

Content Management for EMD: What is “Interesting” Music ?

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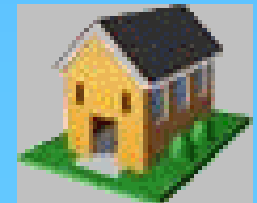
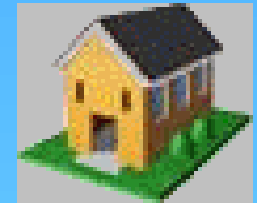
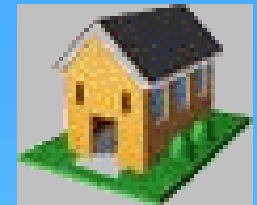
EMD: a Mapping problem

Millions of music titles, billions of users

20 million titles

1 billion users

- Sony Music:
500 K titles
- Western Music labels:
4 M
- Recorded Music:
10 M
- Indies:
10 M
- 1000 new CDs each week



EMD: a Mapping problem

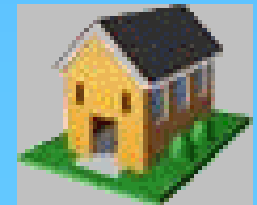
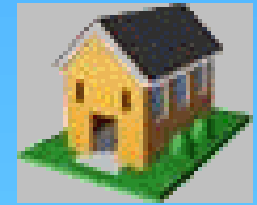
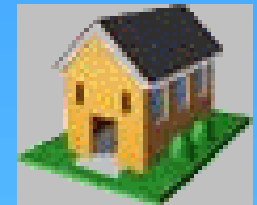
Traditional Solution

20 million titles

- Sony Music:
500 K titles
- Western Music labels:
4 M
- Recorded Music:
10 M
- Indies:
10 M
- 1000 new CDs each week

- *Tangible support (CD)*
- *Complex Dynamics*
Labels / Radios / Retailers
- *Hits phenomenon*

1 billion users



**Small subset of catalogue
actually distributed**

EMD: a Mapping problem

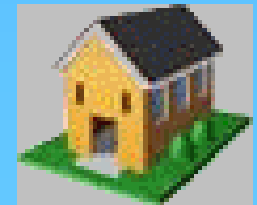
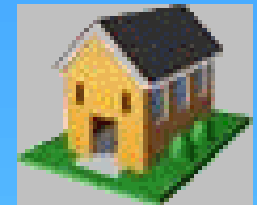
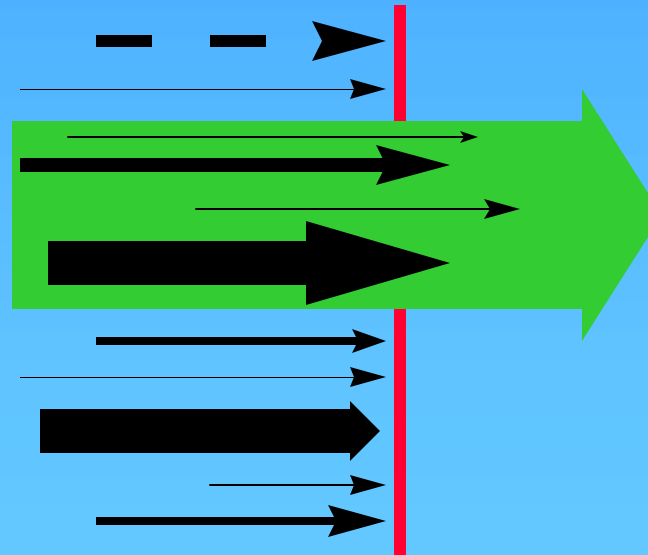
New Solution ?

20 million titles

- Sony Music:
500 K titles
- Western Music labels:
4 M
- Recorded Music:
10 M
- Indies:
10 M
- 1000 new CDs each week

*Satellite, DAB, cable,
internet, HDTV*

1 billion users



EMD: What are the Issues ?

