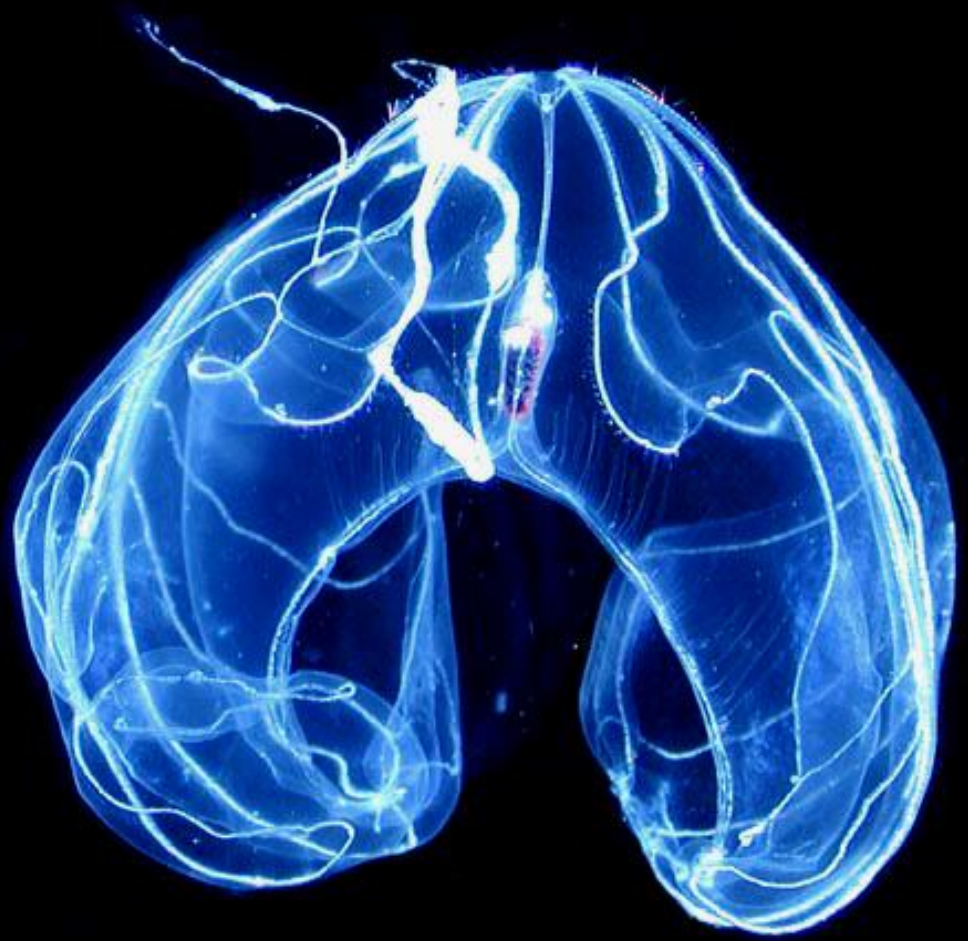
Please ask questions via the mobile app!

Engage

GOTO Berlin
Berlin 6th November 2014
@GOTOber #gotober



carlo zapponi
@littleark

Bioluminescent creatures of the deep sea

Give your proposal a simple and straightforward title.

Clever or inappropriate titles make it harder for people to figure out what you're really talking about.

Bioluminescent creatures
of the deep sea.

what are we really
talking about today?

