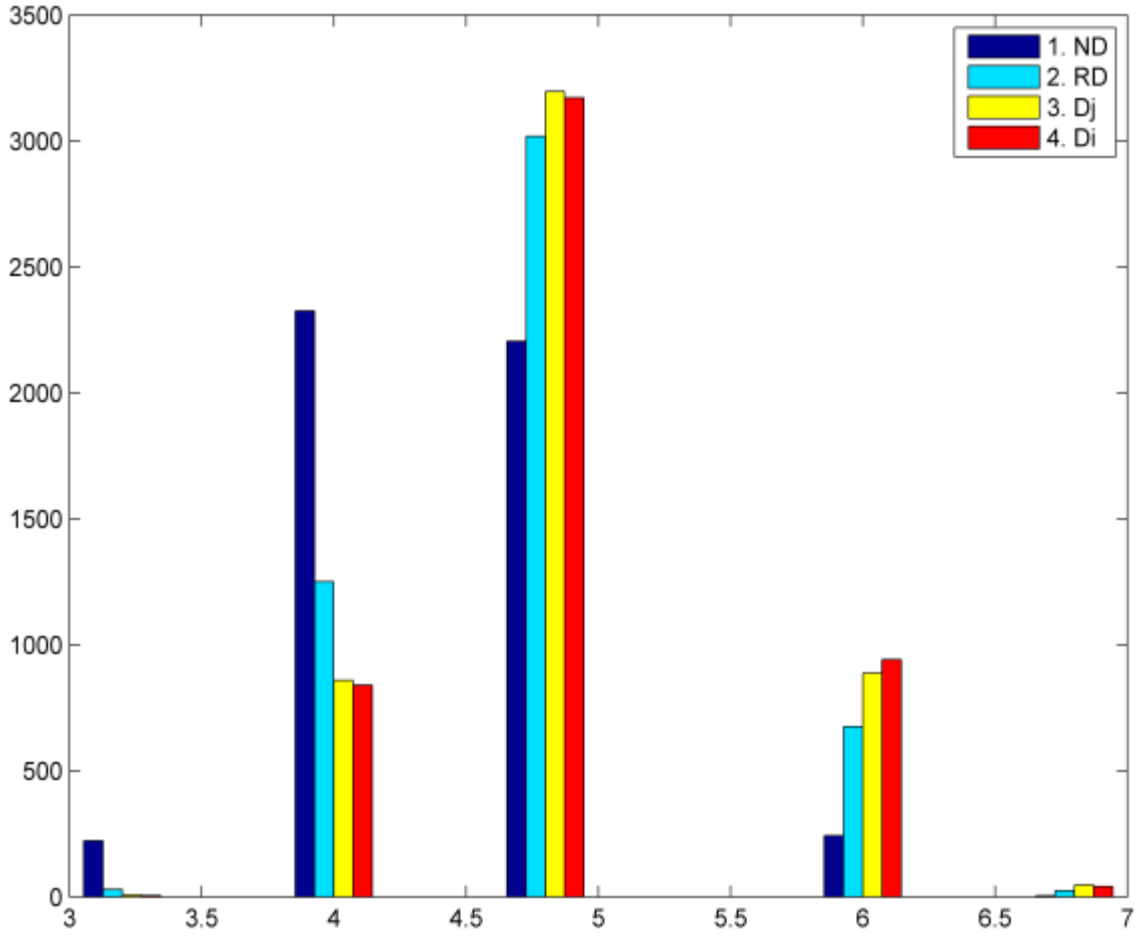
The process of hybridization results in a number of clusters. (isolated groups of agents that interact only with themselves).

The clusters are the emergent genres.

Number of clusters: genre diversity

Some statistics on the number of clusters in the delayed and undelayed models:

Statistics, 5000 simulations



Means, medians and modes for each of the models

MODEL	1. ND	2. RD
MEAN	4.49	5.02
MEDIAN	4	5
MODE	4	5

median styles with delay =5

std=2.1

median styles without delay = 4

std=2.1

in nearly 60 % of the cases there is more diversity in the delayed case. The other way around happened less than 5% of the times.

