# Rameau

# Music Analysis System

by

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PREFACE

The music analysis system is named after *Jean-Philippe Rameau* (1683-1764), a French music theorist, composer, organist, and clavecinist.

RAMEAU is projected as a music analysis system written in C language. It is a tool under development which may help the music analysist to check music pieces under structural and statistical aspects and to examine various diagnostically relevant features. The score must be saved as standard MIDI file – or (in a later version of the program) as PMX standard file of the music typography system SCORE. The computer program may help in comparing pieces of concerted music concerning their fundamental harmonic structures by mapping the successive vertical pitch sets as scatter diagrams. In such structograms, all occurring combinations of successive vertical pitch sets, i.e. simultaneous chords, encoded as Forte numbers of pitch class sets, are plotted.

# A    Introduction

## A.1  Hardware suppositions

The program is designed for IBM compatibles with the operating system DOS. To run it, the following hardware configuration is presumed: processor type at least 80386, 4 MB extended memory, a hard disk with at least 5 MB free space (necessary for the generation of large temporary files). The program facultatively works with GhostScript, a public domain software PostScript$^{TM}$ emulator. By its PostScript option, the program is able to generate diagrams suitable for publication.

## A.2  Getting Started

To get started with Rameau, do the following:

1. Backup the master diskette and store master diskette in a safe location.
2. Follow the instructions below for hard disk installation.
3. Read the User's Manual.

## A.3  Hard Disk Installation

In the case you downloaded RAMEAU1.ZIP and RAMEAU2.ZIP from an FTP Server, first extract the two files by PKUNZIP and copy the contents of RAMEAU1.ZIP on diskette #1 and the contents of RAMEAU2.ZIP on diskette #2.

To install Rameau v 1.0 on a hard disk, put diskette #1 in the floppy drive and enter <INSTALL>. The installation program will first ask you what drive you want to the program have installed on. Then it will look whether there is enough space on the disk partition. Rameau needs at least 5 MB and the program will be installed on the drive you have selected. Then you will be asked for the user's or company's name.

The diskette #2 contains GhostScript, a PostScriptTM interpreter. This emulator is not part of the Music Analysis System and not essential for running it. However, you need GhostScript for visualizing output graphs on the screen and for printing out in PostScript quality on standard printers. The installation program therefore asks you whether you want to have GhostScript installed on your hard disk or not. If so, enter <y>. It is necessary, however, to install GhostScript on the same drive as Rameau.

When installation is completed, you should have the following file structure on your disk (default directory names are shown):


/RAMEAU
README.1ST
RAMEAU.EXE
RAMEAU.CFG
/BIN
MID2RDL.EXE
*PCS*2MAP.EXE
RDL2VPS.EXE
RAMEAU.EXE
VPS2*PCS*.EXE
/DATA
BACH.INF
BACH.MID
JOBIM.INF
JOBIM.MID
MOZART.INF
MOZART.MID
etc.
/HLP
CONFIG.HLP
INPUT.HLP
OUTPUT.HLP

PROCEDUR.HLP

/TMP

*.TMP

Rameau has several user-configurable options. These options are saved in a configuration file that is read whenever it is started. The default configuration file is named RAMEAU.CFG, located in the program directory. These options may be changed when the program is started at any time during a session.

To run the program, you need the initialization files in subdirectory BIN.

A header with information about the music piece being analyzed (*.INF) must be located in the same (sub-)directory as your data files are (e.g. in the subdirectory DATA).

A subdirectory named HLP contains help files [*.hlp]. These file are essential for the online reference in the program.

Important: This documentation indicates text displayed by Rameau by placing it within single quotes. Default responses to prompts are shown by the program as inverted text. Single key responses are shown in <brackets>. For example, <x> means press the x key on the keyboard. The program accepts either upper or lower case for all single key responses. When a default response is displayed, it may be accepted by pressing <Enter>. Pressing <Esc> will abort the current request.

# B    Program Operation

The program is started by entering "RAMEAU" at the DOS command prompt. The host system hardware is checked and if it lacks the necessary memory a message to that effect will appear and the program will terminate.

If the system hardware checks out OK, the opening screen appears. After a few seconds, the main display of the program is drawn. The bottom of the screen consists of the display where you get access to the various submenus.

## B.1  Performance of the Program

The program is menu driven. From the main menu you have access to four submenus, where the various specifications are to be made. The program is therefore easy to handle.

Within the submenus one can access an on-line reference by pressing <H>elp.

## B.2  Main Menu

Having started Rameau, an opening screen appears with information about the program. (You can shorten the display of the opening screen by entering <ESC>). Then you come in the main menu. There, you can select between several menus and the Quit command:

    <A>bout, <I>nput, <O>utput, Op<t>ions, <P>rocedures, <Q>uit

In these menus you can access an on-line reference by pressing <H>elp. Move through the pages of reference using the <RETURN> key.

## B.3  About

This option displays a window with information about Rameau, and the licensing restrictions. Press ENTER to return to the main menu.

