

Evolutionary dataset optimisation: learning algorithm quality through evolution

Henry Wilde, Dr. Jonathan Gillard, Dr. Vincent Knight



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Motivation





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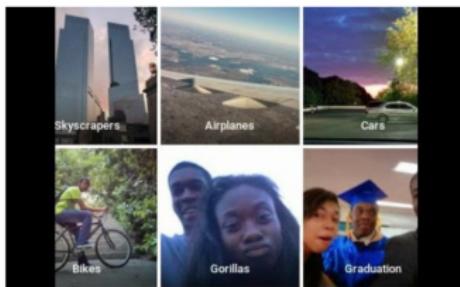
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Google apologises for Photos app's racist blunder

⌚ 1 July 2015

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EU considers potential Brexit delay

EU leaders remain locked in discussions amid reports that they may offer a delay until 7 May.

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Latest as EU leaders meet in Brussels

⌚ 18 March 2019

Trump: Time to recognise Golan as Israeli

⌚ 1 hour ago

Features



via: BBC News (<https://www.bbc.co.uk/news/technology-33347866>)

Reliability and frailty

A. Torralba and A. A. Efros. *Unbiased Look at Dataset Bias*. Proceedings of the 2011 IEEE Conference on Computer Vision and Pattern Recognition. 2011. DOI: [10.1109/CVPR.2011.5995347](https://doi.org/10.1109/CVPR.2011.5995347)

Generating artificial data



via: <https://thispersondoesnotexist.com>

Barney Sparks

✉ barneysparks@gmail.com 🗺 Allentown, Pennsylvania



EXPERIENCE

Operations Analyst

Youth 2014 - Ongoing Allentown, Pennsylvania

Youth is a leading platform that is developing a product in cloud and in-house platforms.

- Provided support of over 50 international startups and change
- Managed a team of 10 people in a staff of 10 people
- Managed 10 projects with 4 projects per day management of the company and included an average of 200 companies and 2 employees in the first role.
- Increased the company by 100% in 2014 and 2011 and 2015.

Head Of Marketing And Controller

X-Main 2010 - 2014 Allentown, Pennsylvania

X-main is a software company that provides young people with leadership development and enterprise software used in Junico and the construction industry.

- Created 3 consultants to provide internal and staff & maintenance strategies and incorporated the company with timely companies resulting in \$2MM in conduct and increased the company to 100 people in less than 3 months

SUMMARY

I am a highly motivated and proven pursuits where my work diverse individual with others into the field of interest and be like interependency to go to their practice clinic.

