

Visualizing Sets and Set-typed Data: State-of-the-Art and Future Challenges (Supplementary Material)

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Abstract

In this document, we provide supplementary material to our report. This includes: a list of the reviewed conference proceedings and journals to conduct the survey; links to available software implementations, demonstrations, presentations and any other additional material about set visualization; a list of theses on set visualizations. Further resources are available on the survey website <http://www.setviz.net>.

1. Covered Literature

The following conference proceedings and journals have been reviewed to conduct our survey:

Short name	Full name	Years
AVI	International Working Conference on Advanced Visual Interfaces	1992-2012
CGF	Computer Graphics Forum (published by Eurographics)	1982-2013
Diagrams	International Conference on Diagrammatic Representation and Inference	2000-2012
-	International Workshop on Euler Diagrams	2005-2012
EuroVis	Joint Eurographics-IEEE Symposium on Visualization (Conferene since 2012)	1999-2013
GD	Symposium on Graph Drawing	1994-2013
InfoVis	IEEE Symposium on Information Visualization (Conferene since 2006)	1995-2013
IV	International Conference Information Visualisation	1997-2013
IVS	Information Visualization (published by SAGE)	2006-2013
JVLC	Journal of Visual Languages and Computing	1990-2013
PacificVis	Asia Pacific Symposium on Information Visualisation	2005-2013
TVCG	IEEE Transactions on Visualization and Computer Graphics (published by IEEE)	1995-2013
VAST	IEEE Conference on Visual Analytics Science and Technology	2006-2013
VL/HCC	IEEE Symposium on Visual Languages and Human-Centric Computing	2004-2013

2. Resources of the Surveyed Techniques

We list available resources of the techniques discussed in the seven categories of our survey. This includes:

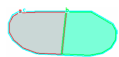
- software implementations,
- demonstrations,
- presentations, and
- other available material.

The techniques are shown in the same categories as in the survey. All links are last accessed in April 2014.

2.1. Euler and Venn Diagrams

2.1.1. Techniques for Any Set Relations

Diagrams Always Well-matched



General Euler Diagram Generation (2008)
Rodgers P, Zhang L, Fish A

Publication: [RZF08]
Website: <http://www.eulerdiagrams.org/tutorial/EmbeddingTool.html>
Software: downloadable executable



Inductively Generating Euler Diagrams (2011)
Stapleton G, Rodgers P, Howse J, Zhang L

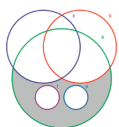
Publication: [SRHZ11]
Website: <http://www.eulerdiagrams.org/inductive.htm>
Software: downloadable executable



EulerView for Fully Automatic Visualisation of Overlapping Sets (2009)
Simonetto P, Auber D, Archambault D

Publication: [SAA09]
Software: open-source plugin for Tulip toolkit

Diagrams Not Always Well-matched – Uses Shading



Drawing Euler Diagrams with Circles (2012)
Stapleton G, Flower J, Rodgers P, Howse J

Publication: [SFRH12]
Website: <http://www.eulerdiagrams.org/inductivecircles.html>
Software: downloadable executable

Layout Improvement



Hill-climbing Multi-criteria Optimizer (2003)
Flower J, Rodgers P, Mutton P

Publication: [FRM03]
Software: in Java, not online

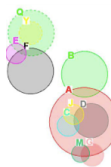


eulerForce (2009)
Micallef L, Rodgers P

Publication: [MR09]
Website: <http://www.eulerdiagrams.org/eulerForce>
Software: open-source (GPLv3, Java) + downloadable executable
Presentation: InfoVis 2009 poster
<http://www.cs.kent.ac.uk/pubs/2009/3120/content.pdf>

2.1.2. Techniques for Specific Set Relations

For Well-formed Diagrams with Circles



Piercing Diagram Generation (2011)
Stapleton G, Zhang L, Howse J, Rodgers P

Publication: [SZHR11]
Website: <http://www.eulerdiagrams.org/piercing.htm>
Software: downloadable executable

For Well-formed Diagrams with Polygons



Generating Euler Diagrams (2002)
Flower J, Howse J

Publication: [FH02]
Software: in Java, not online



Embedding Wellformed Euler diagrams (2008)
Rodgers P, Zhang L, Stapleton G, Fish A

Publication: [RZSF08]
Website: <http://www.eulerdiagrams.org/IV.htm>
Software: downloadable executable