## B.4  Data Input Menu

The Input submenu allows the specifications for the data input and supplies three options.

Show Directory

This option, delivers the content of the working directory, specified with the work path.

Input/Output File Name

In this field, the name of the input file has to be entered. Type the name of the input file. Do not specify an extension. All output files created from this input file will automatically have the same name.

Input File Format

This option defines the format of the Input-File that the program will use and it is possible to select between: MID (MIDI file), *PCS* (listing of pitch class sets), RDL (reduced data listing), and VPS (listing von successive vertical pitch sets. The program version 1.0 needs MIDI as input format. The structure of the files must follow strictly the MIDI standard as defined by the International MIDI Association (IMA). Files which do not follow this standard under any aspect are not suitable as input sources. It is also possible to use RDL, VPS and *PCS* listings (in ASCII format), as input. The format of these data types becomes obvious in Example 1 (chapter E).

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<u>File Header</u>

Various information about the subject of the input file is to be given in under the File Header option. The information you give in is stored as INF files (in ASCII format) and is used as a headers in the output file with identical name (e.g. BACH.INF corresponds with the input file BACH.MID and its contents appears as header in the output file BACH.MAP).

Fill out the file header as complete as possible. Rameau will run the procedures also with an incomplete header, however, for using MIDI input files, the fields: File Name, Time Signature, Time Signature, and Bar Nos from ... to ..., and Offbeat Value are obligatory (for examples see under chapter E).

For delimiting the analysis to a certain number of bars, it is necessary to specify the "Bar Nos from ... to ...", and the "Off<b>eat Value" option in the header in the input menu. [This specification, however, actually works only with MID as input option.]

[During line editing in the File Header Option, the following keys are active: <Tab>: move forwards; <Shift Tab>: move backwards; <Ins>: insert mode and over-type mode; <Back Space>: delete character to left of cursor; <Enter> or <Esc>: accept line as edited, exit command mode.

## B.5  Data Output Menu

The Output submenu allows the specifications for the data output. Rameau has three options on its Output Data Menu.

<u>Data Output File</u>

The first prompt gives the type of Output File. The output data are automatically written to a file with the same name as the current input file and with the specific extension. Any existing output files with the same name and extension are automatically overwritten.

MAP files [*.MAP] (in ASCII or PostScript format) supply a structogram of successive vertical pitch class sets with $pcs_n$, $pcs_{n+1}$.

RDL (Reduced Data Listing) files [*.RDL] (in ASCII format) include all basic information necessary for analyses written in VPS files (and in later versions also in RDA files).

VPS files [*.VPS] (in ASCII format) include listings of successive vertical pitch sets, gained from RDL files.

*PCS* files [*.*PCS*] (in ASCII format) include listings of successive pitch class sets, gained from VPS files.

Map Options

Max. Cardinality: You can select the maximal cardinality of the vertical pitch sets (chords) resp. pitch class sets plotted in a MAP file at a range between 3 and 6.

In the Procedures menu the analysis is getting started. To run the program, select "<R>un Procedure".

The "Run <B>atch" option allows you to run batch files located in the working directory [not implemented in this version].

Selecting the "<P>cs Code" option you may start an interactive mode for direct output of *pcs* numbers (according to Forte 1973) of incoming pitch class sets. Then enter the pitch class set of which the Forte number is wanted, e.g.: "3,7,0". After using the <RETURN> key, the program will give out the Forte number directly, e.g.: "3-11". All procedures at the command prompt are stopped by using the <RETURN> key a second time.

[This option will be implemented in the next version. However you can already use it at DOS level: change to the BIN subdirectory ("cd bin") and start the program module

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VPS2PCS.EXE by entering "VPS2PCS". You enter the interactive mode as described above. Sort by entering <CTRL-C>.]

After the procedures are finished, you may have a look on the results by selecting the <D>isplay option. Pressing <Enter> accepts the selection. If you select the MAP option, the program switches to GhostScript. To return from GhostScript to Rameau, enter: "QUIT".

The Process <P>rotocol option delivers (error) messages with reference to the ultimate run of procedures.

## B.6  Options Menu

The Options menu selection allows all options specified at the program startup to be changed.

Company/User

At the top of the configuration screen the Company/User name is displayed as an identifying header.

Work Path

The work path directs the program to the location (disk drive and/or sub-directory) where it will read and write the input files and data interchange files. The default data path is the one you previously specified (example: C:\RAMEAU\DATA). Pressing <Enter> accepts the path name.

Output File Format

The analysis results (listings or maps) may be either displayed directly on the screen or printed out on a printer. Data output files are generated in ASCII or in PostScript$^{TM}$ format. The generated output data files automatically get the same name as the current input file together with the specific extension.

- Being prompted for <O>utput File Format, you may select between <A>SCII and <P>ostScript. Selecting <A>SCII, all text and graphic output files will be in ASCII conversion format. Selecting <P>ostScript, the graphic output files will be in PostScript format. Pressing <Enter> accepts the selection.