TECHNOLOGIES

PHP Ansi C Perl

Oracle BRM Pipeline Oracle BRM CMT

Java Shell Script Linux

Oracle BRM

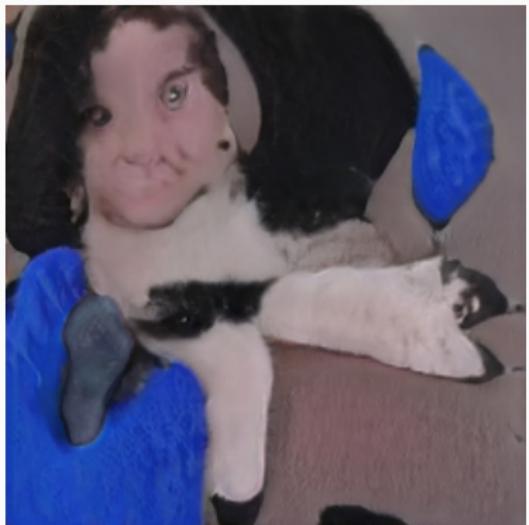
EDUCATION

Unige, Faculty Of Medicine

University Of Geneva

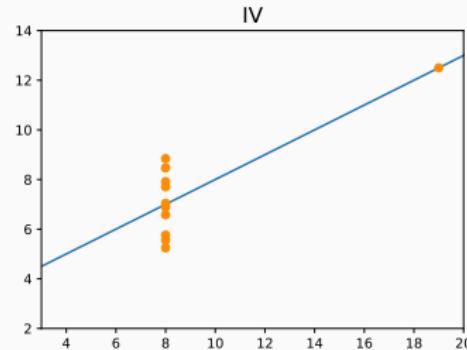
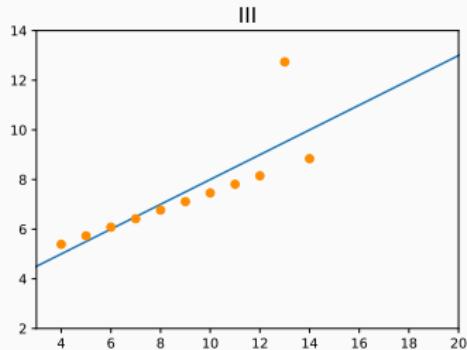
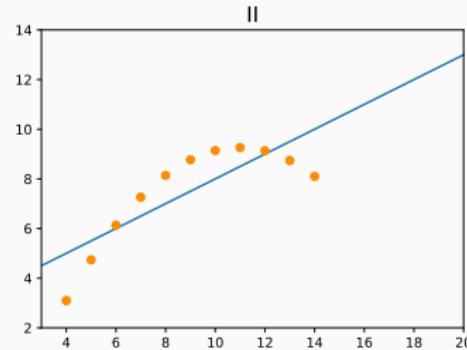
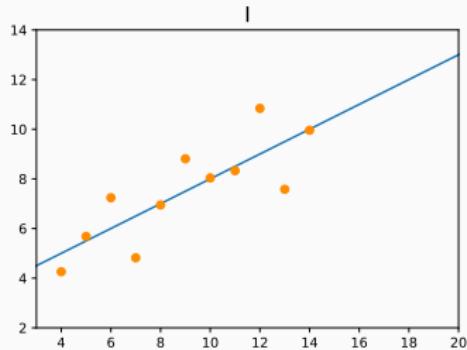
2000 2001 2002 2003 2004

via: <https://thisresumedoesnotexist.com>

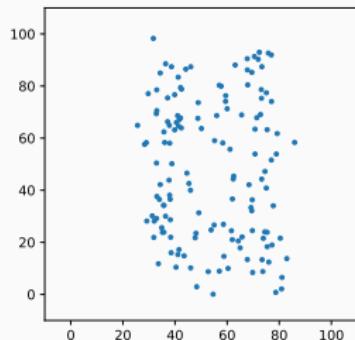
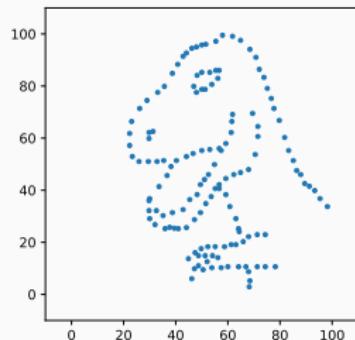
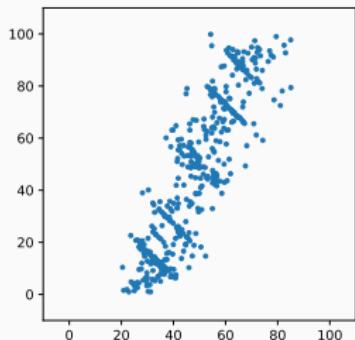