Using Existing Layouts

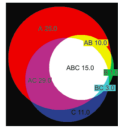


Euler Diagrams from Existing Layouts (2008)
Stapleton G, Howse J, Rodgers P, Zhang L

Publication: [SHRZ08]
Software: in Java, not online

2.1.3. Techniques for Area-Proportional Diagrams

Using Circles



3 Circle Venn Applet (2005)
Chow S, Rodgers P

Publication: [CR05a]
Website: <http://www.cs.kent.ac.uk/people/staff/pjr/EulerVennCircles/EulerVennApplet.html>
Software: Java applet



Venn Diagram Plotter (2004-2013)
Littlefield K, Monroe M

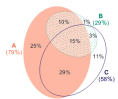
Website: <http://omics.pnl.gov/software/VennDiagramPlotter.php>
Software: open-source (ALv2) + downloadable executable



venneuler (2012)
Wilkinson L

Publication: [Wil12]
Website: <http://www.cs.kent.ac.uk/people/staff/pjr/EulerVennCircles/EulerVennApplet.html>
Software: open-source (MPL, Java) + R function as a CRAN package + a Cytoscape plugin

Using Ellipses



eulerAPE (2012)
Micallef L, Rodgers P

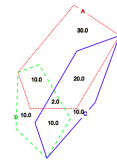
Publication: [MR12]
Website: <http://www.eulerdiagrams.org/eulerAPE>
Software: open-source (GPLv3, Java) + downloadable executable
Presentation: GHC 2012 and ACM SRC 2012 poster <http://kar.kent.ac.uk/30855>

Using Polygons



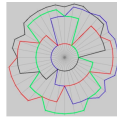
DrawVenn (2003)
Chow S, Ruskey F

Publication: [CR03]
Website: <http://theory.cs.uvic.ca/euler/DrawVenn/>
Software: Java applet



Convex Venn-3 (2010)
Rodgers P, Flower J, Stapleton G, Howse J

Publication: [RFSH10]
Website: <http://www.cs.kent.ac.uk/people/staff/pjr/ConvexVenn3/diagrams2010.html>
Software: Java applet



DrawEuler (2005)
Chow S, Ruskey F

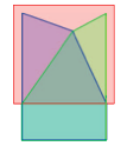
Publication: [CR05b]
Website: <http://theory.cs.uvic.ca/venn/DrawEuler>
Software: Java applet



VennMaster (2005, 2008)
Kestler H A, Muller A, Kraus J M, Buchholz M, Gress T M, Liu H, Kane D W, Zeeberg B R, Weinstein J N

Publications: [KMGB05, KMK*08]
Website: <http://sysbio.uni-ulm.de/?Software:VennMaster>
Software: open-source (GitHub, Java) + downloadable executable

Using Circles, Convex and Non-convex Polygons



Euler3 Applet (2014)
Rodgers P, Howse J, Stapleton G, Flower J

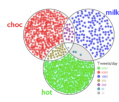
Publication: [RHSF14]
Website: <http://www.eulerdiagrams.com/Euler3.html>
Software: Java applet

2.1.4. Techniques for Euler Diagrams with Glyphs



eulerGlyphs (2012)
Micallef L, Dragicevic P, Fekete J -D

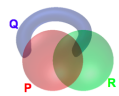
Publication: [MDF12]
Websites: <http://www.eulerdiagrams.org/eulerGlyphs>, <http://www.aviz.fr/bayes>
Software: open-source (GPLv3, Java) + downloadable executable
Demonstration: <http://www.youtube.com/watch?v=D8VZqxcu0I0>
Presentation: InfoVis 2012 talk www.cs.kent.ac.uk/people/staff/lm357/AssessingVisForBayesianReasoning_InfoVis2012-pres.pptx



TwitterVenn (2008)
Clark J

Website: <http://www.neoformix.com/2008/TwitterVenn.html>
Software: Java applet

2.1.5. Other Techniques



3D Venn and Euler Diagrams (2012)
Rodgers P, Flower J, Stapleton G

Publications: [RFS12,FSR14]
Website: <http://www.eulerdiagrams.com/3D/workshop>
Software: in Autodesk Design Review
Demonstration: examples <http://www.eulerdiagrams.com/3D/workshop>



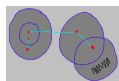
Speedith and Diabelli (2012)
Urbas M, Jannik M, Stapleton G, Flower J