ALGORITHMS

SORTING ALGORITHMS

hold on! don’t run away
because we’ll talk about…

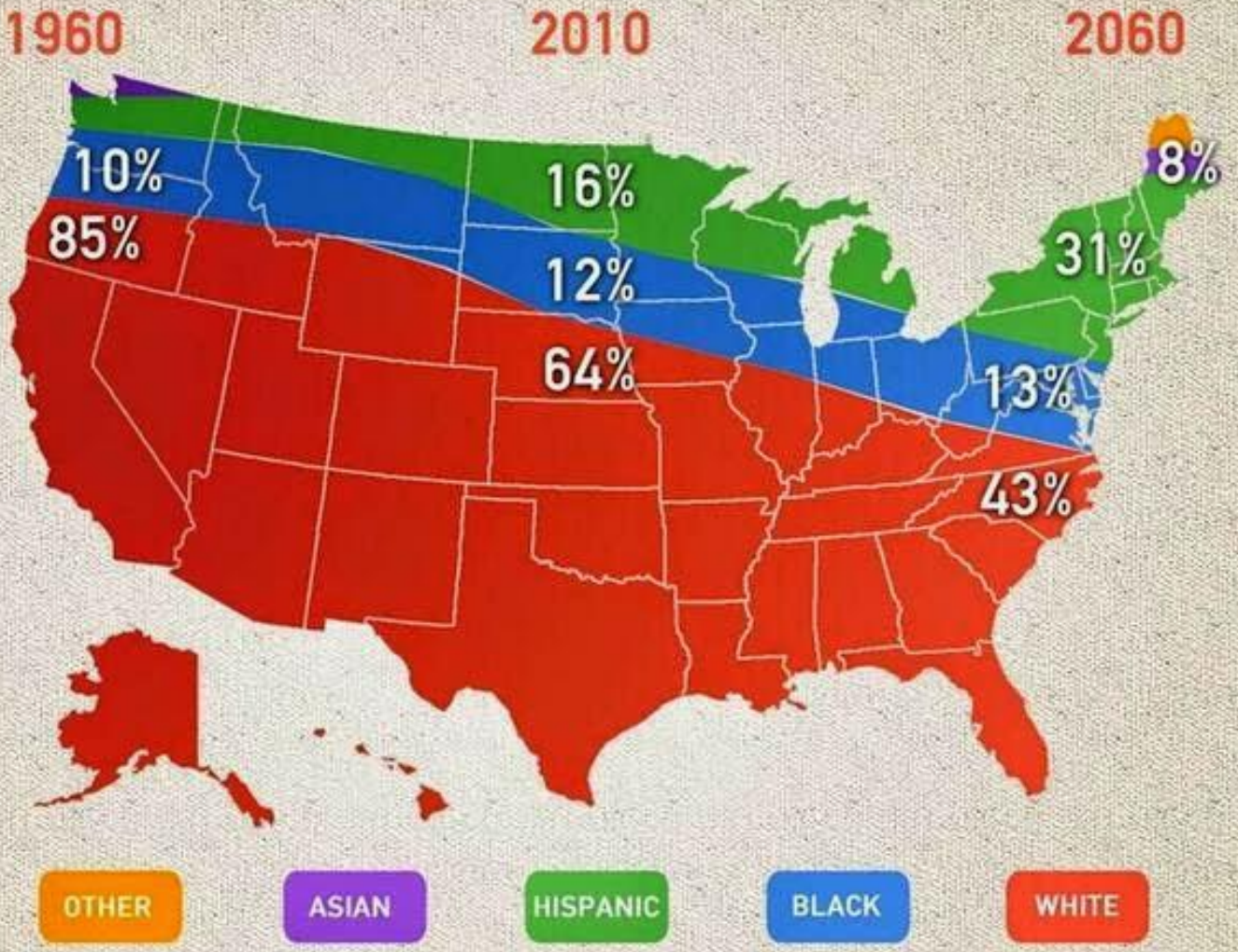
VISUALIZING SORTING ALGORITHMS

fun facts

changing face of America

CHANGING FACE OF AMERICA

Percent of total U.S. population by race and ethnicity, 1960-2060



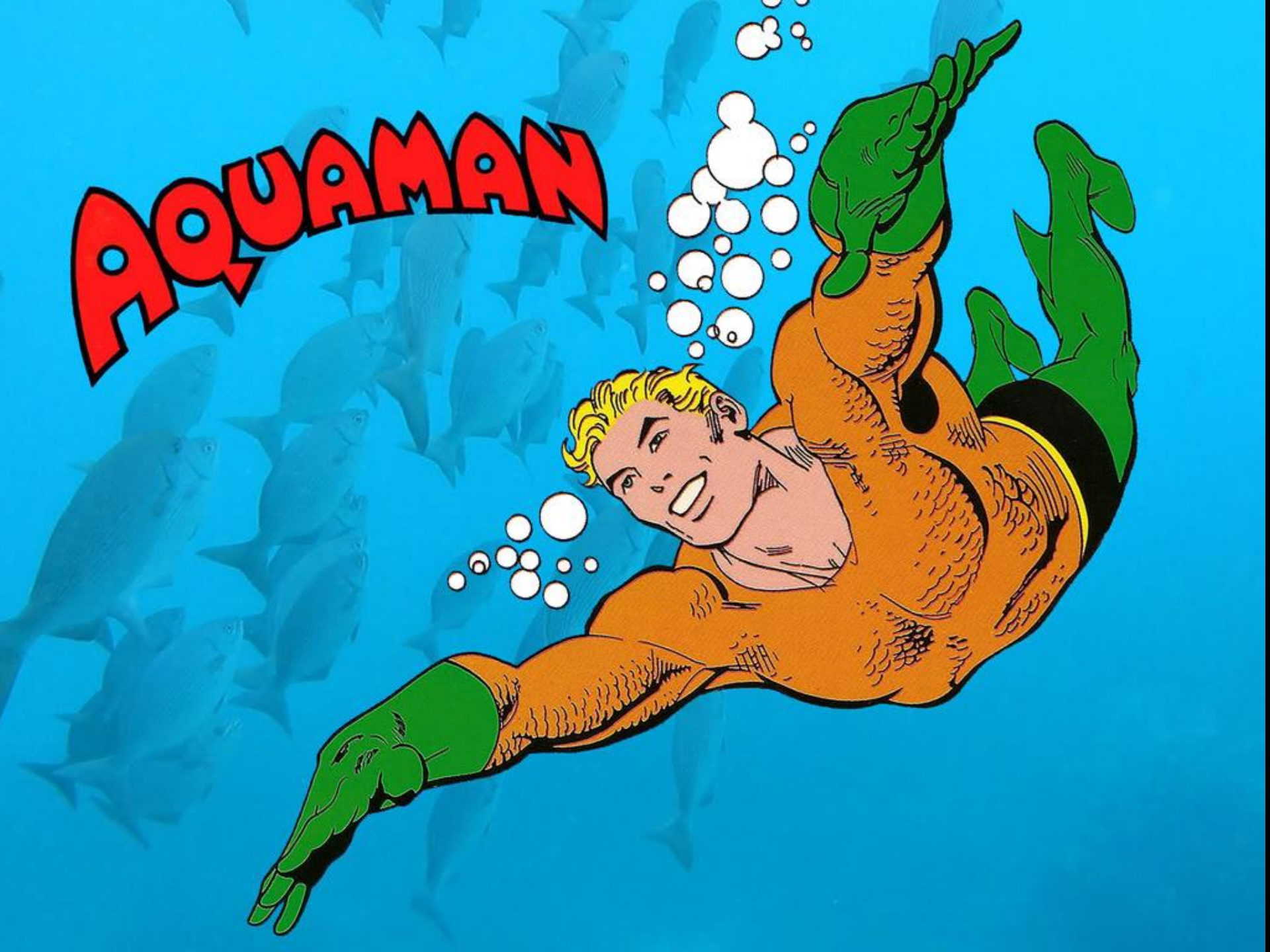
SOURCE: PEW RESEARCH CENTER

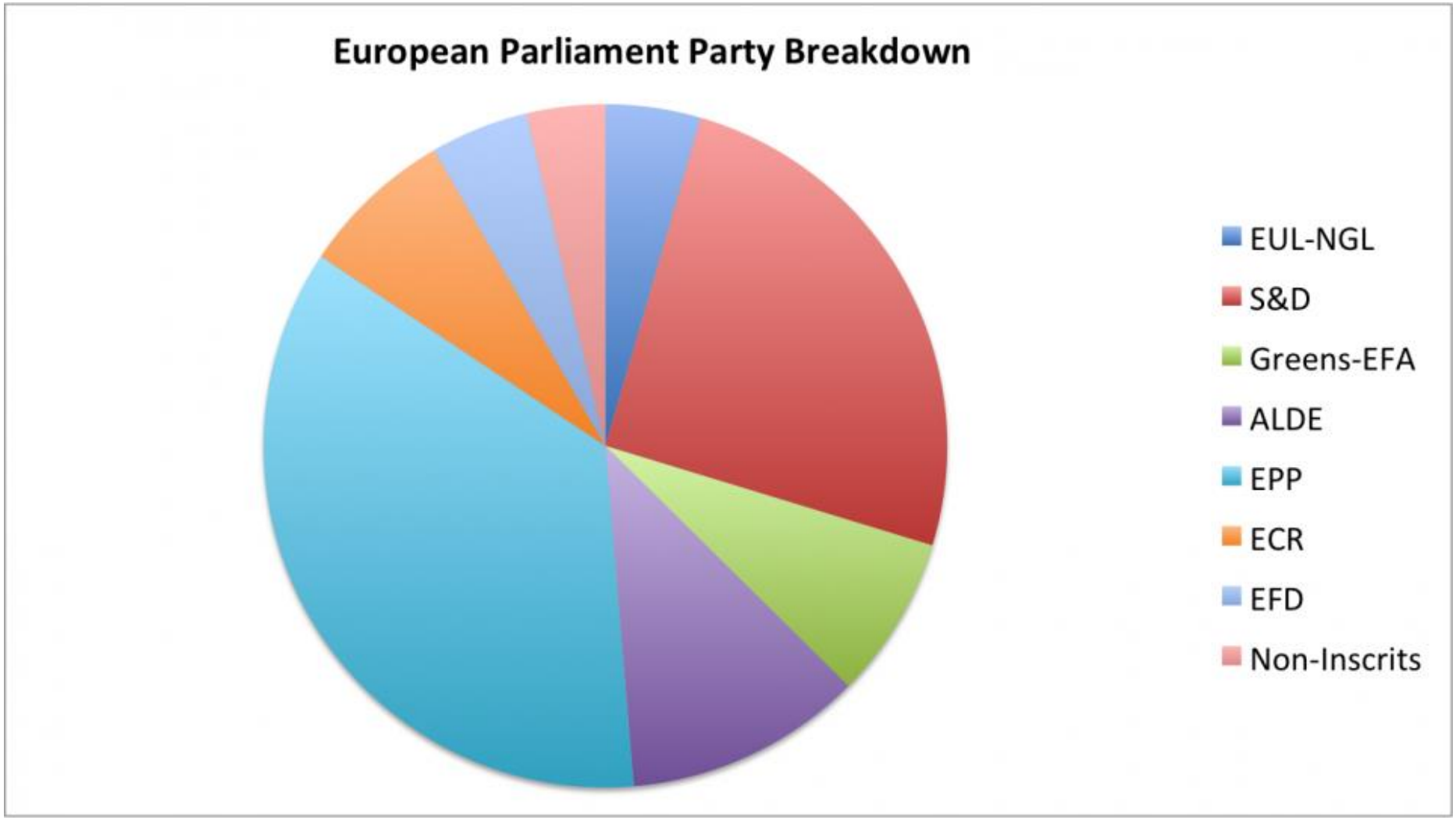
NIGHTLY NEWS with BRIAN WILLIAMS

atlanta falcons

https://twitter.com/mr_mdjones/status/524874356879790080/photo/1

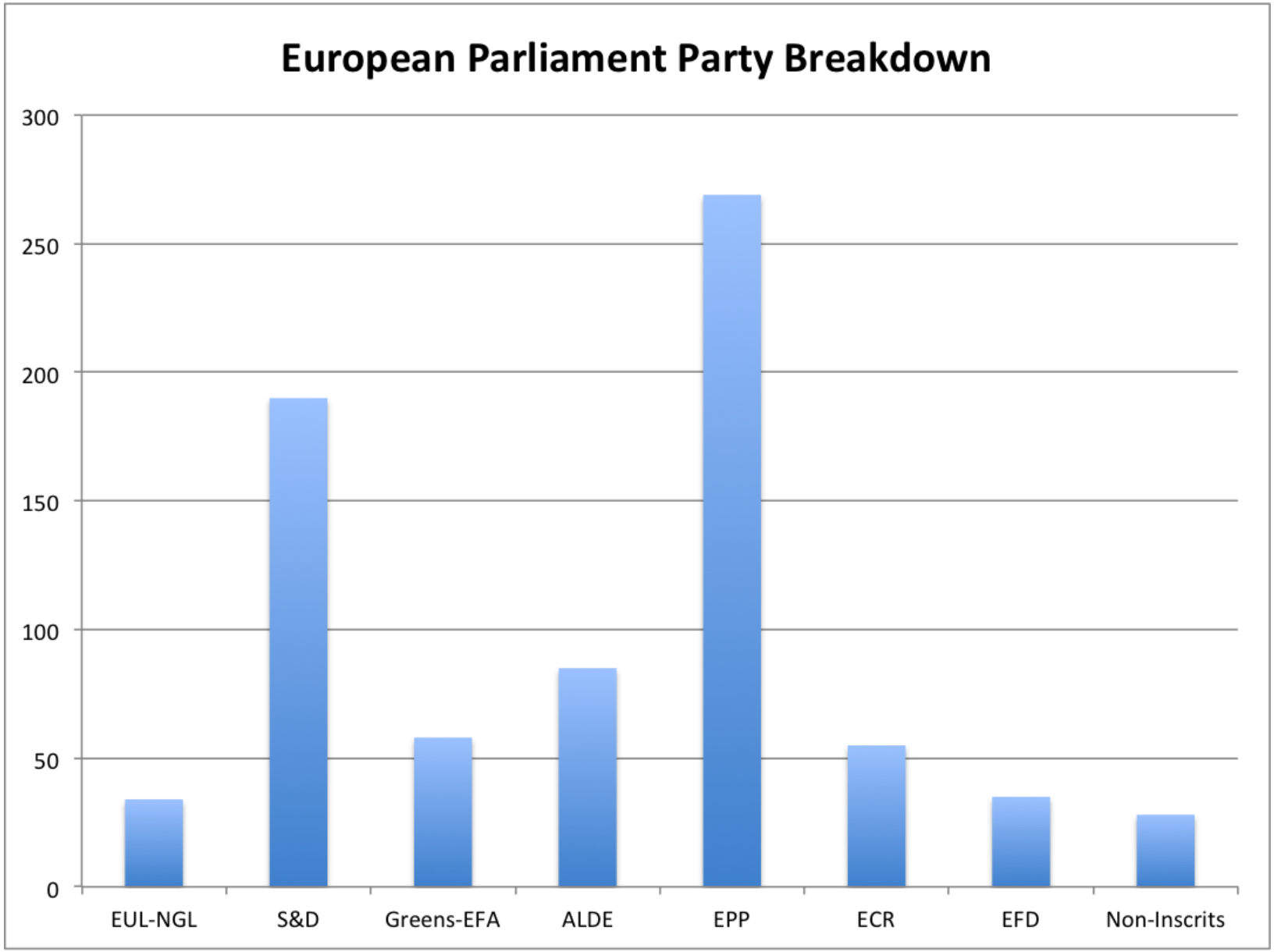
aquaman


AQUAMAN



http://www.businessinsider.com/pie-charts-are-the-worst-2013-6

Walter Hickey / BI



http://www.businessinsider.com/pie-charts-are-the-worst-2013-6

Walter Hickey / BI

pie charts are the Aquaman of data visualization

http://www.businessinsider.com/pie-charts-are-the-worst-2013-6

pie charts are good at one thing.

comparing 2-3 different data points with very different amounts of information

http://www.businessinsider.com/pie-charts-are-the-worst-2013-6

Why do PR pros use social media platforms?