via: <https://thiscatdoesnotexist.com>

Anscombe's quartet

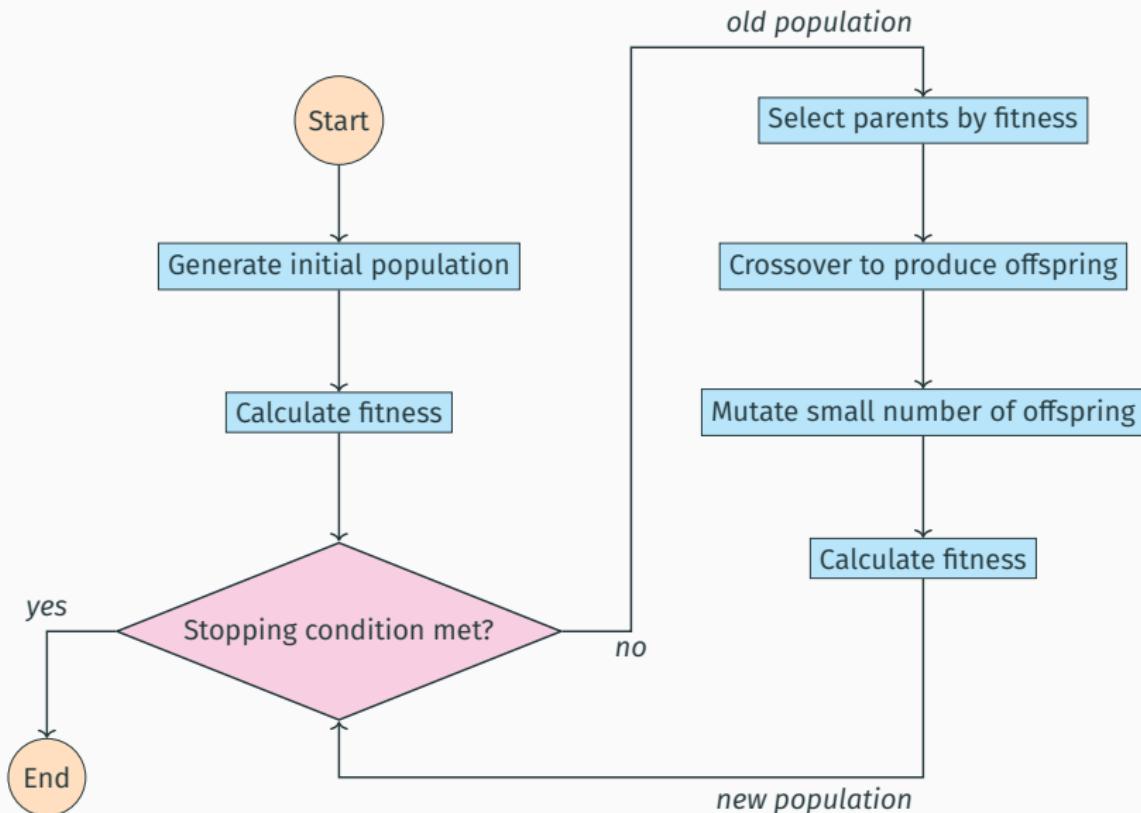


The Datasaurus dozen



Given an algorithm, how can one
find data for which it performs
well?

Evolutionary algorithms



$$f:\mathbb{N}^2\rightarrow \mathbb{N};\qquad f(x_1,x_2)=x_1+x_2$$

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Population (25, 30) (12, 1) (11, 0) (20, 12) (24, 25)

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Population (25, 30) (12, 1) (11, 0) (20, 12) (24, 25)

Get fitness 55 13 11 42 49

$$f : \mathbb{N}^2 \rightarrow \mathbb{N}; \quad f(x_1, x_2) = x_1 + x_2$$

Population	(25, 30)	(12, 1)	(11, 0)	(20, 12)	(24, 25)
Get fitness	55	13	11	42	49
Select parents	(25, 30)			(20, 12)	(24, 25)

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Select parents	(25, 30)			(20, 12)	(24, 25)
Create offspring		(24, 30)	(25, 12)		
Mutate offspring		(15, 30)	(25, 26)		

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Create offspring		(24, 30)	(25, 12)		
Mutate offspring		(15, 30)	(25, 26)		
New generation	(25, 30)	(15, 30)	(25, 26)	(20, 12)	(24, 25)

- A fitness function, f , which acts on a single dataset
- A population size, $N \in \mathbb{N}$
- Limits on the number of rows a dataset can have:

$$R \in \left\{ (r_{\min}, r_{\max}) \in \mathbb{N}^2 \mid r_{\min} \leq r_{\max} \right\}$$

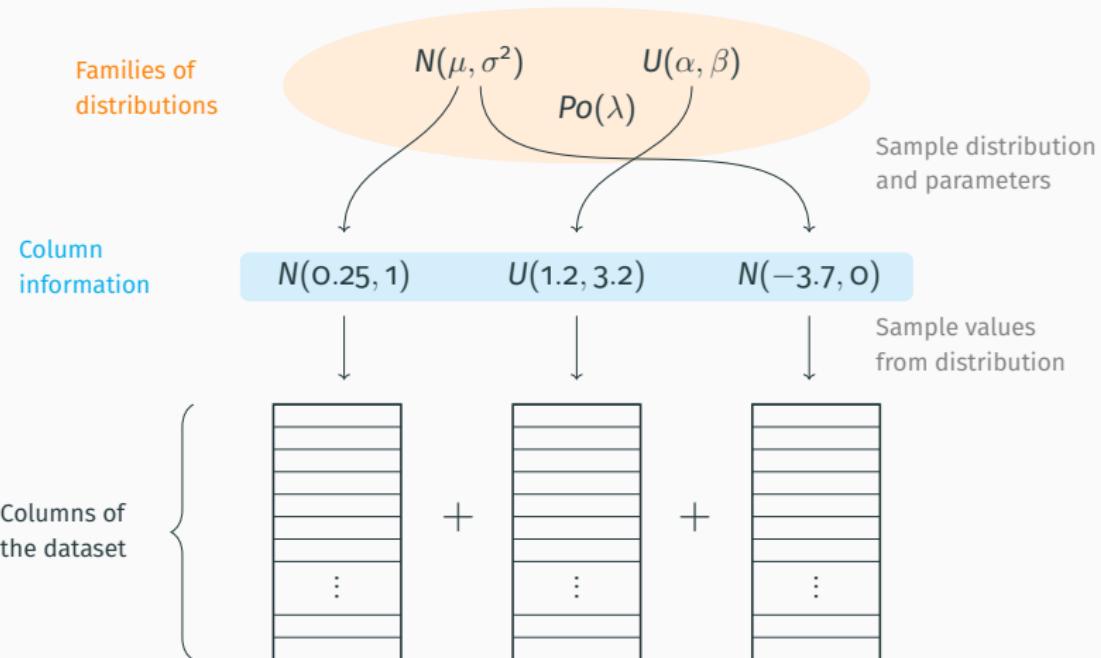
- Limits on the number of columns a dataset can have:

$$C := (c_1, \dots, c_{|\mathcal{P}|}) \text{ where } c_j \in \left\{ (c_{\min}, c_{\max}) \in (\mathbb{N} \cup \{\infty\})^2 \mid c_{\min} \leq c_{\max} \right\}$$

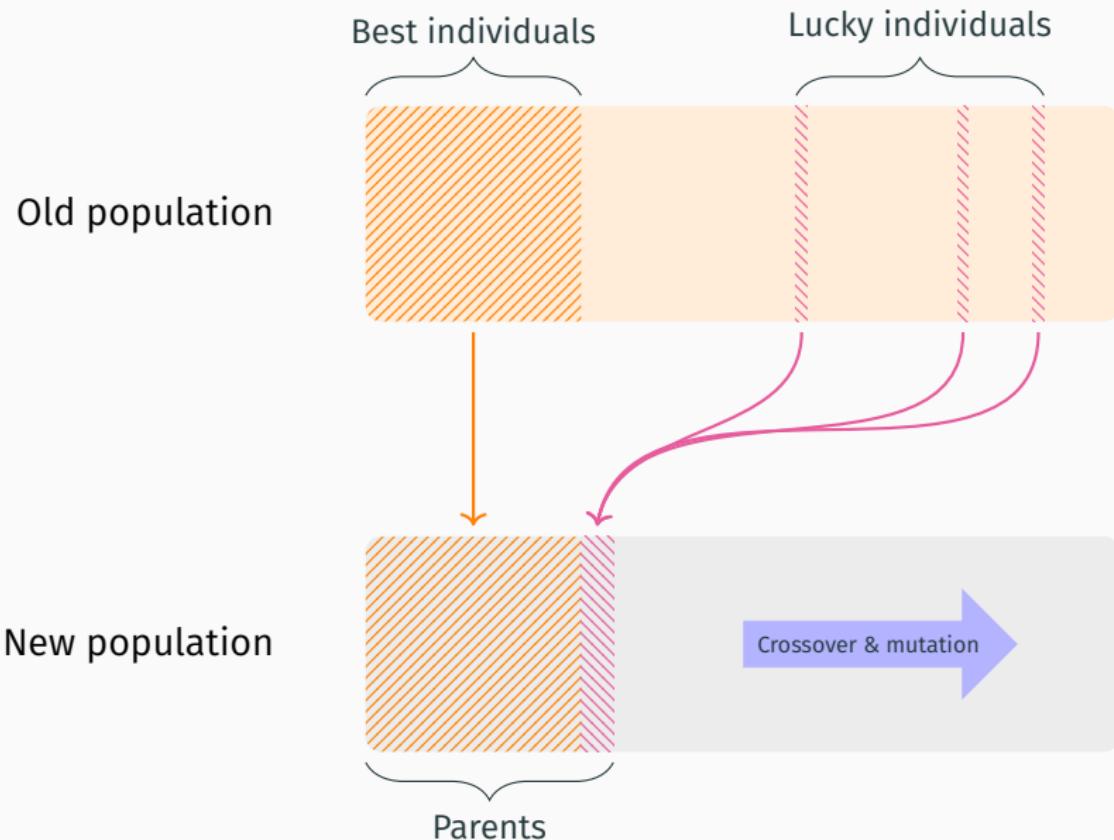
for each $j = 1, \dots, |\mathcal{P}|$

- A set of probability distribution families, \mathcal{P} . Each family in this set has some parameter limits which form a part of the overall search space
- A probability vector to sample distributions from \mathcal{P} , $w = (w_1, \dots, w_{|\mathcal{P}|})$
- A maximum number of iterations, $M \in \mathbb{N}$
- Two selection parameters: one to indicate the proportion of the fittest individuals to carry forward, $b \in [0, 1]$, and the other to allow for a small proportion of “lucky” individuals, $l \in [0, 1]$
- A mutation probability, $p_m \in [0, 1]$
- A shrink factor, $s \in [0, 1]$. The relative size of a component of the search space to be retained after adjustment