Publications: [UJ12,UJSF12]
Website: <http://github.com/urbas/speedith>
Software: open-source (GitHub, SML / Java)



SketchSet (2011)
Wang M, Plimmer B, Schmieder P, Stapleton G, Rodgers P, Delaney A

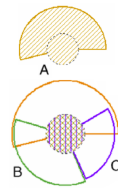
Publications: [WPS*11,DPSR10]
Website: <http://www.cem.brighton.ac.uk/users/ges9/SketchingEulerDiagrams/SketchingEulerDiagrams.html>
Software: in C#, not online
Demonstration: Video available on the website



SpiderSketch (2011)
Stapleton G, Delaney A, Rodgers P, Plimmer B

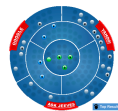
Publication: [SDRP11]
Website: <http://www.cem.brighton.ac.uk/users/ges9/SketchingEulerDiagrams/SketchingEulerDiagrams.html>
Software: downloadable executable

2.2. Euler Diagram Variants



Fan Diagrams (2007)
Kim B, Bongshin L, Seo J

Publication: [KLS07]
Website: <http://hcil.snu.ac.kr/research/conset>
Software: downloadable executable
Presentation: InfoVis 2006 poster <http://www.dropbox.com/s/vyxg0ilgqma3w39/ConSetInfoVisPoster.pdf>



Missing Pieces (2006)
InfoSpace, Inc

Publication: [KSJ*06]
Software: not online



Untangled Euler Diagrams (2010)
Riche N H, Dwyer T

Publication: [HRD10]
Software: not online
Demonstration: <http://www.youtube.com/watch?v=q2tUrqiFHbc>
Presentation: InfoVis 2010 talk <http://vimeo.com/groups/210231/videos/76068208>

2.3. Overlays

2.3.1. Region-based Overlay Techniques



BubbleSets (2009)
Collins C, Penn G, Carpendale S

Publication: [CPC09]
Website: vialab.science.uoit.ca/research
Software: open source executable (Java)
Demonstration: demonstrating interaction <http://www.youtube.com/watch?v=Ju2hSThmPWA>



Vizster (2005)
Heer J, Boyd D

Publication: [HB05]
Website: <http://vis.stanford.edu/jheer/projects/vizster/>
Software: open source executable (Java)
Demonstration: demonstrating interaction <http://www.youtube.com/watch?v=Ju2hSThmPWA>

2.3.2. Line-based Overlay Techniques



LineSets (2011)
Alper B, Henry-Riche N, Ramos G, Czerwinski M

Publication: [CPC09]
Software: in C# (contact authors)
Demonstration: demonstrating interaction
<http://ieeexplore.ieee.org/xpl/abstractMultimedia.jsp?arnumber=6064991&tag=1>



Kelp Diagrams (2012)
Dinkla K, Van Kreveld M, Speckmann B

Publication: [DvKSW12]
Presentation: EuroVis 2012 slides
<http://www.dropbox.com/s/3fculfyu4398mv7/presentation.pptx>



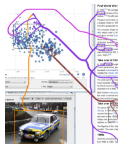
KelpFusion (2013)
Meulemans W, Henry Riche N, Speckmann B, Alper B, Dwyer T

Publication: [MHRS*13]
Demonstration: demonstrating interaction
<http://ieeexplore.ieee.org/xpl/abstractMultimedia.jsp?arnumber=6509874>
Presentation: IEEE VIS 2013 slides
<http://www.dropbox.com/s/bu713lmp4mnptx/slides.pdf>



Parallel Tag Clouds (2011)
Collins C, Viegas F, Wattenberg M

Publication: [CVW09]
Website: <http://vialab.science.uoit.ca/research>
Demonstration: demonstrating interaction
<http://www.youtube.com/watch?v=rL3Ga6xBgLw>
Presentation: IEEE VAST 2009 slides available on the website.