http://visual.ly/impact-social-media-pr-industry-infographic // via @WTFViz

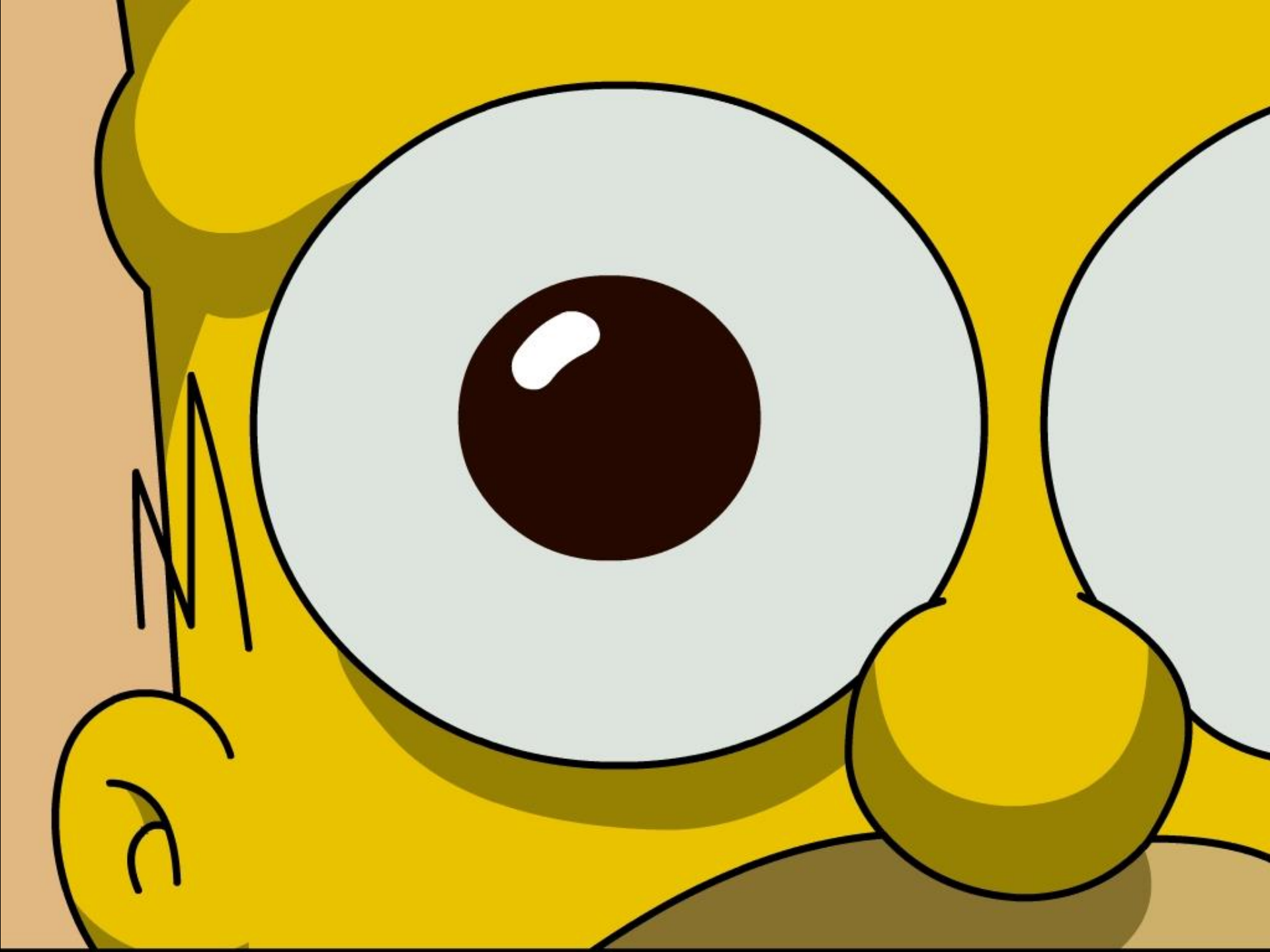
Walter Hickey / BI

I have a problem…

carlo, what do you do?

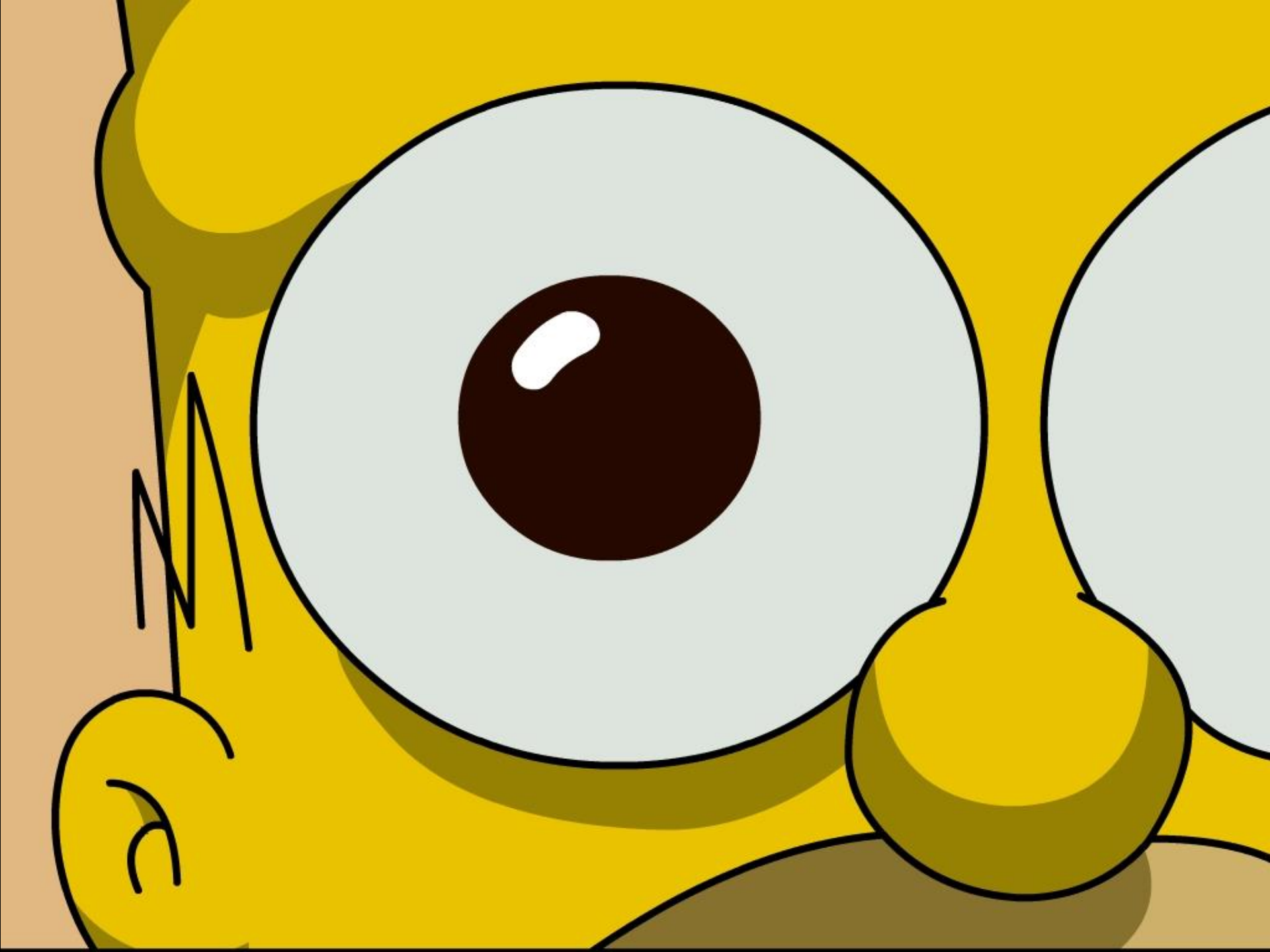
1st try

I am a data visualization designer.



