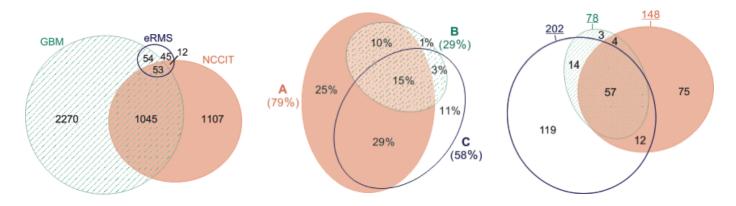
euler APE Drawing Area-Proportional Euler and Venn Diagrams using Ellipses

This is the first automatic area-proportional Euler diagram drawing tool that uses ellipses. It generates an exact diagram for most of the cases, and when it fails, the best diagram obtained through the hill climbing search is displayed, together with the inaccuracy values for each region. Formal evaluation demonstrates that in contrast to various methods that use either circle or polygons, accurate and intuitive Venn diagrams can be drawn for most random 3-set data using ellipses, which like circles are smooth and have good continuity. Other formal evaluation is being carried out to investigate how well it can handle data sets with regions whose area has to be zero. More work is being carried out to improve the design and features of future releases. Thus, any feedback is greatly appreciated. It is currently restricted to three curves, but later on, it will be extended to handle more curves. Please acknowledge euler*APE* whenever used.



eulerAPE for real-world data: click on the image to view the diagram published in the journal article that discussed this real-world data

New improved version: eulerAPE v3

This page is dedicated to the latest version, eulerAPE v3. Previous versions are available at: v2, v1.

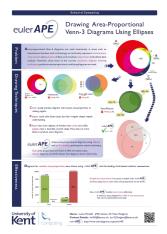
The drawing algorithm of eulerAPE v3 has been improved. Minor changes to the interface have been made.

As in eulerAPE v2,

- diagrams can be exported in png and svg formats or in eld format to reveal the properties of the ellipses in the diagram,
- black and white images of the generated diagrams can be produced,
- region areas saved in a file (.els) or computed from a diagram in a file (.eld) can be loaded.

Also, eulerAPE v3 is:

- locale-independent,
- support command-line execution,
- fully tested on both Windows and Mac OS X.



The Pacific Northwest National Laboratory (PNNL) mentions eulerAPE on their Venn Diagram Plotter webpage, as an improved method for drawing area-proportional Venn diagrams with three curves.

Currently, eulerAPE is being used for various application areas, such as health, medicine, bioinformatics, proteomics, genomics, biophysics, life sciences, brain and mind sciences, statistics, marketing, classification and database queries.

eulerAPE v2 was selected for participation in the ACM Student Research Competition (SRC) at the 2012 Grace Hopper Celebration (poster to the left).

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Downloads

file	executable / source	comments	date
eulerAPE_3.0.0.jar	executable	the executable to run eulerAPE v3.0.0 on Windows or Mac OS X (not tested on other operating systems)	Nov 18, 2013
eulerAPE_3.0.0_src.zip	source	the source code for eulerAPE v3.0.0	Nov 18, 2013

Ideal screen resolution: 1290×740 or better

NOTE: when you download any of these files, you are agreeing to eulerAPE's Licensing Terms

Getting Started

- 1. Download and install Java version 6.0 or greater. on your machine.
- 2. Download eulerAPE_3.0.0.jar.
- 3. Double click on the downloaded eulerAPE_3.0.0.jar to run eulerAPE.

Running on Mac OS X and getting the following message?



Open System Preferences and go to Security & Preferences.

If you get a message like the one in the red, dashed box below

00	Security & Privacy
Image: Share S	now All
	General FileVault Firewall Privacy
Α	login password has been set for this user Change Password
	Require password immediately + after sleep or screen saver begins
	Show a message when the screen is locked Set Lock Message
Al	low apps downloaded from: Mac App Store Mac App Store and identified developers Anywhere
	ulerAPE_3.0.0.jar" was blocked from opening because it is Open Anyway of from an identified developer.
Click th	ne lock to make changes. Advanced ?

click on **Open Anyway** and then click on **Open** when you get the following.