Context-preserving Visual Links (2011)
Steinberger M, Waldner M, Streit M, Lex A, Schmalstieg D

Publication: [SWS*11]
Software: open-source (Java) <https://github.com/Caleydo/visuallinks>
Demonstration: <http://www.youtube.com/watch?v=F2k4V8KGl1I>

2.3.3. Glyph-based Overlay Techniques



searchCrystal (2007)
Spoerri A

Publication: [Spo07]
Website: <http://comminfo.rutgers.edu/~aspoerri>
Software: Adobe Flash demo <http://comminfo.rutgers.edu/~aspoerri/searchCrystal/>
Demonstration: demonstrating interaction
http://comminfo.rutgers.edu/~aspoerri/searchCrystal/WikiEditWars_Screencast/WikiEditWars_Screencast.html

2.4. Node-link Diagrams



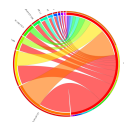
Jigsaw (2007)
Stasko J, Görg C, Liu Z

Publication: [SGL08]
Website: www.cc.gatech.edu/gvu/ii/jigsaw/
Software: open source executable (Java)
Demonstration: List view in Jigsaw <http://www.cc.gatech.edu/gvu/ii/jigsaw/tutorial/listview/listview.html>



PivotPaths (2012)
Dörk M, Henry Riche N, Ramos G, Dumais S

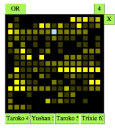
Publication: [DHRRD12]
Website: <http://mariandoerk.de/pivotpaths/>
Software: interactive web demo (JavaScript)
Demonstration: demonstrating interaction
<http://www.youtube.com/watch?v=Md3ySGr5alc>



Circos (2009)
Krzywinski M

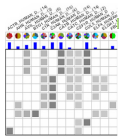
Publication: [KSB*09]
Website: <http://circos.ca>
Software: open source (Perl)
D3 implementations of chord diagrams <http://d3js.org/>

2.5. Matrix-based Techniques



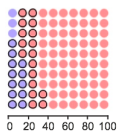
AquaVis (2012)
Sadana R, Dove A, Stasko J

Publication: [SDS13]
Website: <http://www.cc.gatech.edu/gvu/ii/setvis/>
Software: interactive web demo (JavaScript)
Demonstration: system demonstration <http://www.cc.gatech.edu/gvu/ii/setvis/AquaViz.mov>



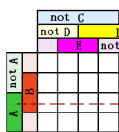
ConSet (2007)
Kim B, Bongshin L, Seo J

Publication: [KLS07]
Website: <http://hcil.snu.ac.kr/research/conset>
Software: downloadable executable
Presentation: InfoVis 2006 poster <http://www.dropbox.com/s/vyxg0ilgqma3w39/ConSetInfoVisPoster.pdf>



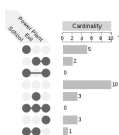
eulerGlyphs (2012)
Micalef L, Dragicevic P, Fekete J-D

Publication: [MDF12]
Websites: <http://www.eulerdiagrams.org/eulerGlyphs>, <http://www.aviz.fr/bayes>
Software: open-source (GPLv3, Java) + downloadable executable
Demonstration: <http://www.youtube.com/watch?v=D8VZqxcu0I0>
Presentation: InfoVis 2012 talk http://www.cs.kent.ac.uk/people/staff/lm357/AssessingVisForBayesianReasoning_InfoVis2012-pres.pptx



KMVQL (2008)
Kim B, Bongshin L, Seo J

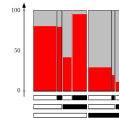
Publication: [Huo08]
Presentation: Vis 2003 poster http://www.cgl.uwaterloo.ca/poster/ann_VIS03.pdf



UpSet (2014)
Lex A, Gehlenborg N, Strobel H, Vuillemot R, Pfister H

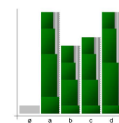
Software: open-source (JavaScript) <http://vcg.github.io/upset>

2.6. Aggregation-based Techniques



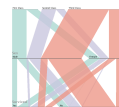
Double-Decker Plot (2000)
Hofmann H, Siebes A, Wilhelm A

Publication: [HSW00]
Software: open source (Java) <http://www.lifl.fr/~jourdan/download/arv.html>
R implementation (as part of the arulesViz package, which also produces mosaic displays) <http://cran.r-project.org/web/packages/arulesViz/index.html>.