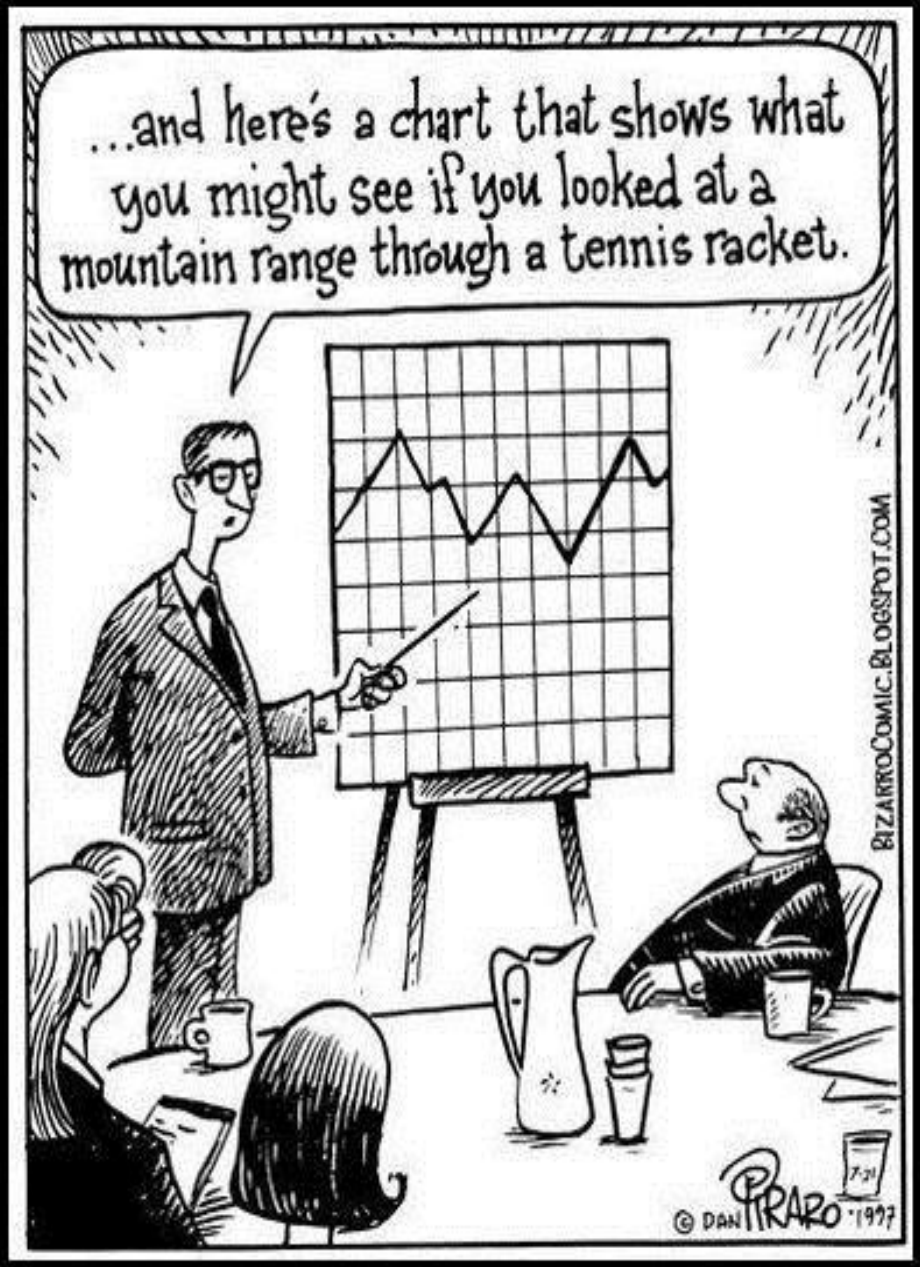
2nd try

I study data and I transform them into some type of visual stuff.



3rd and last try

Out there, there is a lot of data generated by people and the environment. Sometime it is very scary to be put face to face with this giant amount of data. My job is to take all the information, understand it and transform it into some type of interactive tool that simplify the understanding of the data. Usually I generate a web application that can be used by people who have no knowledge of the data...


...and here's a chart that shows what you might see if you looked at a mountain range through a tennis racket.
BIZARROCOMIC.BLOGSPOT.COM
© DAN PIRARO '1997

the answer I like

generate order before people's brains try to do it in their own.

but what is data visualization?

a tool for your eyes and brain to perceive what lies beyond their natural reach.

Alberto Cairo – the functional art, 2012

FORM vs BEAUTY

FORM FOLLOWS FUNCTION

Louis Sullivan, 1896

Feeling good about an artefact makes us better at using it to accomplish a goal.

Don Norman, Emotional Design 2003

FORM vs BEAUTY vs FUN

FORM + BEAUTY + FUN

FUN?

FUN

+

FUNCTIONALITY

FUNTIONALITY

FUNTIONALITY

Experimenting with novel forms
is not just an impulse,
it's a necessity.