	"eulerAPE_3.0.0.jar" is a Java application downloaded from the Internet. Are you sure you want to open it?
	Safari downloaded this file today at 16:50 from www.eulerdiagrams.org.
?	Show Web Page Cancel Open

Else, click on the lock in the bottom left corner, marked with a red, dashed box below

	Security & Privacy		
Show All		Q	
General	FileVault Firewall	Privacy	
A login password has been	set for this user Chang	ge Password	
Require password im	mediately 💠 after sleep	p or screen saver begins	
Show a message whe	en the screen is locked	Set Lock Message	
Allow apps downloaded fro Mac App Store Mac App Store and i Anywhere			
Click the lock to make changes.		Advanced	?

enter your Mac OS X account password

⊖ ⊖ ⊖ ⊲ ⊳ Sh	Security & Privacy	
	System Preferences is trying to unlock Security & Privacy preferences. Type yo password to allow this.	
Aŀ	Name: Luana Micallef	
	Password:	ns
	Cancel	Unlock
Allow apps dow	nloaded from:	
O Mac App		
Mac App Anywher	o Store and identified developers re	
0,	-	
Authenticating		Advanced ?

select **Anywhere** for *Allow apps downloaded from* and click on **Allow From Anywhere** when the warning message appears.

000	Security & Privacy	
Show All		Q.
A logir Re	Choosing "Anywhere" makes your Mac less secure. Instead, you can allow an individual application f an unknown developer by control-clicking its icc and selecting Open. Allow From Anywhere Can	from
Allow apps download Mac App Store Mac App Store Anywhere		
Click the lock to prevent fur	ther changes.	Advanced ?

Finally click on the lock in the bottom left corner, close the **Security & Preferences** window, and try to run eulerAPE by double clicking on the downloaded eulerAPE_3.0.0.jar.

If you get the follow message box, click **Open** to run eulerAPE.

	"eulerAPE_3.0.0.jar" is a Java application downloaded from the Internet. Are you sure you want to open it?
	Safari downloaded this file today at 16:47 from www.eulerdiagrams.org.
?	Show Web Page Cancel Open

Running eulerAPE: in 3 steps

* the image below illustrates interface when run on Windows

eulerAPE: Drawing Area-Proportional Euler and Venn Diagrams using Ellipses								- • ×
euler APE in 3 steps		region a b c ab ac bc abc	random	6 area	actu area	Jal % area	required	- actual % area
2 choose your p i or leave as defa			SAVE TO F Directo File nar LABELS	ry	no	COLOUR ®	browse	
3 click RUN to g diagram	enerate the	Starting [TS ® ell	ipses () cir ves () no RUN	cles	

Running euler APE: reference guide

* the images below illustrate interface when run on Windows and when the system locale is set to English

When eulerAPE starts, such a window opens:

🗇 eulerAPE: Drawing Area-Proportional Euler and Venn Diagrams using Ellipses							- 🗆 🗙
	region	req	uired	act		required	
		area	% area	area	% area	area	% area
	а						
	b						
	с						
	ab						
	ac						
	bc						
	abc						
		random					
		load	clear all		diagError		
			TO FILE rectory			browse	
			e name]	
		LAB	ELS 🖲 yes 🤇	⊃ no	COLOUR @	ves 🔾 no	
	CURVES FOR SETS ellipses circles 						
	VIEW SEARCH 🔾 yes 🖲 no						
					2 111		
	Starting [Jiagram			RUN		

To draw an area-proportional diagram, enter the area of every region or click on the **random** button to generate random region areas from a uniform distribution in the interval [1, 10000].

🔵 eulerAPE: Drawing Area-Proportional Euler and Venn Diagrams using Ellipses						Į	- 🗆 🗙
	region	req	uired	act	ual	required	- actual
		area	% area	area	% area	area	% area
	а	6416.0	18.2%				
	b	3097.0	8.8%				
	с	7012.0	19.8%				
	ab	1742.0	4.9%				
	ac	9634.0	27.3%				
	bc	267.0	0.8%				
	abc	7163.0	20.3%				
		random					
		load	clear all		diagError		
			TO FILE				
			irectory le name			browse	
		FI	le name				
		LAB	ELS 🖲 yes (🔵 no	COLOUR @) yes 🔘 no	
	CURVES FOR SETS						
	VIEW SEARCH 🔘 yes 🖲 no						
	Starting Diagram RUN						

Alternatively, click on the **load** button and select a **.els** file ('eulerAPE region areas' file) or a **.eld** file ('eulerAPE diagram' file).