Heterophily

While interacting with the similar, prefer those less similar

if abs(M(i,t-1)-M(j,t-1))<=1 (interact with similars)

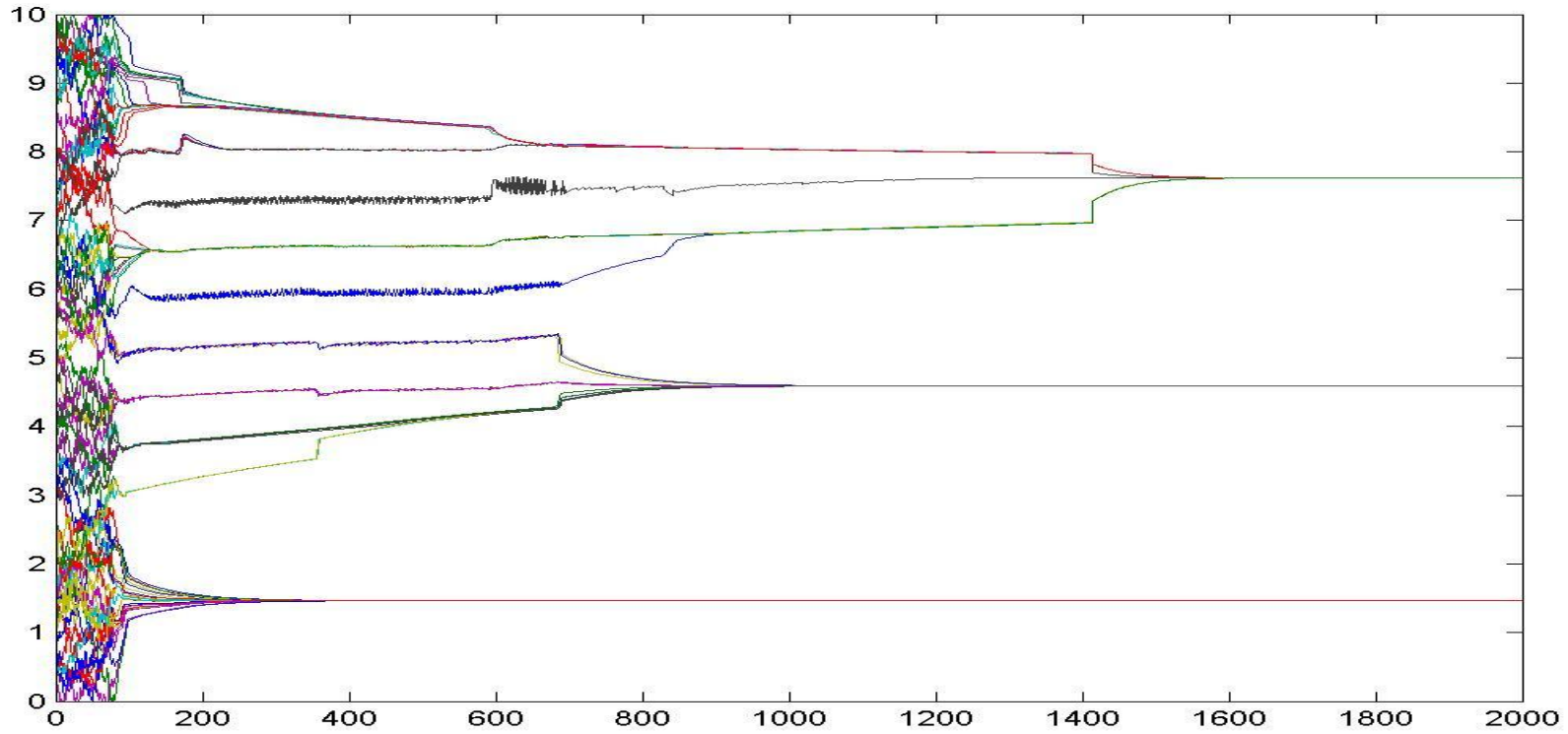
G(i,j)=(M(j,t-D(i))-M(i,t-1));