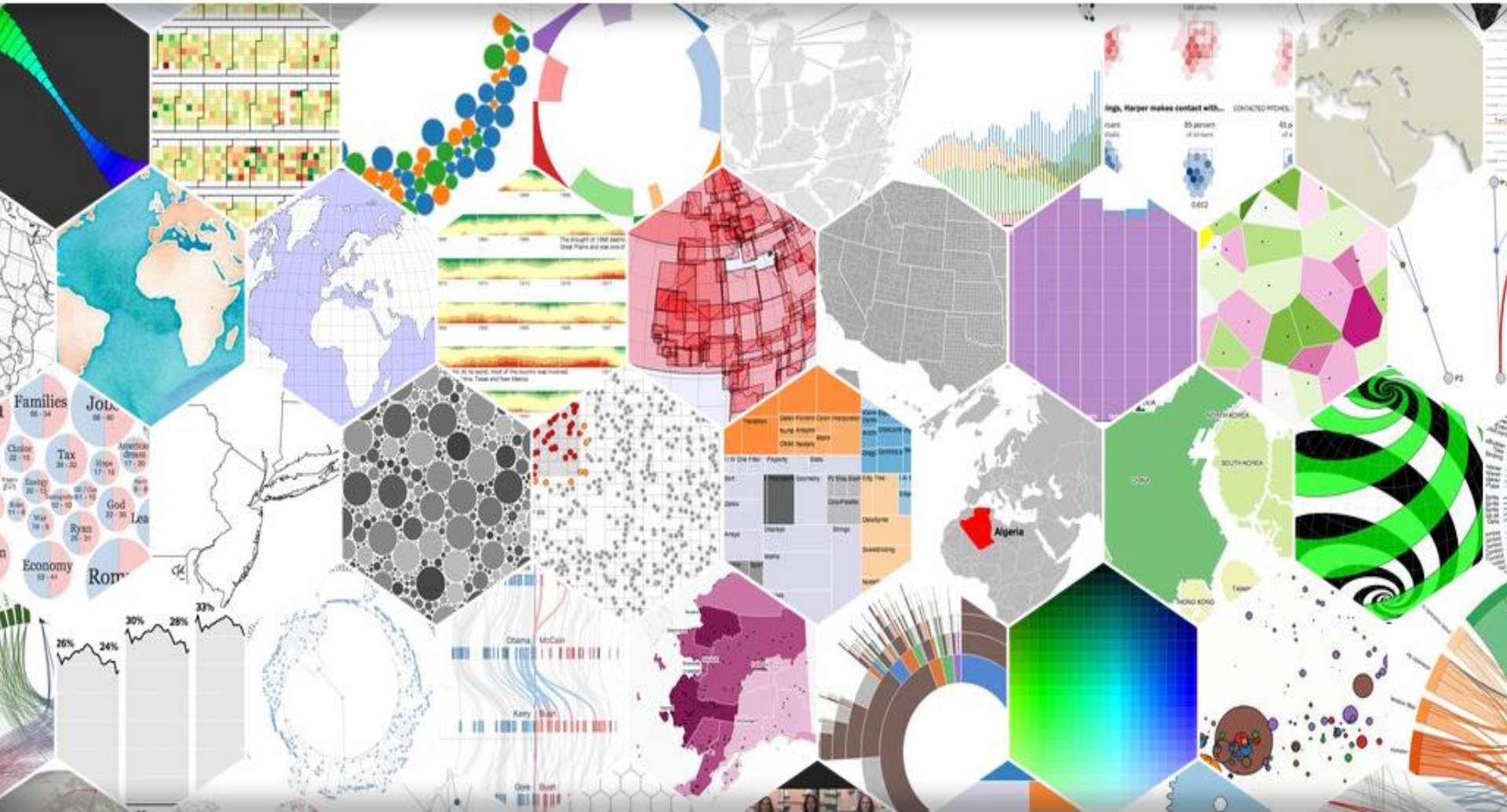
Alberto Cairo – the functional art, 2012

The mind and eye demand stimulation and surprise.

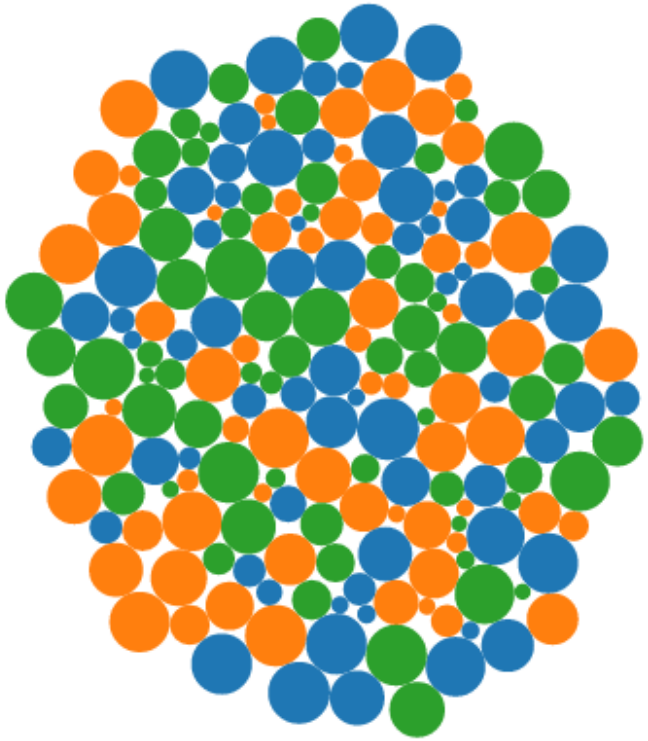
Donis Dondis, A Primer of Visual Literacy, 1973

FUN? GREAT, BUT HOW?