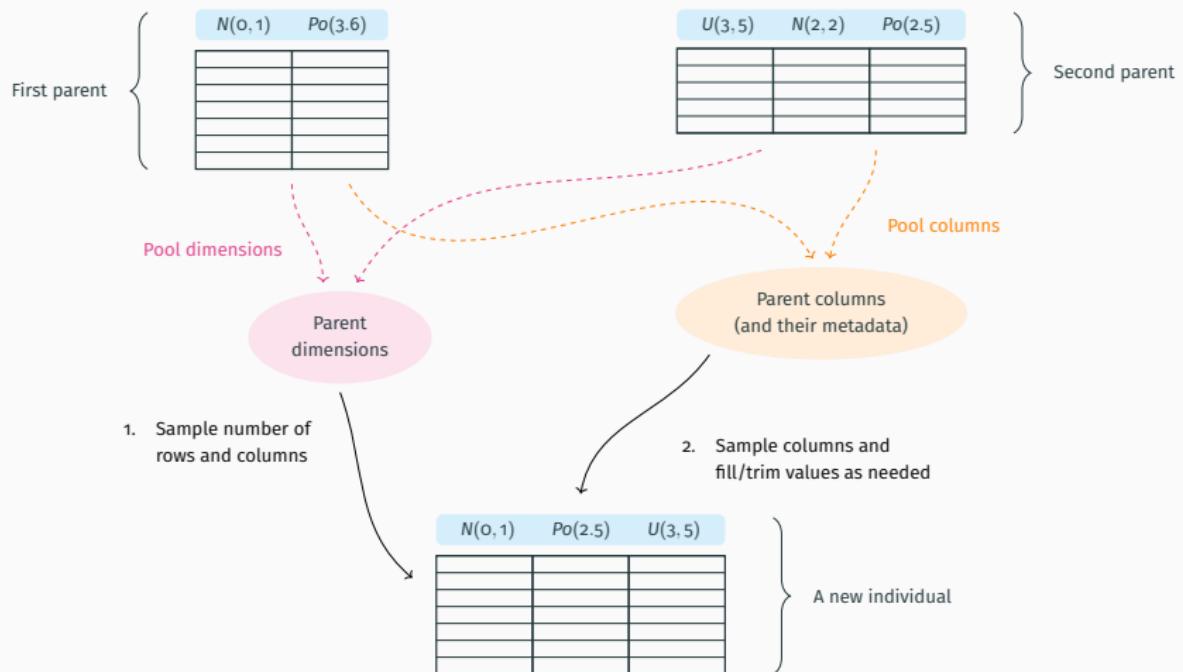
Individuals



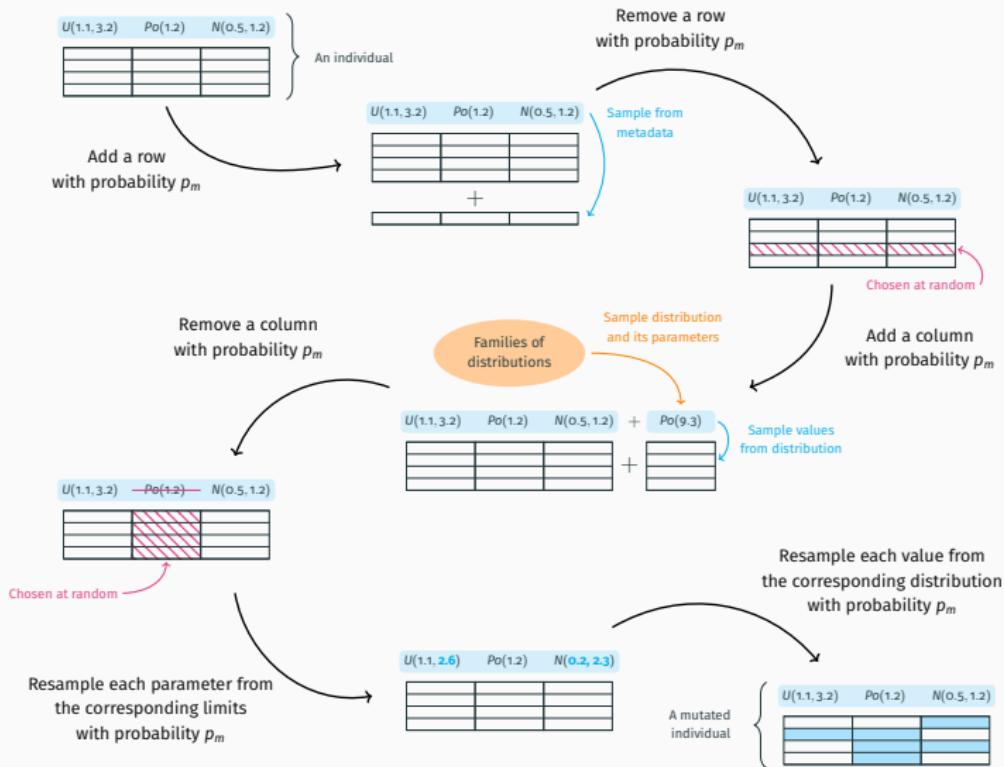
Selection



Crossover



Mutation



Some example use cases

Input: A dataset, $X \in \mathbb{R}^n \times \mathbb{R}^n$;

$$f : \mathbb{R}^n \times \mathbb{R}^n \rightarrow \mathbb{R}, \quad f(A, B) = \text{Var}(A) - \max_i |B_i - 1|$$

Output: The maximal value for f