Attention has been focused on *enabling technologies*:

- *network transmission,*
- *audio compression,*
- *copy protection,*
- *copyright management.*

Now remains the hard questions:

how to provide users with what they want ?

should EMD systems provide only music they want ?

how to attract attention of users ?

how to exploit fully catalogues ?

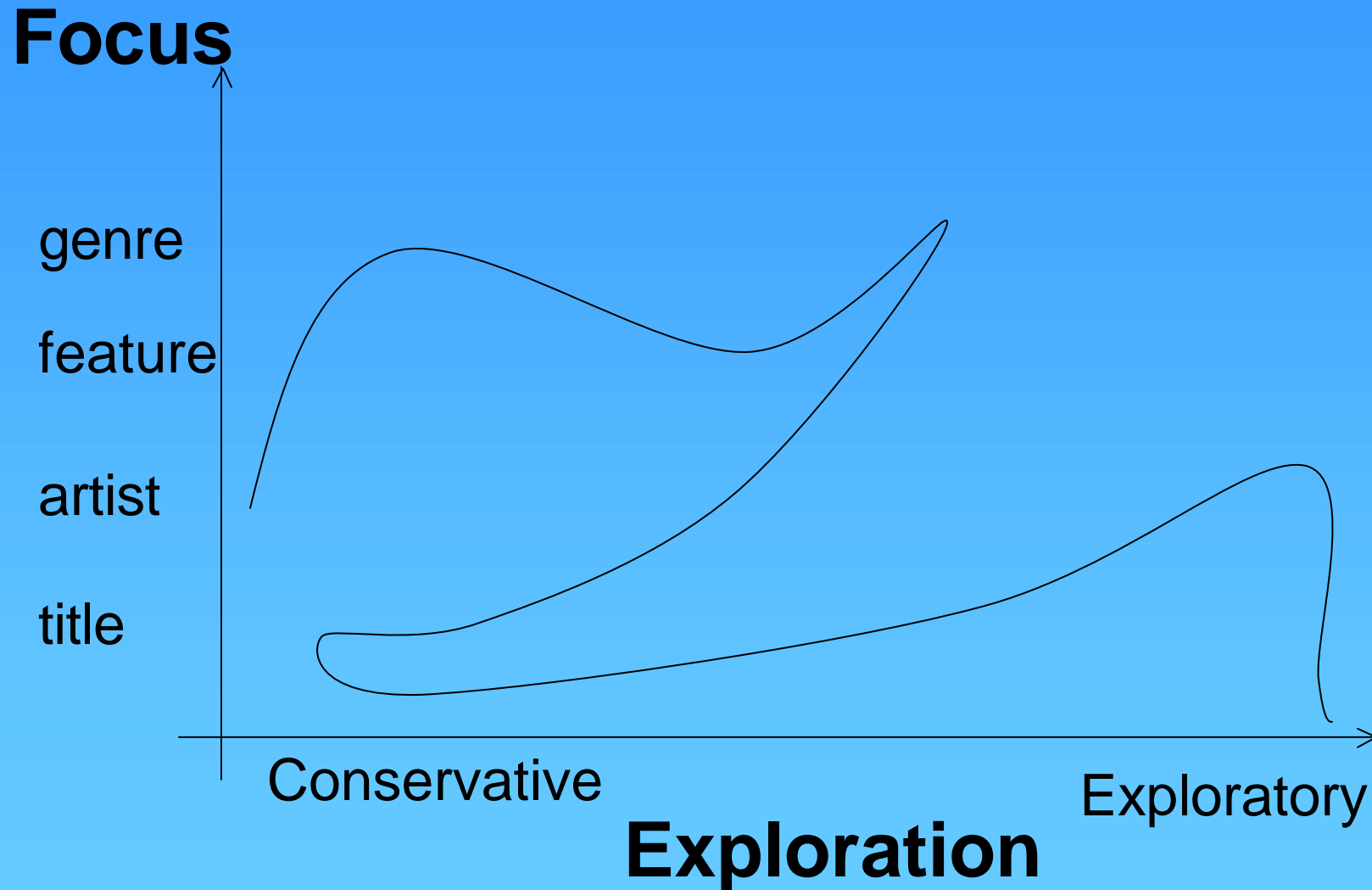
what is “interesting” music ?