Printer

The printer option [to be implemented in the next version] defines the printer that the program will use: Standard, PostScript, or none. The default printer is the type specified when Rameau was installed or when the configuration was last changed. ASCII files may be printed out directly by every standard printer. Select this option if you want the program to create a map file that can be loaded, enhanced and then printed by every text processor. PostScript output files, being text or graphic files, may only be printed out by printers able to read PostScript language or by ordinary printers using a PostScript interpreter like GhostScript. In the case you have a PostScript printer, select <Post>Script. If you have a standard printer and want to get PostScript outprints by emulation, select <P>ostScript under the output file format and <S>tandard under the printer option. GhostScript, which you have installed together with Rameau, will then automatically emulate PostScript language on a standard printer.

Selecting printer <N>one [default option], the program will display the analysis results on the screen.

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<u>Port</u>

Under this option, you may choose between "<L>PT" [to be implemented in the next version] and "<F>ile". Selecting LPT, it is possible to make direct outprints of the output data and graphs. Selecting File, the program writes the output data and graphs to a file in the working directory. The output file may consist of ASCII or PostScript format (see output file format).

## B.7  Quit

Quit exits the program. When you are finished with the program, select <Q>uit. Since this action is irrevocable, the program requires confirmation for preserving the configuration changes. Rameau will prompt "Quit [Y/N]?". Responding <y>, the program closes all files and exits to the DOS prompt. It will save the configuration options and use them as the default settings for future sessions.

# C     Structures and Formats of Files

Input and output files are connected in the order as demonstrated in Fig. 1.
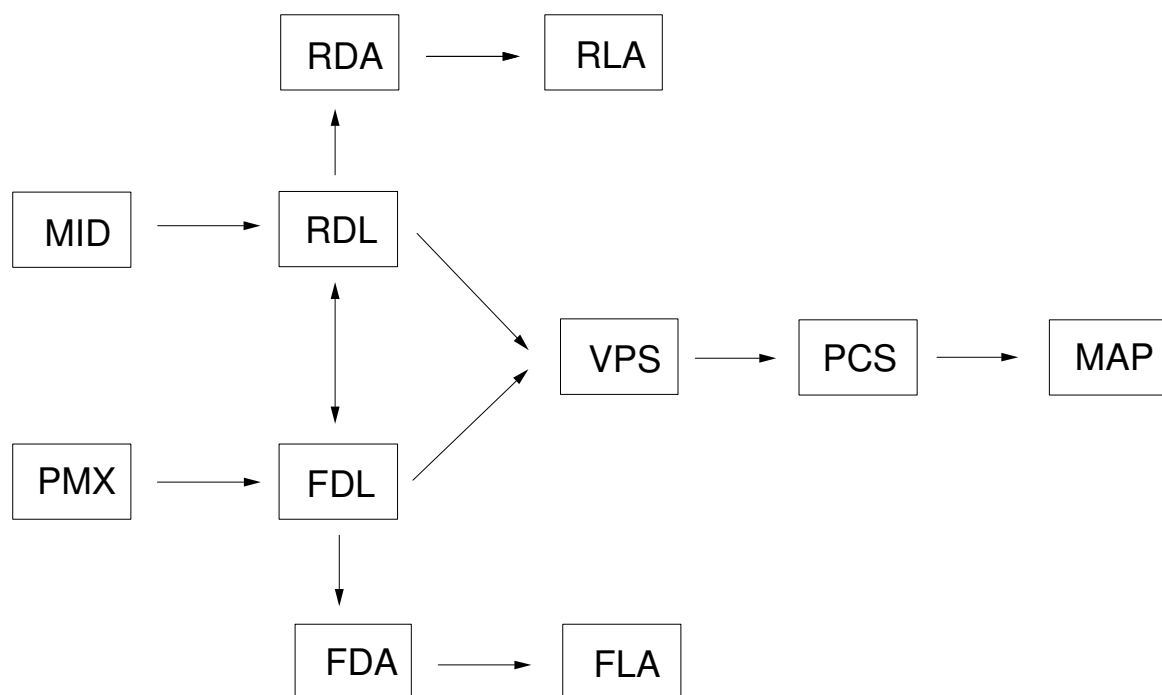


Fig. 1: The connections between the input files and the output files created by Rameau. (File names marked by broken lines will be implemented in future versions of the program.)

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Input files:

[*.INF]

INF files contain information about the music piece in the input file with identical name (e.g. BACH.INF corresponds to BACH.MID).

[*.MID]

MIDI input files must follow the MIDI standard. The sequence must be stored as a MIDI file in format 1, i.e., in multi-track format. (The copyright for the files within the subdirectory DATA is owned by ARION Verlag, München.)

Output files:

All files contain a header with the identification data supplied by an INF file (with the same name as the MIDI or PMX input files). Output files may be in ASCII format or PostScript format.