values $\leftarrow \emptyset$

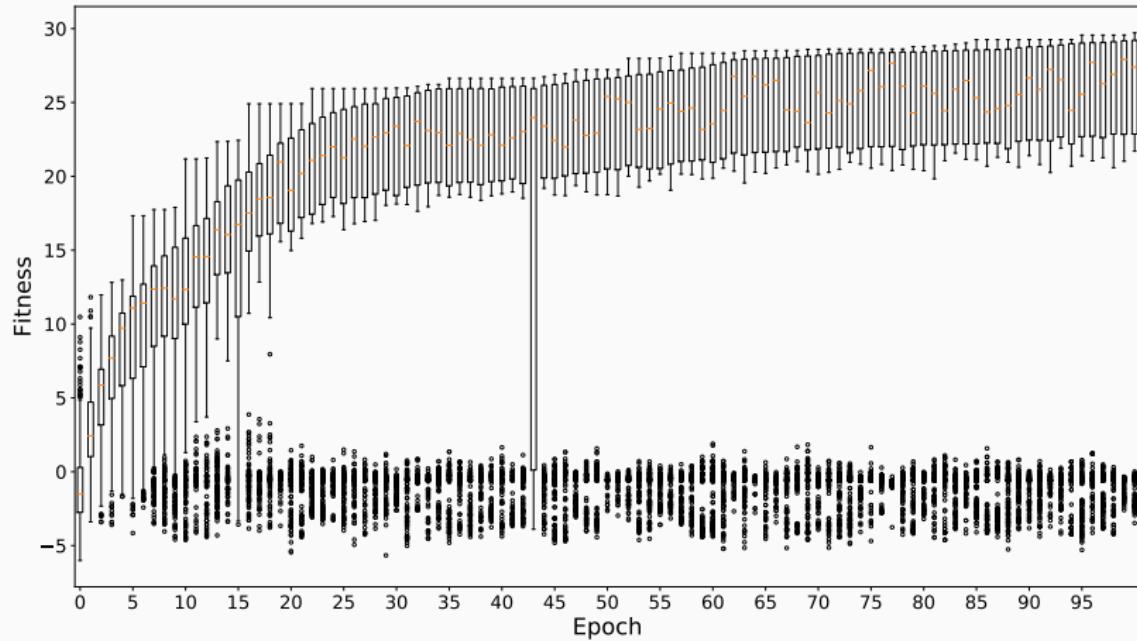
for each ordering, $a, b \in \{0, 1\}^2$, of the columns **do**

calculate $f(X^{(a)}, X^{(b)})$

append this to *values*

end

return max *values*



Input: A dataset, $X \in \mathbb{R}^n$; some sampling proportion, $p \in [0, 1]$;
a number of samples to take, k