Is User Requirement Possible ?

Many Individual Listening Behaviors

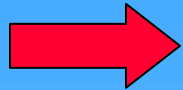
- For accessing known music:
 - support –based (SACD)
 - genre based, artist based, album-based
 - feature-based,
- For accessing unknown music: exploratory vs exclusive.
- People usually cannot explicit musical features
- Listening Behaviors change with time
 - Most people (90%) do not like novelty – at first.*
- Some behaviors are unexpected
 - *Accumulation of music never listened to (Napster)*
 - *Compulsive zapping*

User Requirements ?



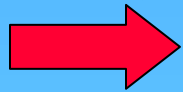
Research Areas at CSL

Features extraction - one title



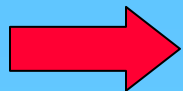
From the signal : Rhythm Extraction
From data mining : Genre Extraction

Features of *sequences of titles*



PathBuilder

User models and *exploration*



PersonalRadio

Extracting Features

2 main methods to extract features/descriptors:

signal analysis : the hard way

data mining & collaborative filtering : the easy way

Signal well adapted to low level features:

segmentation

fundamental frequency

beat tracking

Statistical analysis well adapted to high level features:

genre

clusters and similarity at the title level

Rhythm Extraction

Goal:

Extract an representation the rhythmic structure of a title

Rhythm structure made up of repeated occurrences of percussive sounds

Problem:

- *Percussive sounds are infinite, a priori unknown*
- *Percussive sounds do not fit well with spectral methods*
- *Temporal synchronization between different sounds contribute to rhythm: need to differentiate between sound classes (e.g. snare and bass drum)*

First Step

Extract occurrences of percussive events

Audio signal samples



Symbolic data: time indexes series



Descriptors

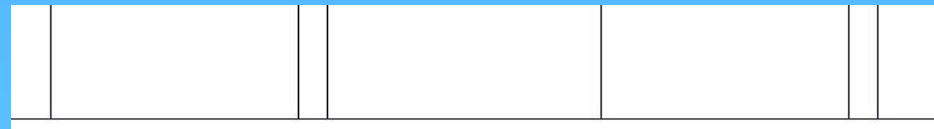
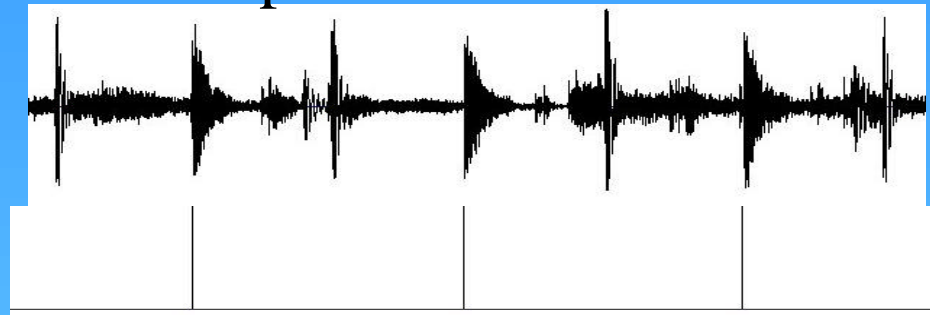
Extraction

Extract occurrences of two different percussive timbres

Two classes:

■ Snare-like sounds

■ Bass Drum-like sounds



Classification embedded in a detection scheme

Extracting Features: Genre

Genre taxonomy is necessary

No standard genre classification (Pachet 2000, RIAO)

