

# Genre Comparison through Music Signal Processing

Jeremy Grifski



Fig. 1. In the Clouds: Vancouver from Cypress Mountain. Note that the teaser may not be wider than the abstract block.

**Abstract**—Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue dui dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue dui dolore te feugait nulla facilisi.

**Index Terms**—Signal Processing, Python, JavaScript, D3

## 1 INTRODUCTION

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## 2 DATA COLLECTION

In order to visualize the differences in music genre, I had to first collect some data. Fortunately, I had quite the collection of songs from iTunes purchases over the years. In particular, I had 4,194 songs spread across 983 folders.

From there, I had two challenges: choosing which file format to process and selecting what data to collect from those files. Of the 4,194 songs, roughly 1,800 of them were in the M4A format, so I chose to parse that format.

In terms of data collection, I decided to mine several fields from the M4A files such as:

- Title

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- Genre
- Artist
- Album
- Purchase Date
- Release Date
- Track Number
- Sample Rate (Hz)
- Sample Size (bits)
- Duration (HH:MM:SS)
- Number of Channels
- Average dBFS
- Max dBFS
- RMS
- Max Amplitude

In the following sections, I'll discuss how I parsed the M4A files, and how I aggregated that data for visualization.

Table 1. All Parsed Atoms

atom	description								
moov	-								
trak	-								
mdia	-								
minf	-								
stbl	-								
udta	-								
dinf	-								
pinf	-								
schl	-								
ftyp	-								
mvhd	-								
hdlr	-								
mdhd	-								
sum	1545	9	632	310	50	123	25	2694	2546

## 2.1 File Parsing

The first major challenge in this project was finding a way to collect information from the M4A file format. Unfortunately, I was unable to find a tool which could easily glean all the data I wanted from an M4A file. As a result, I decided to write my own file parsing code in Python.

With the aid of the Quicktime documentation, I was able to write a Python script which could roughly interpret the various atoms of an M4A file. In particular, I wrote enough code to parse all of the following atoms:

## 3 BIBLIOGRAPHY INSTRUCTIONS

- Sort all bibliographic entries alphabetically but the last name of the first author. This  $\LaTeX$ /bib $\TeX$  template takes care of this sorting automatically.
- Merge multiple references into one; e. g., use [3, 5] (not [3] [5]). Within each set of multiple references, the references should be sorted in ascending order. This  $\LaTeX$ /bib $\TeX$  template takes care of both the merging and the sorting automatically.
- Verify all data obtained from digital libraries, even ACM's DL and IEEE Xplore etc. are sometimes wrong or incomplete.
- Do not trust bibliographic data from other services such as Mendeley.com, Google Scholar, or similar; these are even more likely to be incorrect or incomplete.
- Articles in journal—items to include:
  - author names
  - title
  - journal name
  - year
  - volume
  - number
  - month of publication as variable name (i. e., {jan} for January, etc.; month ranges using {jan #}{/}# feb} or {jan #}{--}# feb})
- use journal names in proper style: correct: "IEEE Transactions on Visualization and Computer Graphics", incorrect: "Visualization and Computer Graphics, IEEE Transactions on"
- Papers in proceedings—items to include:
  - author names
  - title

– abbreviated proceedings name: e. g., "Proc.\ CONF\_ACRONYM" without the year; example: "Proc.\ CHI", "Proc.\ 3DUI", "Proc.\ Eurographics", "Proc.\ EuroVis"

– year

– publisher

– town with country of publisher (the town can be abbreviated for well-known towns such as New York or Berlin)

- article/paper title convention: refrain from using curly brackets, except for acronyms/proper names/words following dashes/question marks etc.; example:

– paper "Marching Cubes: A High Resolution 3D Surface Construction Algorithm"

– should be entered as "{M}arching {C}ubes: A High Resolution {3D} Surface Construction Algorithm" or "{M}arching {C}ubes: A high resolution {3D} surface construction algorithm"

– will be typeset as "Marching Cubes: A high resolution 3D surface construction algorithm"

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## 4 EXAMPLE SECTION

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## 5 EXPOSITION

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$$\sum_{j=1}^z j = \frac{z(z+1)}{2} \quad (1)$$