[*.MAP]

MAP files (in ASCII or PostScript format) supply a structogram of successive vertical pitch class sets with x = $pcs_n$, y = $pcs_{n+1}$ as well as the relative frequencies of the successive vertical pitch class sets. For examples see Figs. 2 a–f. These structograms generated by Rameau may be considered as a 'harmonic fingerprints' of concerted music exhibiting the integrated harmonic structure.

According to the three colours blue, red, you may distinguish on screen between three types of succession of pitch class sets resp. vertical pitch sets:

blue dots on the scatter diagram in cases when:
$pcs_n$ = extentionally diatonic (= subset of $pcs$ 7-35); $pcs_{n+1}$ = extentionally diatonic (= subset of $pcs$ 7-35);

green dots: $pcs_n$ = extentional diatonic (= subset of $pcs$ 7-35); $pcs_{n+1}$ = extentionally not diatonic (not subset of $pcs$ 7-35) – or vice versa;

red dots: $pcs_n$ = extentionally not diatonic (not subset of $pcs$ 7-35); $pcs_{n+1}$ = extentionally not diatonic (not subset of $pcs$ 7-35).

For the division of the x and y scale see Fig. 1 a. (Please notice that white lines crossing the diagram are only effects due to the screen resolution and do not appear on offprints.)

[*.*PCS*]
*PCS* files (in ASCII format) include the Forte numbers (Forte 1973) of the successive vertical pitch sets.

[*.RDL]
Reduced Data Listing files (in ASCII format) include all basic information necessary for analyses based on VPS files. They supply all information concerning pitch, time and tone length for every voice, however supplies delimited data concerning intentionality of the pitches (e.g., cis versus des). The file is produced from a MID file. The pitch numbers are coded as follows: h/ces = 0 + n × 12; his/c = 1 + n × 12; cis/des = 2 + n × 12; d = 3 + n × 12; dis/es = 4 + n × 12; e/fes = 5 + n × 12; eis/f = 6 + n × 12; fis/ges = 7 + n × 12; g = 8 + n × 12; gis/as = 9 + n × 12; a = 10 + n × 12; ais/b = 11 + n × 12.

[*.VPS]
VPS files (in ASCII format) include successive vertical pitch sets, gained from *.RDL files. [Pitch numbers: his/c = 1; cis/des = 2; d = 3; dis/es = 4; e/fes = 5; eis/f = 6; fis/ges = 7; g = 8; gis/as = 9; a = 10; ais/b = 11; h/ces = 0.]

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Procedures under construction to be implemented in future versions:

For program version > 1.0, the implementation of the procedures listed below are projected.

1) Reduced Data Analysis output files [*.RDA] as an additional output option will include basic statistical analyses and graphical documentations based on RDL files.

2) Reduced Data Linear Analysis files [*.RLA] as an additional output option, will supply supplementary data on melodic and intervallic features.

3) PMX files, an export data file of the music typography system SCORETM by Passport Designs, Inc. [*.PMX], is projected as an additional input format which supplies the full set of SCORE data.

4) Full Data Listing files [*.FDL] as a further output option will include all basic information for full data analysis. FDL files will be gained from PMX files.

5) Full Data Analysis output files [*.FDA] as a further output option will supply various supplementary statistics including graphical documentations of the analyzed piece of music.

6) Full Data Linear Analysis files [*.FLA] as an additional output option will supply diagrams of various linear successive features. FLA files will be gained from FDL files.

# D    Examples

**Example 1**: The construction of a MAP structogram of J.S. Bach (1685-1750): Passionsmusik nach dem Evangelisten Matthäus, Choral: Wenn ich einmal soll scheiden.