Very difficult to extract from the signal,
easier to extract from data mining

Experiments on 3 sources of data using co-occurrence techniques

Tracks on this CD

Tears For Fears-Everybody Wants To Rule The World
 Split Enz - Message To My Girl
 Suzanne Vega - Marlene On The Wall
 Fine Young Cannibals - Suspicious Minds
 Robert Cray - Don't Be Afraid Of The Dark
 The Bluebells - Young At Heart
 James Brown - I Got You (I Feel Good)
 The Christians - Harvest Of The World
 Big Country Fields Of Fire
 Roger Daltrey - Giving It All Away
 Curiosity Killed The Cat - Down To Earth
 Was Not Was - Papa Was A Rolling Stone
 D.N.A. Featuring Suzanne Vega - Tom's Diner

Sources of data

<http://www.amazon.com/...>

...

1962-1966 : *The Red Album* by **the Beatles**

...

Disc: 2

12. **Eleanor Rigby**

...

Comment from a customer:

"Still, with just about every song here an absolute classic (the remainder are simply "great"), this essential album is as important to pop as Beethoven's symphonies and Mozart's Requiem are to classical music."

CDDB

40 M titles

Google
billions pages

Radio (Fip)
BDS (100K titles)

2:50 CUNNIE WILLIAMS	MY FATHER S WORDS
2:54 GIL SCOTT HERON	NEW YORK CITY
2:59 STEELY DAN	GASLIGHTING ABBIE
3:05 EDDY MITCHELL	HIP HUG HER
3:10 CHRIS JOSS	THE MAN WITH A SUITCASE MUSIC
3:14 TEARS FOR FEARS	EVERYBODY WANTS TO RULE THE WORLD
3:18 NEY MATOGROSSO	POEMA
3:22 SMADJ GLOGG	EQUILIBRISTE
3:27 PORTISHEAD	ONLY YOU
3:30 BOBBY WOMACK	SUMMERTIME

Data Mining and Music Genre

Data sources:

- CDDDB
- Radio Programs
- The Web (Google)

Co-occurrence: two items appear in a same context.

- Co-occurrence matrix

$C(i, j)$ = nb of times T_i and T_j appeared together

- Similarity matrix $Sim(T^1, T^2) = \sum_i T_i^1 \cdot T_i^2$

- PCA and clustering performed

Data Mining and Music Genre (Ctd)

Preliminary results

- CDDB and Google produce almost systematically:
 - *Artist clustering*
 - *Main genre clustering*
- Need large databases to produce relevant information (over 5000)
- Radio does not produce artist and genre clustering, but does produces unexpected (interesting) relations between titles:
 - *Covers:*
 - “Lady Madonna” / Baroque ensemble close to
 - “Ticket to Ride” / The Beatles
 - *Timbral similarity*
 - “Eleanor Rigby” and a Haydn String quartet
 - *Content of lyrics*
 - “Kiss – Prince” and “Le baisser / A. Souchon”

Google clustering

** (25, 97)
**** (51, 75)
***** Midnight Mood / Wes Montgomery
***** (51, 51)
***** Body and Soul / Jim Hall
***** Girl from ipanema / Stan getz
**** (25, 90)
***** (34, 38)
***** california girls / The Beach Boys
***** (34, 34)
***** Good vibrations / The Beach Boys
***** God only knows / The Beach Boys
***** (25, 79)
***** (25, 54)
***** (25, 25)
***** Michelle / The Beatles
***** Music / Madonna
***** (34, 34)
***** All you need is love/The Beatles
***** Eleanor rigby / The Beatles
***** (67, 67)
***** Goldeneye / Tina Turner
***** Requiem / Mozart