end

if abs(M(i,t-1)-M(j,t-1))<=0.5

G(i,j)=(M(j,t-D(i))-M(i,t-1))/20;(interact less with

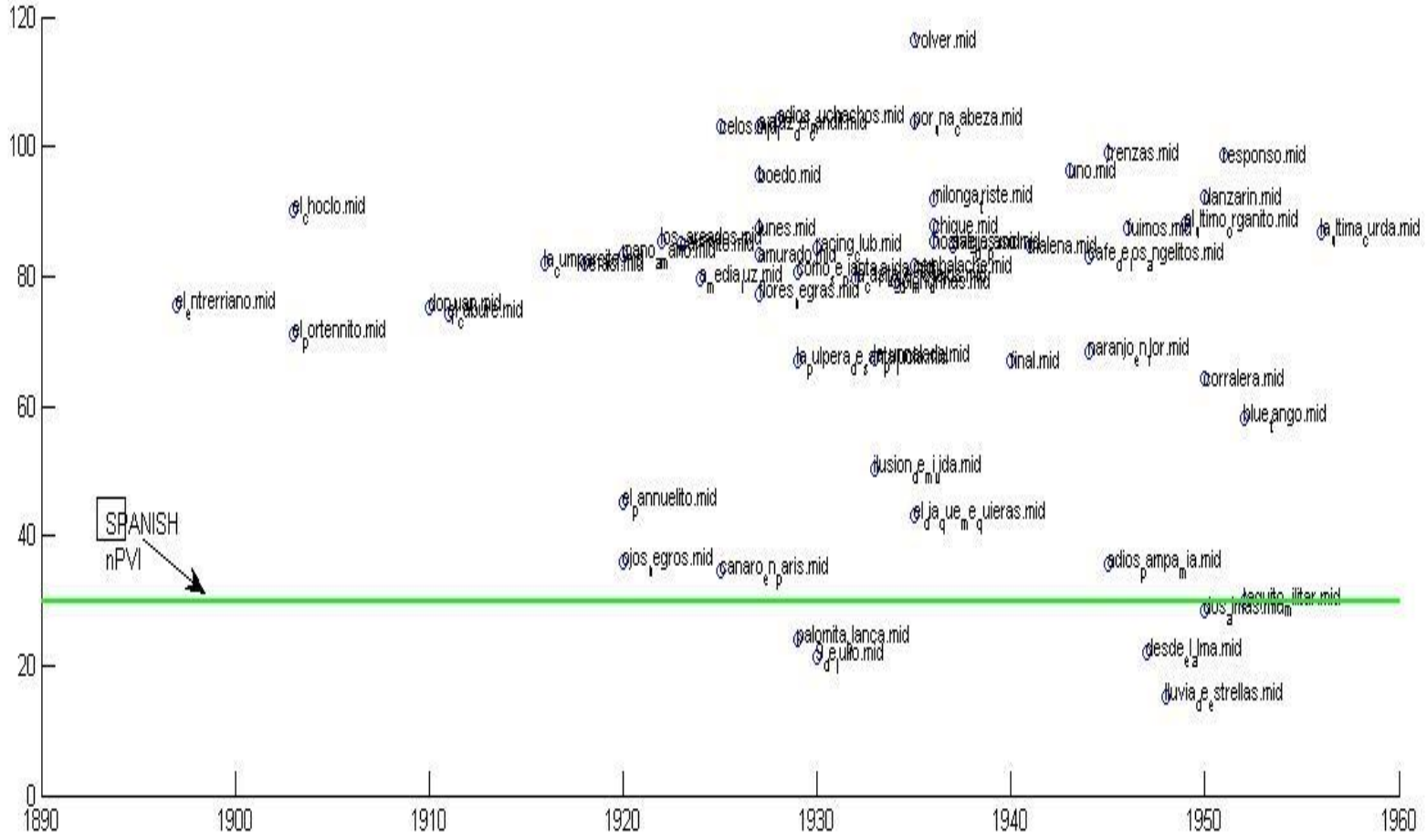
Heterophilia leads to slower convergence to a smaller number of final styles



We want to examine examples of stylistic clusters and analyze the process of their formation

for example, in the case of few emerging clusters we hypothesize small delays or heterophilic interchanges or both, etc

Example: nPVI of tangos



Thank you!!!