Output: The maximum **difference** between each sampled
mean of X and 0

values $\leftarrow \emptyset$

for $i = 1, \dots, k$ **do**

$Y \leftarrow$ a random sample of $\lfloor np \rfloor$ entries from X
evaluate the mean of Y :

$$\bar{Y} = \frac{1}{|Y|} \sum_{i=1}^{|Y|} Y_i$$

append \bar{Y} to *values*

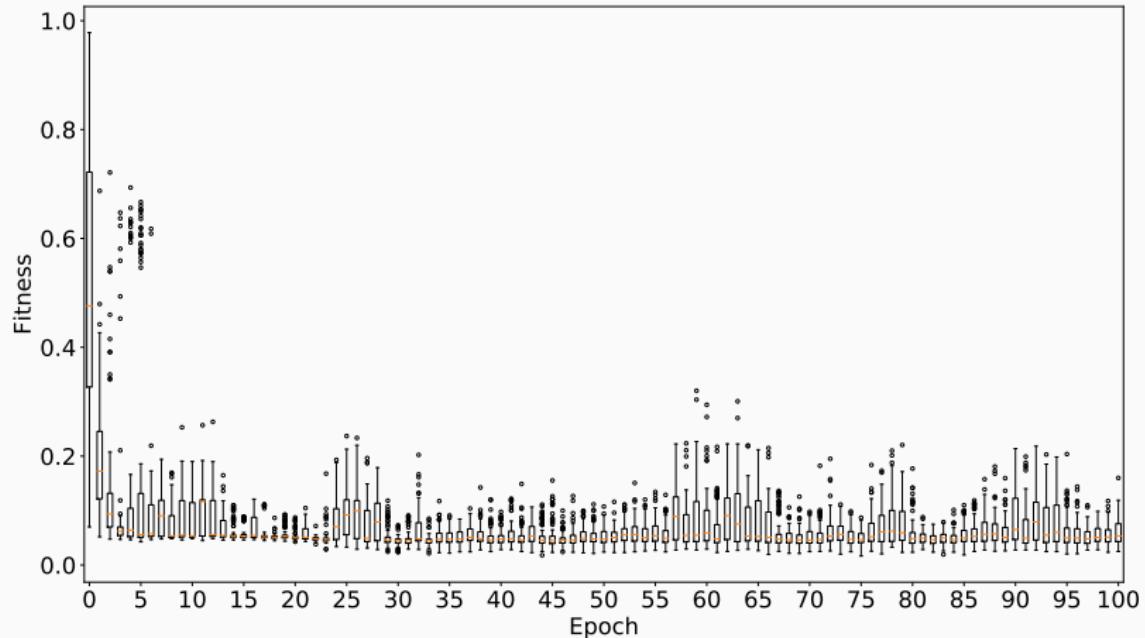
end

return *max values*

X {

$U(-0.06, 0.91)$		Metadata
<hr/>		
o		
0	-0.142152	
1	0.0433848	
2	0.0727756	
...	...	
45	0.0670734	
46	0.0866879	
47	0.0137398	
<hr/>		

} Dataset

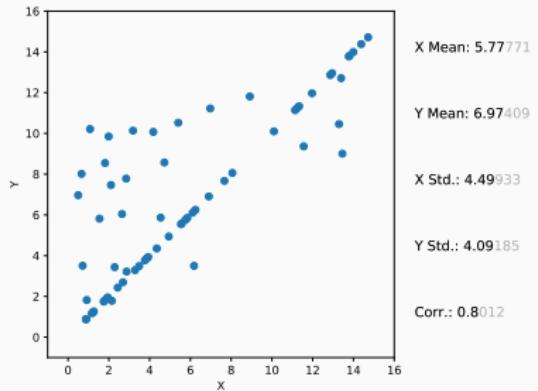
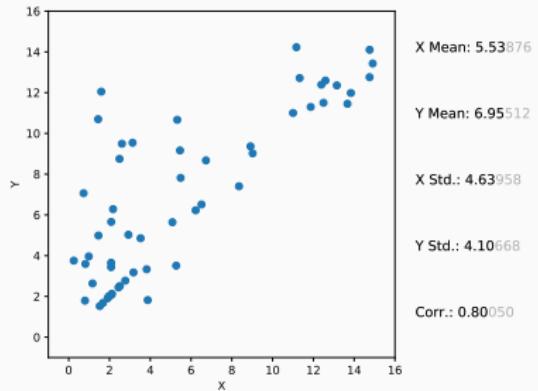
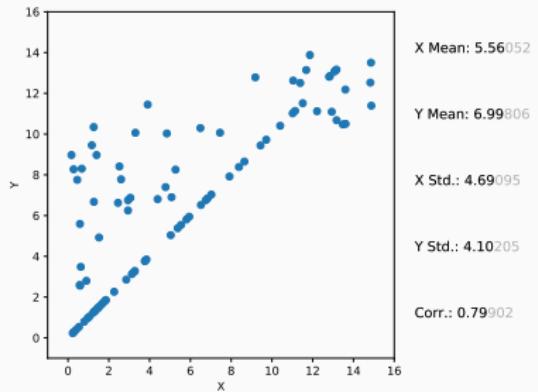
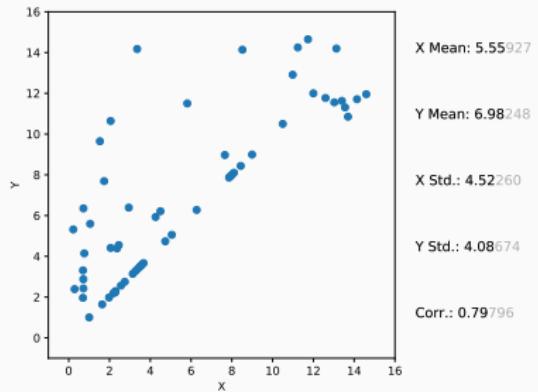