CDDB clustering

** (0, 100)
**** (5, 100)
***** (13, 13)
***** Music / Madonna
***** Goldeneye / Tina Turner
***** (5, 28)
***** All you need is love / The Beatles
***** (5, 5)
***** Michelle / The Beatles
***** Eleanor rigby / The Beatles
**** (0, 100)
***** (14, 72)
***** Girl from ipanema / Stan getz
***** (14, 19)
***** God only knows / The Beach Boys
***** (14, 14)
***** Good vibrations / The Beach Boys
***** california girls / The Beach Boys
***** (0, 100)
***** Requiem / Mozart
***** (0, 0)
***** Body and Soul / Jim Hall
***** Midnight Mood / Wes Montgomery

Music retrieval: the sequence approach

Rationale:

- Music listening is rarely performed on individual titles
But rather by sequences: radio, concert, album, etc.
- Querying titles is possible only for titles you know how to describe) : the *language mismatch* problem

Idea: specify properties of the music *sequences* instead of properties of individual titles.

Solve the related combinatorial problem and let the system chose the items

Which properties ? How to solve the combinatorial problem ?

Musical descriptors ?

Low-level: Mpeg-7 (e.g. spectral centroid, segmentation)

High-level:

- *Energy*
- *Tempo*
- *Genre*
- *Rhythm type*
- *Voice type*
- *Main instruments*
- *Configuration*
- *Danceability ...*

Mpeg7 : Spectral Descriptors

- Spectral Envelope
- Spectral Envelope of Sinusoidal Component
- Spectral Envelope of Stochastic Component
- Spectral Centroid
- Spectral Tilt
- Noise Shape
- Harmonic Distortion
- Harmonics Odd/Even ratio
- Harmonic/noise cutting frequency

The Database (excerpt)

1 It's only make believe

Mc Dovell / Twi Country Crooner 231s slow low-pitched Two men calif guitar strings

2 Take it to the limit

W. Nelson / Jen Country Blues 229s slow nasal Two men piano harmonica

3 Sunrise

Atkins Chet Jazz Calif 250s slow fast instrumental Instrumental jazz guitar strings

4 Cricket Ballet (The)

Atkins Chet Jazz Calif 211s fast slow instrumental Instrumental jazz guitar funk bass