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## Listing of RDL file

RAMEAU converts the MIDI data to a reduced data listing file (*.RDL).

```
   0  +65 +61 +70 +58 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
      96  ..  ..  ..  −58 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
      96  ..  ..  ..  +56 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
──── bar 1
     192  −65 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     192  +70 −61 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     192  ..  +61 −70 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     192  ..  ..  +70 −56 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     192  ..  ..  ..  +54 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     288  ..  −61 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     288  ..  +63 −70 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     288  ..  ..  +72 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     384  −70 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     384  +68 −63 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     384  ..  +65 −72 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     384  ..  ..  +73 −54 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     384  ..  ..  ..  +53 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     576  −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     576  +66 −65 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     576  ..  +58 −73 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     576  ..  ..  +75 −53 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     576  ..  ..  ..  +51 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     672  ..  −58 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     672  ..  +60 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     768  −66 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     768  +65 −60 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     768  ..  +61 −75 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     768  ..  ..  +68 −51 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     768  ..  ..  ..  +49 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
──── bar 2
     960  −65 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     960  +63 −61 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     960  ..  +61 −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     960  ..  ..  +70 −49 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
     960  ..  ..  ..  +43 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
    1152  ..  −61 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
    1152  ..  +60 −70 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
    1152  ..  ..  +68 −43 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
    1152  ..  ..  ..  +44 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
    1344  −63 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
    1344  +65 −60 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
    1344  ..  +61 −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
```

```
    1344  ..   ..   +68 -44  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1344  ..   ..   ..   +49  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1536  -65  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1536  +72 -61  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1536  ..   +65 -68  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1536  ..   ..   +72 -49  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1536  ..   ..   ..   +45  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
──── bar 3
    1728  -72  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1728  +73 -65  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1728  ..   +65 -72  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1728  ..   ..   +70 -45  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1728  ..   ..   ..   +46  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1920  -73  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1920  +72 -65  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1920  ..   +66 -70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1920  ..   ..   +70 -46  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    1920  ..   ..   ..   +51  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2016  -72  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2016  +73  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2064  -73  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2064  +75  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2112  -75  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2112  +73 -66  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2112  ..   +65 -70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2112  ..   ..   +70 -51  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2112  ..   ..   ..   +53  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2304  -73  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2304  +72 -65  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2304  ..   +63 -70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2304  ..   ..   +69 -53  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2304  ..   ..   ..   +53  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2400  -72  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2400  +70 -63  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2400  ..   +61  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
──── bar 4
    2496  -70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2496  +70 -61  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2496  ..   +61 -69  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2496  ..   ..   +65 -53  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    2496  ..   ..   ..   +46  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    3072  -70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    3072  +73 -61  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    3072  ..   +65 -65  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    3072  ..   ..   +70 -46  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    3072  ..   ..   ..   +58  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    3168  ..   ..   -70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
    3168  ..   ..   +68  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
──── bar 5
    3264  -73  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
```

```
3264   +72 −65 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3264   ..  +67 −68 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3264   ..   ..  +67 −58 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3264   ..   ..   ..  +52 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3360   −72 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3360   +70 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3456   −70 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3456   +68 −67 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3456   ..  +65 −67 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3456   ..   ..  +72 −52 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3456   ..   ..   ..  +53 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3648   −68 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3648   +70 −65 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3648   ..  +66 −72 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3648   ..   ..  +73 −53 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3648   ..   ..   ..  +52 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3840   −70 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3840   +72 −66 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3840   ..  +66 −73 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3840   ..   ..  +75 −52 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
3840   ..   ..   ..  +51 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
── bar 6
4032   −72 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4032   +73 −66 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4032   ..  +68 −75 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4032   ..   ..  +73 −51 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4032   ..   ..   ..  +53 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4128   ..   ..  −73 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4128   ..   ..  +71 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4224   ..  −68 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4224   ..  +66 ..  −53 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4224   ..   ..   ..  +54 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4320   ..   ..  −71 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4320   ..   ..  +69 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4416   −73 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4416   +73 −66 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4416   ..  +65 −69 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4416   ..   ..  +68 −54 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4416   ..   ..   ..  +49 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4608   −73 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4608   +68 −65 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4608   ..  +65 −68 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4608   ..   ..  +73 −49 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4608   ..   ..   ..  +49 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4704   ..   ..  −73 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4704   ..   ..  +71 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
── bar 7
4800   −68 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4800   +70 −65 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4800   ..  +65 −71 ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
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4800   ..   ..  +70 −49  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4800   ..   ..   ..  +54  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4896   ..  −65  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4896   ..  +63  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4992  −70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4992  +68 −63  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4992   ..  +62 −70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4992   ..   ..  +71 −54  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
4992   ..   ..   ..  +53  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5088   ..  −62  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5088   ..  +63  ..  −53  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5088   ..   ..   ..  +51  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5184  −68  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5184  +70 −63  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5184   ..  +65 −71  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5184   ..   ..  +70 −51  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5184   ..   ..   ..  +50  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5280  −70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5280  +68  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5376  −68  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5376  +66 −65  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5376   ..  +65 −70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5376   ..   ..  +70 −50  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5376   ..   ..   ..  +51  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5472   ..  −65  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5472   ..  +63  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
—— bar 8
5568  −66  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5568  +65 −63  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5568   ..  +63 −70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5568   ..   ..  +70 −51  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5568   ..   ..   ..  +46  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5760   ..  −63  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
5760   ..  +62  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6144  −65  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6144  +73 −62  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6144   ..  +70 −70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6144   ..   ..  +75 −46  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6144   ..   ..   ..  +55  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
—— bar 9
6336  −73  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6336  +72 −70  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6336   ..  +68 −75  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6336   ..   ..  +75 −55  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6336   ..   ..   ..  +56  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6432  −72  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6432  +73  ..   ..  −56  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6432   ..   ..   ..  +58  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6528  −73  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
6528  +75 −68  ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..   ..
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6528  ..  +68 −75 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6528  ..  ..  +75 −58 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6528  ..  ..  ..  +60 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6624  ..  ..  −75 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6624  ..  ..  +77 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6672  ..  ..  −77 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6672  ..  ..  +78 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6720  −75 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6720  +73 −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6720  ..  +68 −78 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6720  ..  ..  +77 −60 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6720  ..  ..  ..  +53 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6816  ..  −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6816  ..  +70 ..  −53 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6816  ..  ..  ..  +55 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6912  −73 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6912  +72 −70 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6912  ..  +72 −77 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6912  ..  ..  +75 −55 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
6912  ..  ..  ..  +56 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7008  ..  −72 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7008  ..  +68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
── bar 10
7104  −72 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7104  +70 −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7104  ..  +68 −75 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7104  ..  ..  +77 −56 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7104  ..  ..  ..  +50 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7296  ..  −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7296  ..  +67 −77 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7296  ..  ..  +75 −50 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7296  ..  ..  ..  +51 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7488  −70 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7488  +72 −67 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7488  ..  +68 −75 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7488  ..  ..  +75 −51 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7488  ..  ..  ..  +44 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7680  −72 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7680  +65 −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7680  ..  +61 −75 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7680  ..  ..  +68 −44 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7680  ..  ..  ..  +49 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
── bar 11
7872  −65 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7872  +66 −61 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7872  ..  +63 −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7872  ..  ..  +68 −49 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
7872  ..  ..  ..  +48 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8064  −66 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8064  +65 −63 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
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8064  ..  +61 −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8064  ..  ..  +68 −48 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8064  ..  ..  ..  +49 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8256  −65 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8256  +63 −61 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8256  ..  +63 −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8256  ..  ..  +68 −49 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8256  ..  ..  ..  +47 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8352  ..  ..  −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8352  ..  ..  +70 −47 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8352  ..  ..  ..  +46 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8448  −63 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8448  +68 −63 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8448  ..  +65 −70 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8448  ..  ..  +71 −46 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8448  ..  ..  ..  +44 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8544  −68 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8544  +66 −65 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8544  ..  +63 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
── bar 12
8640  −66 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8640  +65 −63 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8640  ..  +63 −71 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8640  ..  ..  +72 −44 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8640  ..  ..  ..  +45 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8832  ..  −63 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8832  ..  +61 −72 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8832  ..  ..  +70 −45 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
8832  ..  ..  ..  +46 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
9024  ..  −61 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
9024  ..  +60 −70 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
9024  ..  ..  +69 −46 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
9024  ..  ..  ..  +53 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
9216  −65 −60 −69 −53 ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
```