O eulerAPE: Drawing Area-Proportional Euler and Venn Diagrams using Ellipses						Į	- 🗆 X
	diag1_f diag1_i	diags_regi inal.eld dia nit.eld dia inal.eld dia nit.eld nit.eld inal.eld inal.eld e: eulerAPE eulerAPE	% area	d e e	ual % area	area	9% area 9% area
	Starting D	iagram	VIEW SEA	ARCH O	yes () no RUN		

An **eulerAPE region areas** file with extension **.els**, such as <u>this example</u> (use a text editor to open or edit the file), defines the region areas to be loaded as follows:

//a | b | c | ab | ac | bc | abc 6416.46 | 3097.123 | 7012.0 | 1742.5 | 9634.67 | 267.0 | 7163.0

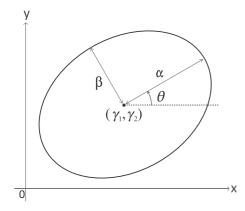
An **eulerAPE diagram** file with extension **.eld**, such as <u>this example</u> (use a text editor to open or edit the file), defines the properties of the ellipses in the diagram as follows:

DIAGRAM

ABSTRACTDESCRIPTION

0 a b c ab ac bc abc

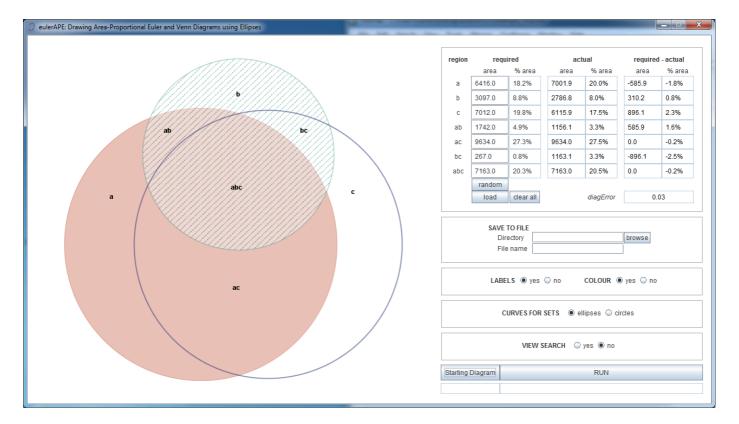
ELLIPSES - label | semi-major axis | semi-minor axis | centre - x | centre - y | rotation | a|52.0770762121543|57.12818461089164|2.891387939453125|0.003662109375|307.1356201171875| b|42.17083337286026|34.68449741129755|12.592274634627673|34.713064198564346|74.014892578125| c|48.55774377211602|59.11052662064727|27.344059440869614|-8.125|0.9979248046875|



The **label**, the semi-major axis α , the semi-minor axis β , the *x*-coordinate γ_1 and *y*-coordinate γ_2 of the centre (γ_1, γ_2) , and the angle of rotation θ of the three ellipses must be defined (one line for each ellipse). The ellipses must be labelled as **a**, **b**, **c**.

If such a file is chosen, the region areas of the diagram in the file are computed and loaded. When eulerAPE diagram files are saved (as explained later), a .eld file is generated for both the initial and the final diagram in the search.

To view the initial diagram that eulerAPE uses to start off the search process, click on the Starting Diagram button.

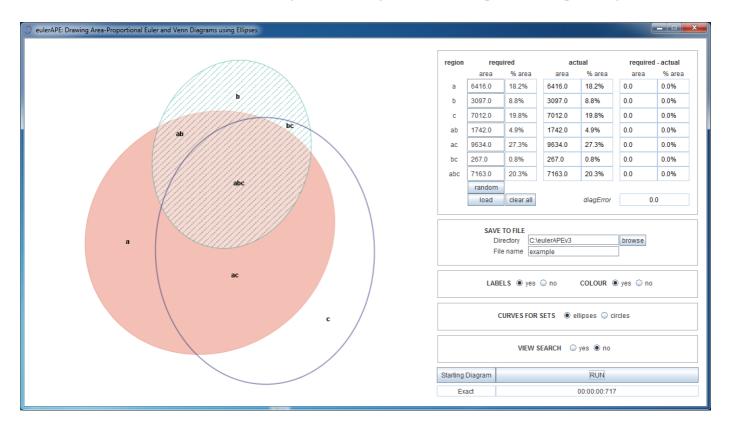


Alternatively or consequently, start the search process by clicking on the **RUN** button. Before doing so:

- 1. **SAVE TO FILE**: select the directory and the file name where images (in png and svg formats) and details of the initial and final diagram will be saved locally (if required), once the search is over and a diagram is generated
- 2. LABELS: decide whether the shown and saved diagram should have labels
- 3. COLOUR: decide whether the shown and saved diagram should be coloured or black and white
- 4. CURVES FOR SETS: select 'ellipses' or 'circles' to draw the set curves
- 5. VIEW SEARCH: decide whether you would like to view the search process or not

During the search, a timer (hours : mins : secs : msecs) is displayed in the bottom right corner of the window.