Data-Driven Documents

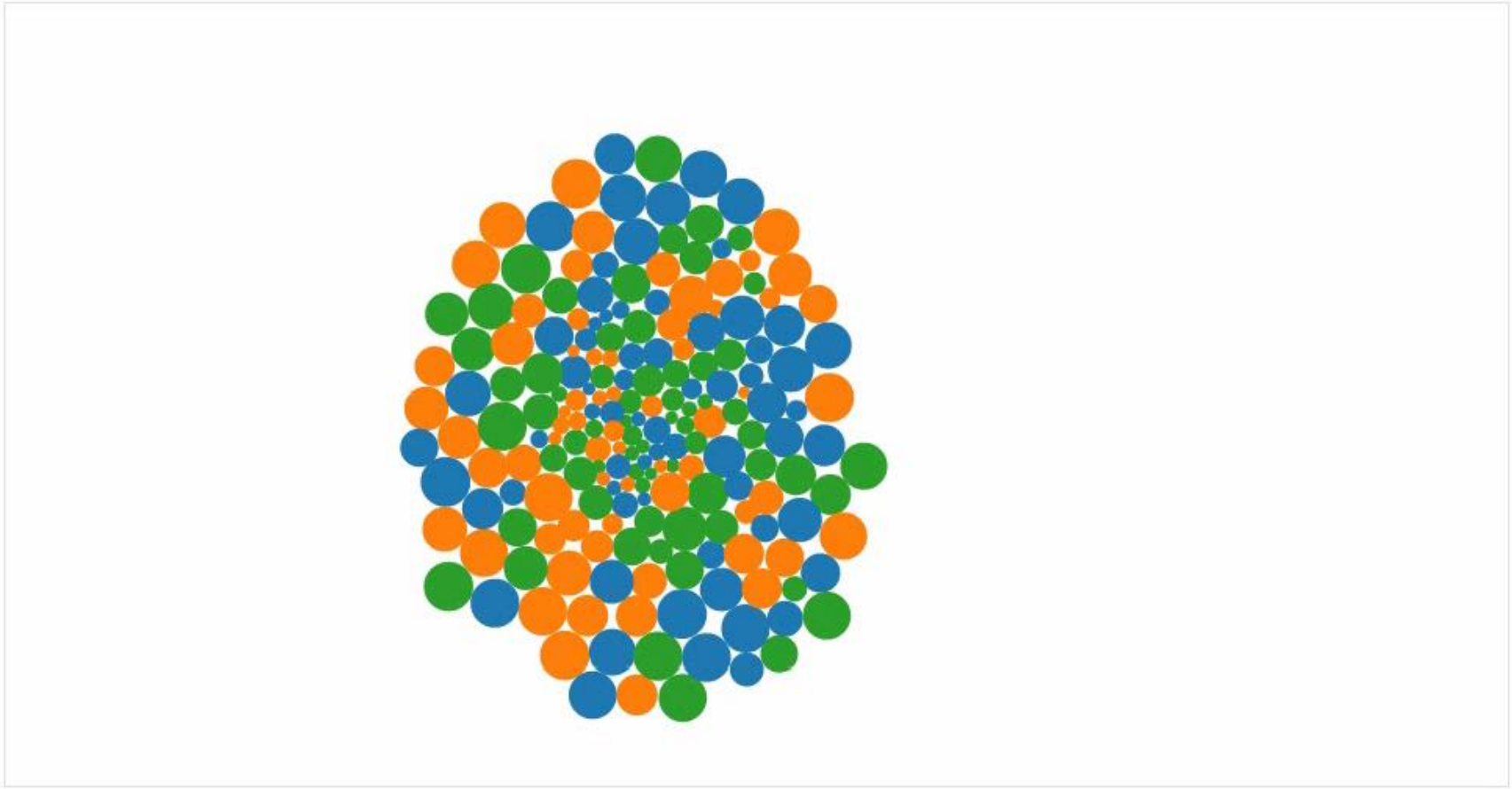


Collision Detection



http://bl.ocks.org/mbostock/3231298

Collision Detection



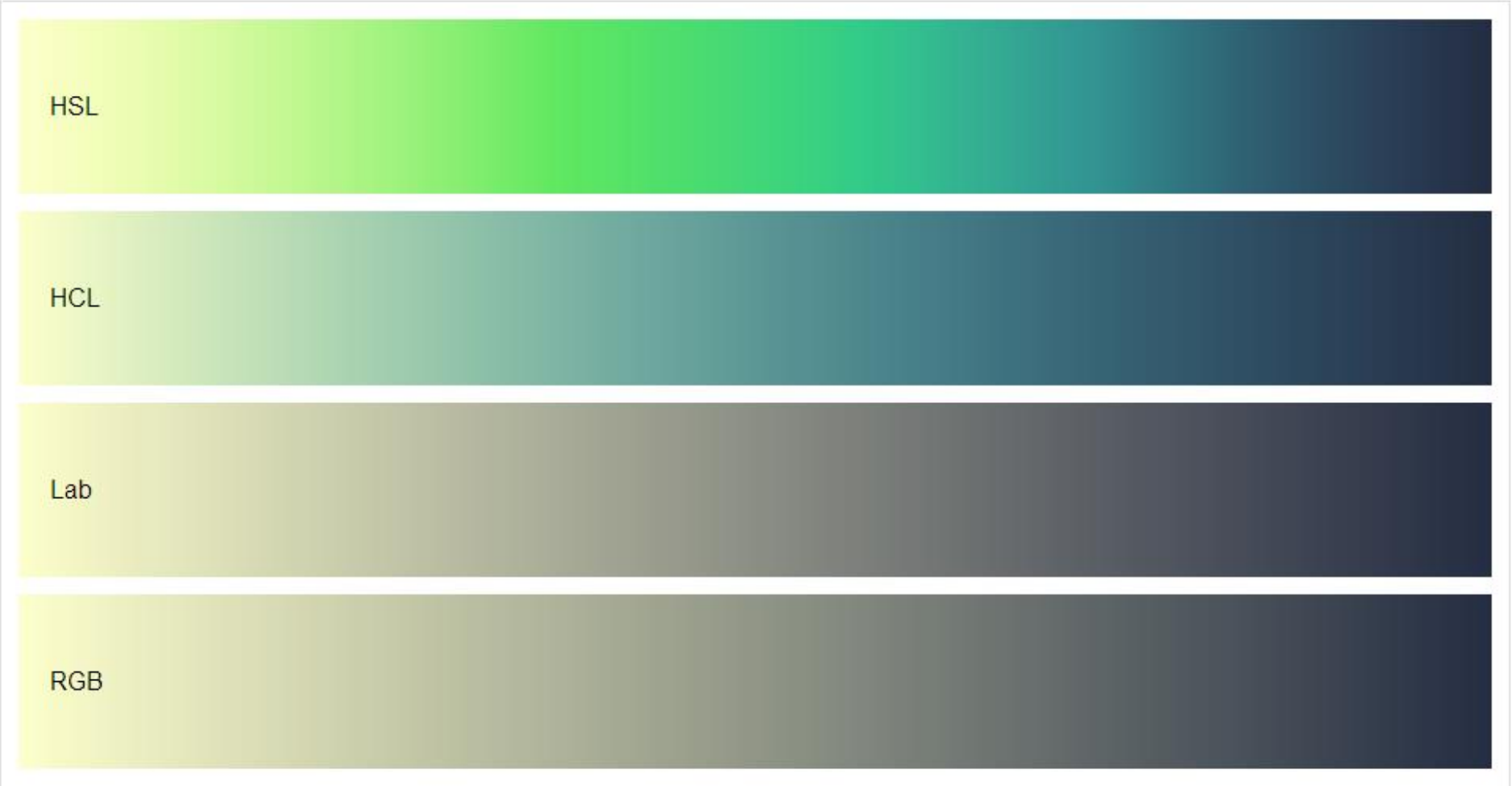
Mouseover to repel nodes. Adapted from my talk on force layouts. Compare to the canvas version.

Open in a new window.