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## Listing of VPS file

RAMEAU converts the RDL file to a VPS file. The program makes vertical "cross sections" at every change of notes, i.e. "harmonic **e**vent" ($e_1$ ..... $e_n$) and determines the "successive vertical pitch sets" (*vps*), i.e. the simultaneous chords (example 1).

```
e₁   = vps₁  =   10,1,5,10,                          6,6,11,1,
e₂   = vps₂  =   8,1,5,10,                           6,6,9,1,
──── bar 1                                           1,5,8,1,
e₃   = vps₃  =   6,1,10,                             1,5,8,1,
e₄   = vps₄  =   6,3,10,0,                           1,5,8,11,
e₅   = vps₅  =   5,5,8,1,                 ──── bar 7
e₆   = vps₆  =   3,10,6,3,                           6,5,10,
e₇   = vps₇  =   3,0,6,3,                            6,3,10,
e₈   = vps₈ =    1,1,5,8,                            5,2,8,11,
──── bar 2                                           3,3,8,11,
e₉   = vps₉  =   7,1,3,10,                           2,5,10,
e₁₀  = vps₁₀ =   8,0,3,8,                            2,5,8,10,
e₁₁  = vps₁₁ =   1,1,5,8,                            3,5,6,10,
e₁₂  = vps₁₂ =   9,5,0,                              3,3,6,10,
──── bar 3                               ──── bar 8
                 10,5,10,1,                          10,3,5,10,
                 3,6,10,0,                           10,2,5,10,
                 3,6,10,1,                           7,10,1,3,
                 3,6,10,3,                ──── bar 9
                 5,5,10,1,                           8,8,0,3,
                 5,3,9,0,                            10,8,1,3,
                 5,1,9,10,                           0,8,3,
──── bar 4                                           0,8,3,5,
                 10,1,5,10,                          0,8,3,6,
                 10,5,10,1,                          5,8,1,5,
                 10,5,8,1,                           7,10,1,5,
──── bar 5                                           8,0,3,
                 4,7,0,                              8,8,0,3,
                 4,7,10,                  ──── bar 10
                 5,5,8,0,                            2,8,10,5,
                 4,6,10,1,                           3,7,10,3,
                 3,6,0,3,                            8,8,0,3,
──── bar 6                                           1,1,5,8,
                 5,8,1,                   ──── bar 11
                 5,8,11,1,                           0,3,6,8,
```

```
          1,1,5,8,                                    8,5,8,11,
          11,3,8,                                     8,3,6,11,
          10,3,10,
──── bar 12
          9,3,5,0,
          10,1,5,10,
          5,0,5,9,
```