5 Don't give up

Nelson W. / O' Country Pop 290s slow nasal Man/Wom acoustic guitar harmonica

6 Still is still moving to

Nelson Willie Country Calif 210s fast nasal Man calif guitar calif guitar

7 Jukebox Junkie

Mellons Ken Country Swing 162s very fast low-pitched Man violin calif guitar

8 Little Rock

Raye Colin Country Pop 237s slow normal Man piano strings

9 Not a moment too soon

Mac Graw Tim Country Calif 222s slow fast hoarse Man calif guitar piano

10 Lovin' all night

Crowell Rodney Country Pop 227s fast normal Man calif guitar brass

11 Hard way (the)

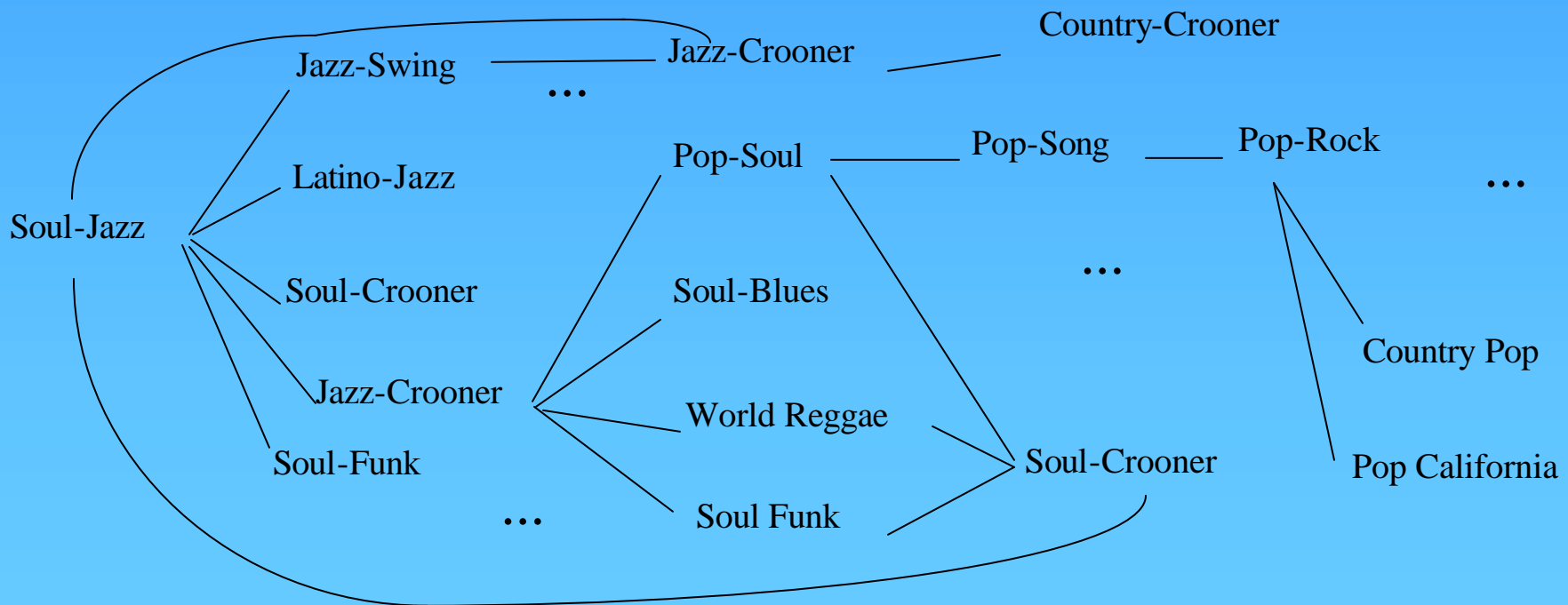
Carpenter Mary Country Pop 262s slow fast normal Woman calif guitar piano

12 Girls with guitars

Judd Winonna Country Pop 194s fast powerful Woman pop guitare piano

Classification of Music Genres

A graph of genres with 2 relations:
isA
closeTo



Example of Music Program

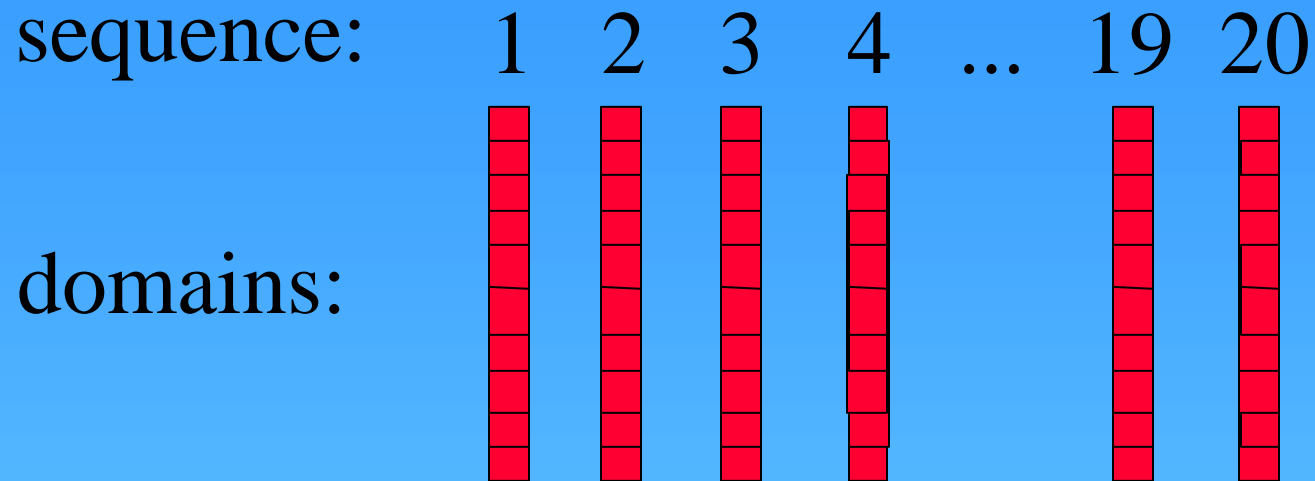
“Liner note-like” description of desired Music Program:

- *12 Titles, all different*
- *Styles are close to their neighbors*
- *No slow/very slow tempos (Cardinality Constraint)*
- *At least 30% female-type voice*
- *At least 30% purely instrumental pieces*
- *At least 40% brass*
- *Authors are all different*
- *At most 20% “Country Pop” style*
- *One song by “Harry Connick Jr”*

A Solution

3	Sunrise	Atkins Chet	Jazz Calif	250s	slow fast
		instrumental	Instrumental	jazz guitar	strings
21	Surrounded	Kreviazuk Chant	Pop Calif	238s	slow fast
		powerful	Woman	piano	strings
6	Still is still moving to	Nelson Willie	Country Calif	210s	fast
		nasal	Man	calif guitar	calif guitar
9	Not a moment too soon	Mac Graw Tim	Country Calif	222s	slow fast
		hoarse	Man	calif guitar	piano
10	Lovin' all night	Crowell Rodney	Country Pop	227s	fast
		normal	Man	calif guitar	brass
11	Hard way (the)	Carpenter Mary	Country Pop	262s	slow fast
		normal	Woman	calif guitar	piano
17	Point of rescue (the)	Ketchum Hal	Country Calif	265s	fast
		normal	Man	calif guitar	calif guitar
50	At seventeen	Ian Janis	Pop Folk	281s	slow fast
		soft	Woman	acoustic guitar	brass
27	Dream on	Labounty Bill	Pop Calif	298s	slow fast
		broken	Man	keyboard	brass
106	Another time another plac	Steely Dan	Jazz Calif	245s	fast slow
		instrumental	Instrumental	piano	keyboard
112	Learn to love you	Connick Harry J	Jazz Crooner	279s	slow fast
		muffled	Man	brass	strings
137	Heart of my heart	Elgart Les	Jazz Swing	151s	slow fast
		instrumental	Instrumental	double bass	brass

Problem Complexity



- Build a sequence of 20 titles
each title in database of 100.000 items,
- satisfy a set of global constraints
- naive search space = $100.000^{20} = 10^{100}$

Constraint Satisfaction

- Set of variables: item1, item2, item3 ...
- Variables have a *finite domain* (e.g. the database of titles)
- Set of constraints holding on variables

Exhaustive search with pruning = *constraint filtering*:
At each step, constraints are considered individually
and used to reduce the domains of future variables

Filtering depends on the constraint, and on the variables
already instantiated.

Global Constraints

- Running constraints
- Cardinality constraints
- Difference constraints
- Pattern constraints

Each constraint class has efficient filtering procedures

Music Exploration: the Personal Radio Project

Aim:

provide music for all possible listening behaviors
collect user feedback and behaviours

Focus on the *exploration* aspect:

System provides ability to shift explicitly between exploratory and non exploratory modes: the *Magic slider*

Personal Radio

- User Workshop in progress in Europe in 4 locations.
10,000 titles

Analysis of Listening Behaviors change with time

Most people use the magic slider intensively, after an initial period of conservatism.



Conclusion

- Music can be “interesting” for users for many reasons
 - *grounded features yielding similarity functions*
 - *sequences*
 - *exploration / discovery of unknown music*
- **Cuidado** European IST project in progress (Ircam, UPF, Oracle) to develop other extractors and perform scale-up on very large catalogues (1 million)