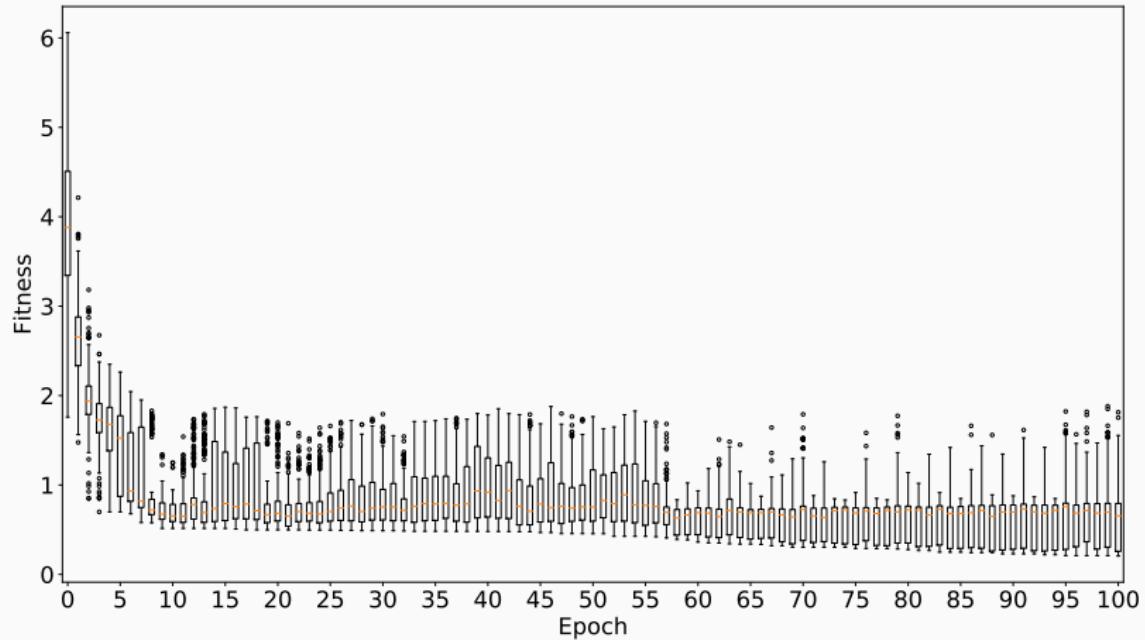
Input: A dataset, $X \in \mathbb{R}^n \times \mathbb{R}^n$; a set of **dissimilarity** measures,
 $f_1, \dots, f_k : \mathbb{R}^n \times \mathbb{R}^n \rightarrow \mathbb{R}$

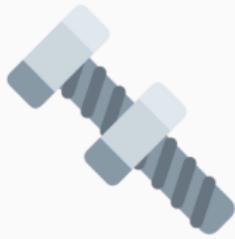
Output: The total of the measures: $\sum_{i=1}^k f_i(X)$

```
sum ← 0
for  $i = 1, \dots, k$  do
    | evaluate  $f_i(X)$ 
    | add this to sum
end
return sum
```

X Mean: 5 Y Mean: 7 X Std.: 4.7 Y Std.: 4.1 Corr.: 0.8







```
$ pip install edo
```

Henry Wilde

Twitter: @daffidwilde

Email: henrydavidwilde@gmail.com

Repository: <https://github.com/daffidwilde/edo>

Documentation: <https://edo.readthedocs.io>

Paper in preparation:

“Evolutionary Dataset Optimisation: understanding algorithm quality through evolution”