## Listing of PCS file:

These *vps* are encoded as numbers of *pitch class sets* (*pcs*) according to FORTE (1973) (Append. 1).

```
e₁  = pcs  3–11                                      3–10
e₂  = pcs  4–26                                      3–11
──── bar 1                                           4–27
e₃  = pcs  3–11                                      3–10
e₄  = pcs  4–27                           ──── bar 6
e₅  = pcs  3–11                                      3–11
e₆  = pcs  3–11                                      4–27
e₇  = pcs  3–10                                      3–9
e₈  = pcs  3–11                                      3–11
──── bar 2                                           3–11
e₉  = pcs  4–27                                      3–11
e₁₀ = pcs  3–11                                      4–27
e₁₁ = pcs  3–11                           ──── bar 7
e₁₂ = pcs  3–11                                      3–4
──── bar 3                                           3–11
           3–11                                      4–28
           4–27                                      3–11
           4–26                                      3–11
           3–11                                      4–27
           3–11                                      4–14
           4–27                                      3–11
           4–19                           ──── bar 8
──── bar 4                                           3–9
           3–11                                      3–11
           3–11                                      4–27
           4–26                           ──── bar 9
──── bar 5                                           3–11
           3–11                                      4–23
```

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3—11
4—26
4—27
3—11
4—27
3—11
3—11
3—11
—— bar 11
4—27
3—11
3—11
2—5
3—10
4—26
—— bar 12
4—27
3—11
3—11

3—11
3—11
—— bar 10
4—27

Structogram in MAP file

The Forte numbers of the occurring combinations of successive vertical pitch sets, are grouped in couples as $e_n/e_{n+1}$ resp. $pcs_n/pcs_{n+1}$. These pairs of $pcs$ are plotted in a scatter diagram as $x=e_n$, $y=e_{n+1}$. [In example 1, the successive vertical pitch sets" ($vps$) = harmonic events are marked as $e_1$, $e_2$, $e_3$, $e_4$, $e_5$ etc.].

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**x,y 1:** ($x=e_1$, $y=e_2$) = ($e_1 = pcs$ 3-11, $e_2 = pcs$ 4-26);

**x,y 2:** ($x=e_2$, $y=e_3$) = ($e_2 = pcs$ 4-26, $e_3 = pcs$ 3-11);

**x,y 3:** ($x=e_3$, $y=e_4$) = ($e_3 = pcs$ 3-11, $e_4 = pcs$ 4-27);

**x,y 4:** ($x=e_4$, $y=e_5$) = ($e_4 = pcs$ 4-27, $e_5 = pcs$ 3-11) . . . .

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pcs numbers according to FORTE (1973)