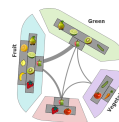
Set'o'grams (2008)
Freiler W, Matkovic K, Hauser H

Publication: [FMH08]
Website: <http://www.cg.tuwien.ac.at/research/publications/2008/freiler-2008-ste/>
Software: contact authors (C++)
Presentation: talk at InfoVis 2008 <http://vimeo.com/groups/210427/videos/76193449/>



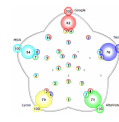
Parallel Sets (2005)
Bendix F, Kosara R, Hauser H

Publication: [KBH06]
Website: <http://eagereyes.org/parallel-sets>
Software: open source Java implementation downloadable from the website. Web implementation in JavaScript <http://www.jasondavies.com/parallel-sets/>



Radial Sets (2013)
Alsallakh B, Aigner W, Miksch S, Hauser H

Publication: [AAMH13]
Website: <http://radialsets.org>
Software: interactive Demos in Java and JavaScript
Demonstration: demonstrating interaction <http://youtu.be/UcYRrPqC5A8>
Presentation: available on the website



MetaCrystal (2004)
Spoerri A

Publication: [Spo04]
Website: <http://comminfo.rutgers.edu/~aspoerri>

3. Theses on Set Visualizations

Stirling Christopher Chow (2007), *Generating and Drawing Area-Proportional Venn and Euler Diagrams*, PhD thesis, Department of Computer Science, University of Victoria, Victoria, BC, Canada.

Wolfgang Freiler (2008), *Set Type Enabled Information Visualization*, Master thesis, Institute of Computer Graphics and Algorithms, Vienna University of Technology, Austria.

Paolo Simonetto (2011), *Visualisation of Overlapping Sets and Clusters with Euler Diagrams*, PhD thesis, École doctorale de mathématiques et informatique, Université Bordeaux 1, Talence, France.

Luana Micallef (2013), *Visualizing Set Relations and Cardinalities Using Venn and Euler Diagrams*, PhD thesis, School of Computing, University of Kent, UK.

References

- [AAMH13] ALSALLAKH B., AIGNER W., MIKSCH S., HAUSER H.: Radial sets: Interactive visual analysis of large overlapping sets. *Visualization and Computer Graphics, IEEE Trans. on 19*, 12 (2013), 2496–2505. 6
- [CPC09] COLLINS C., PENN G., CARPENDALE S.: Bubble sets: Revealing set relations with isocontours over existing visualizations. *Visualization and Computer Graphics, IEEE Trans. on 15*, 6 (2009), 1009–1016. 4, 5
- [CR03] CHOW S., RUSKEY F.: Drawing area-proportional Venn and Euler diagrams. In *Graph Drawing* (2003), Springer, pp. 466–477. 3
- [CR05a] CHOW S., RODGERS P.: Constructing area-proportional Venn and Euler diagrams with three circles. In *International Workshop on Euler Diagrams* (2005). 3
- [CR05b] CHOW S., RUSKEY F.: Towards a general solution to drawing area-proportional Euler diagrams. *Electronic Notes in Theoretical Computer Science 134* (2005), 3–18. 3
- [CVW09] COLLINS C., VIEGAS F. B., WATTENBERG M.: Parallel tag clouds to explore and analyze faceted text corpora. In *IEEE Symposium on Visual Analytics Science and Technology (VAST)* (2009), IEEE, pp. 91–98. 5
- [DHRRD12] DÖRK M., HENRY RICHE N., RAMOS G., DUMAIS S.: PivotPaths: Strolling through faceted information spaces. *Visualization and Computer Graphics, IEEE Trans. on 18*, 12 (2012), 2709–2718. 5
- [DPSR10] DELANEY A., PLIMMER B., STAPLETON G., RODGERS P.: Recognizing sketches of Euler diagrams drawn with ellipses. *Proceedings of the 16th International Conference on Distributed Multimedia Systems (DMS)* (2010), 305–310. 4
- [DvKSW12] DINKLA K., VAN KREVELD M., SPECKMANN B., WESTENBERG M.: Kelp diagrams: Point set membership visualization. *Computer Graphics Forum 31*, 3 (2012), 875–884. 5
- [FH02] FLOWER J., HOWSE J.: Generating Euler diagrams. In *Diagrammatic Representation and Inference (Diagrams)*, LNCS, vol. 2317. Springer, 2002, pp. 285–285. 2
- [FMH08] FREILER W., MATKOVIC K., HAUSER H.: Interactive visual analysis of set-typed data. *Visualization and Computer Graphics, IEEE Trans. on 14*, 6 (2008), 1340–1347. 6

- [FRM03] FLOWER J., RODGERS P., MUTTON P.: Layout metrics for Euler diagrams. In *International Conference Information Visualisation (IV)* (2003), pp. 272–280. 2
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