Once it stops running, a note saying **Exact** or **Inexact** is displayed just below the *Starting Diagram* button, to indicate whether an accurate or inaccurate diagram has been generated with respect to the required region areas.



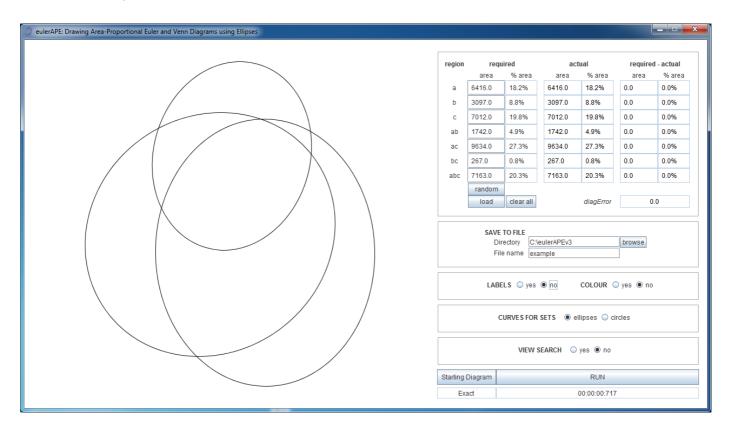
The accuracy of the generated diagram is measured by *diagError*, which is displayed below the table of the required and actual region areas.

If R is the set of regions in the diagram,

$$diagError = max_{r \in \mathbb{R}} \left| \frac{\text{required area of region } r}{\text{total area of the required diagram}} - \frac{\text{actual area of region } r}{\text{total area of the actual diagram}} \right|$$

An accurate, **Exact** diagram with respect to the required region areas is one with $diagError \le 10^{-6}$.

At any point, you can show or hide **labels** and switch between **colour** and black and white mode. The diagram is saved after the search is completed and thus, for the desired visuals to be saved locally, these options have to be set before clicking on the **RUN** button.



To generate a diagram for a new set of region areas, click the **clear all** button and enter the areas manually, randomly or load them automatically from a file, as explained earlier.

Running eulerAPE: from the command-line

Open the **command prompt** and change the **current working directory** to the directory where <u>eulerAPE_3.0.0.jar</u> is saved.

Type in

```
java -Duser.language=xx -Duser.region=XX -jar eulerAPE 3.0.0.jar
```

where

- xx is the ISO 639 alpha-2 (or ISO 639-1) **language code** (e.g., it for Italian; codes available at <u>http://www.loc.gov/standards/iso639-2/php/code_list.php</u>)
- XX is the ISO 3166 alpha-2 (or ISO 3166-1) **country code** (e.g., IT for Italy; codes available at <u>http://www.iso.org/iso/home/standards/country_codes/iso-3166-1_decoding_table.htm</u>)

followed by the required options:

option	parameter	requ ired	default
-i or input	the path to a .els ('eulerAPE region areas') file, such as <u>this</u> <u>example</u> (use a text editor to open or edit the file) defining the region areas for which a diagram will be generated	yes	-
-o or output	the path to the directory where the images (in png and svg formats) and the .eld ('eulerAPE diagram') file, such as <u>this</u> <u>example</u> (use a text editor to open the file) of the generated diagram will be saved	no	current working directory
-l or showlabels	yes or no	no	yes
-c or showincolour	yes or no	no	yes
curves	ellipses or circles	no	ellipses
-s or silent	-	no	-

Example

```
java -Duser.language=it -Duser.region=IT -jar eulerAPE_3.0.0.jar
-i "C:\regionareas.els" -o "C:\eulerAPEv3_diagrams"
-l yes -c yes --curves ellipses -s
```

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Other Drawing Tools - you might be interested in



The first method using a force-directed approach to automatically lay out Euler diagrams and to do so in relatively fast time. http://www.eulerdiagrams.org/eulerForce

The first automatic diagram drawing tool that draws area-proportional Euler diagrams, glyph representations and hybrid visualizations combining both Euler diagrams and glyphs. http://www.eulerdiagrams.org/eulerGlyphs

For any questions, please contact <u>Luana Micallef</u> or <u>Peter Rodgers</u> (L.Micallef@kent.ac.uk; P.J.Rodgers@kent.ac.uk).

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