## Complete structogram

**Analysis no.:** 0001      **Input File:** BACH     **Date:** 01/02/93

**Title:** Passionsmusik nach dem     **Composer:** J. S. Bach (1685–1750)

     Evangelisten Matthäus

**Opus:**                      **Year**: 1729

**Editor:** Ernst Eulenburg, Leipzig    **Publisher:** G. Schumann

**Movement:** Choral: Wenn ich einmal soll scheiden

**Key:** A MIN          **Time Signature:** 4/4

**Bar Nos from:** 1  **to:** 999

**Offbeat Value:** 1/4          **Minimal Rhythm Value:** 1/16

**Input by:** ARION Verlag, München
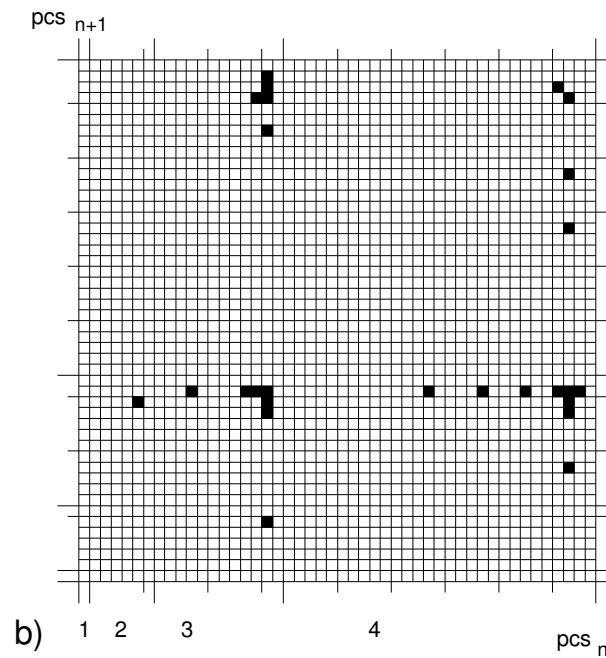
**2a–f:** a) PEROTINUS (c. 1200): Descendit; b) DUNSTABLE, J. (c. 1380–1453): Sancta Maria; c) DUFAY, G. (c. 1400–1474): Missa L'homme armé, Kyrie I; d) MOZART, W. A. (1756–1791): Ave verum corpus (KV 618); e) SCHÖNBERG, A. (1874–1951): op. 25, Menuett (excl. Trio); f) JOBIM, J. A.: Desafinado.
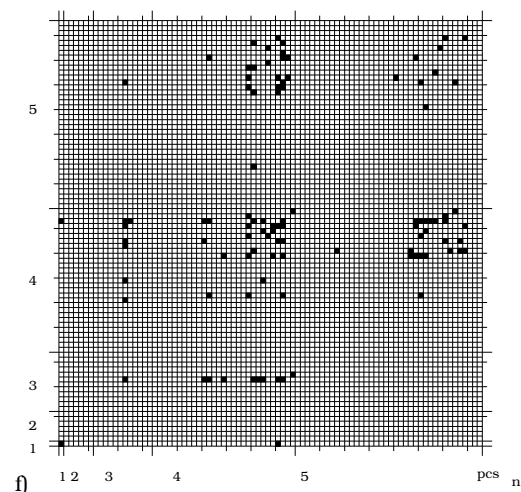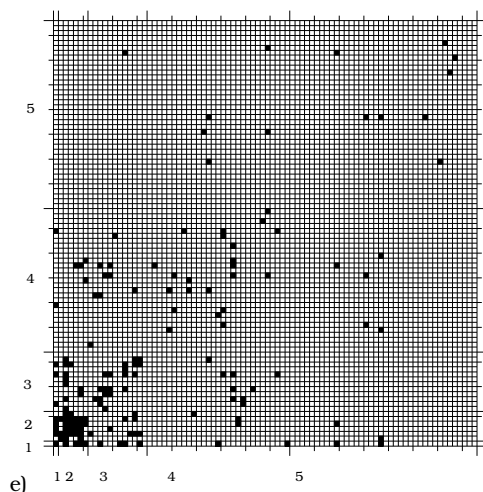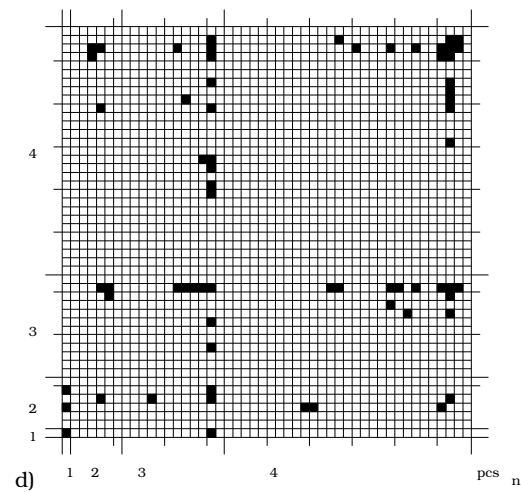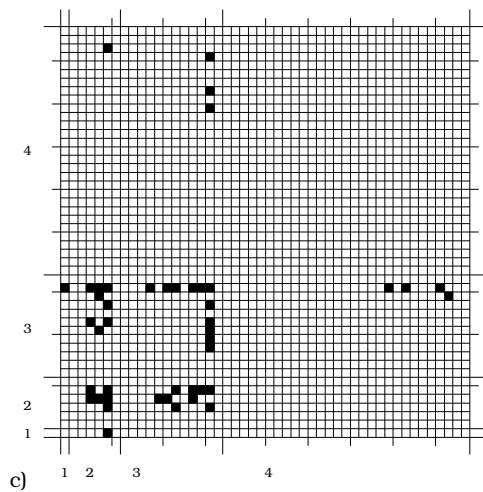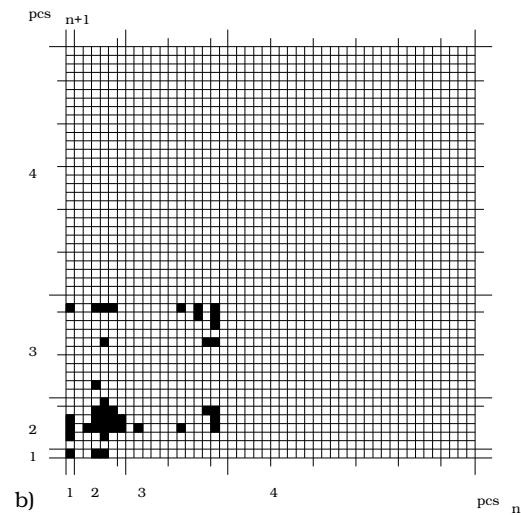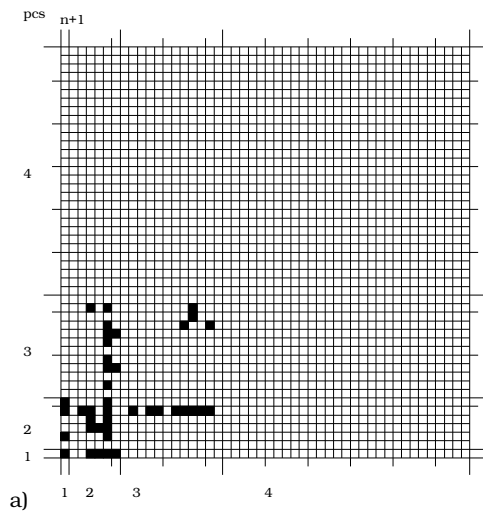
## References

FORTE, A. 1973. The structure of atonal music. – Yale University Press, New Haven and London.