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Table 2. VIS/VisWeek accepted/presented papers: 1990–2016.

year	Vis/SciVis	SciVis conf	InfoVis	VAST	VAST conf	TVCG @ VIS	CG&A @ VIS	VIS/VisWeek incl. TVCG/CG&A	VIS/VisWeek w/o TVCG/CG&A
2016	30		37	33	15	23	10	148	115
2015	33	9	38	33	14	17	15	159	127
2014	34		45	33	21	20		153	133
2013	31		38	32		20		121	101
2012	42		44	30		23		139	116
2011	49		44	26		20		139	119
2010	48		35	26				109	109
2009	54		37	26				117	117
2008	50		28	21				99	99
2007	56		27	24				107	107
2006	63		24	26				113	113
2005	88		31					119	119
2004	70		27					97	97
2003	74		29					103	103
2002	78		23					101	101
2001	74		22					96	96
2000	73		20					93	93
1999	69		19					88	88
1998	72		18					90	90
1997	72		16					88	88
1996	65		12					77	77
1995	56		18					74	74
1994	53							53	53
1993	55							55	55
1992	53							53	53
1991	50							50	50
1990	53							53	53
sum	1545	9	632	310	50	123	25	2694	2546

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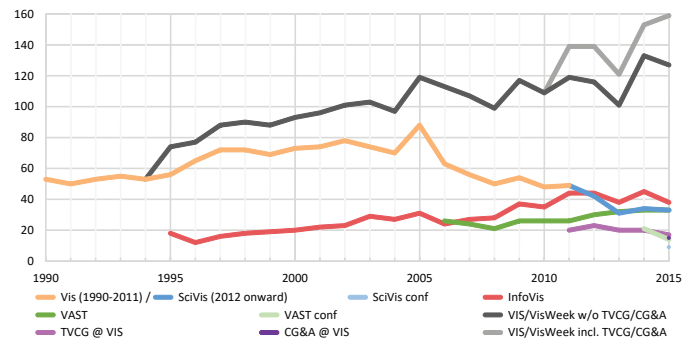


Fig. 2. A visualization of the 1990–2015 data from Table 2. The image is from [1] and is in the public domain.

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<sup>1</sup>The algorithm behind Marching Cubes [4] had already been described by Wyvill et al. [7] a year earlier.

<sup>2</sup>Footnotes appear at the bottom of the column.

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## 6 CONCLUSION

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## ACKNOWLEDGMENTS

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## REFERENCES

- [1] P. Isenberg, F. Heimerl, S. Koch, T. Isenberg, P. Xu, C. Stolper, M. Sedlmair, J. Chen, T. Möller, and J. Stasko. vispubdata.org: A Metadata Collection about IEEE Visualization (VIS) Publications. *IEEE Transactions on Visualization and Computer Graphics*, 23, 2017. To appear. doi: 10.1109/TVCG.2016.2615308
- [2] G. Kindlmann. Semi-automatic generation of transfer functions for direct volume rendering. Master's thesis, Cornell University, USA, 1999.
- [3] Kitware, Inc. *The Visualization Toolkit User's Guide*, January 2003.
- [4] W. E. Lorensen and H. E. Cline. Marching cubes: A high resolution 3D surface construction algorithm. *SIGGRAPH Computer Graphics*, 21(4):163–169, Aug. 1987. doi: 10.1145/37402.37422
- [5] N. Max. Optical models for direct volume rendering. *IEEE Transactions on Visualization and Computer Graphics*, 1(2):99–108, June 1995. doi: 10.1109/2945.468400
- [6] G. M. Nielson and B. Hamann. The asymptotic decider: Removing the ambiguity in marching cubes. In *Proc. Visualization*, pp. 83–91. IEEE Computer Society, Los Alamitos, 1991. doi: 10.1109/VISUAL.1991.175782
- [7] G. Wyvill, C. McPheeters, and B. Wyvill. Data structure for *soft* objects. *The Visual Computer*, 2(4):227–234, Aug. 1986. doi: 10.1007/BF01900346