index.html

http://bl.ocks.org/mbostock/3231298

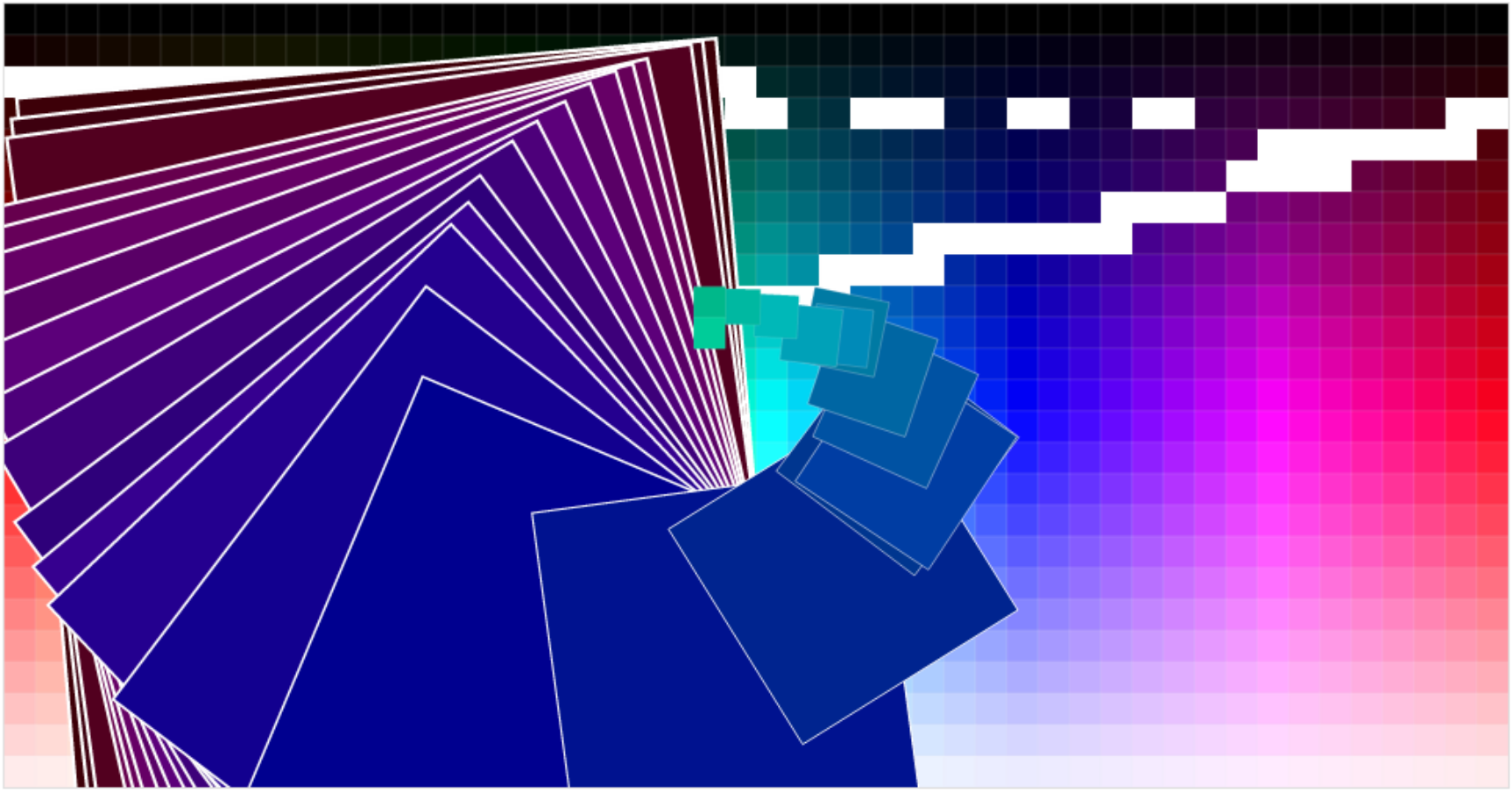
Lab and HCL Color Spaces



http://bl.ocks.org/mbostock/3014589

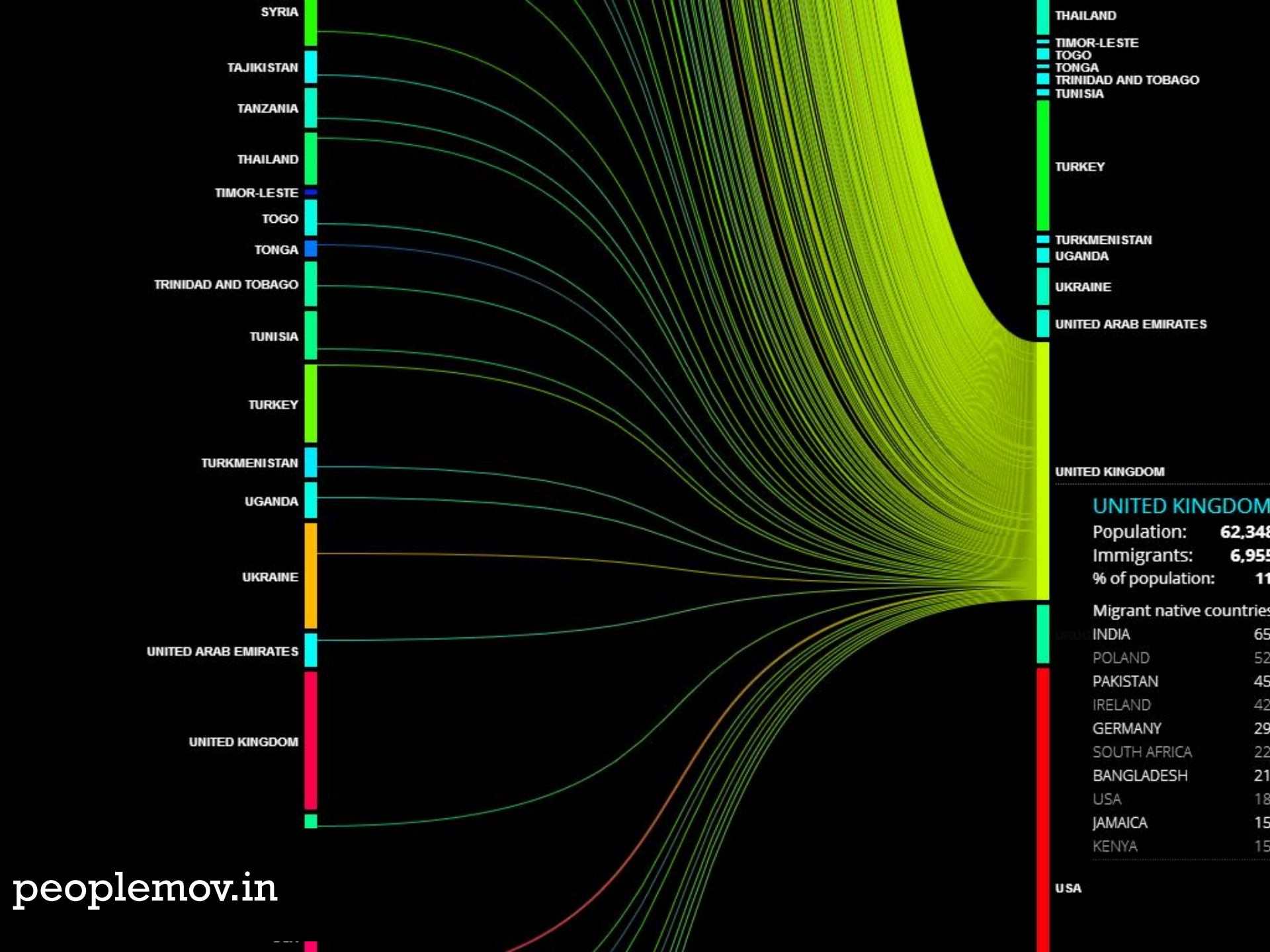
mbostock's block #1345853 November 7, 2011

Transform Transitions



http://bl.ocks.org/mbostock/1345853

it’s not just D3.js



peoplemov.in

peoplemovin

migration flows across the world

World Population: 6,853,328,460

Migrants in the world: 215,738,321

Almost 216 million people, or 3.15% of the world population, live outside their countries.

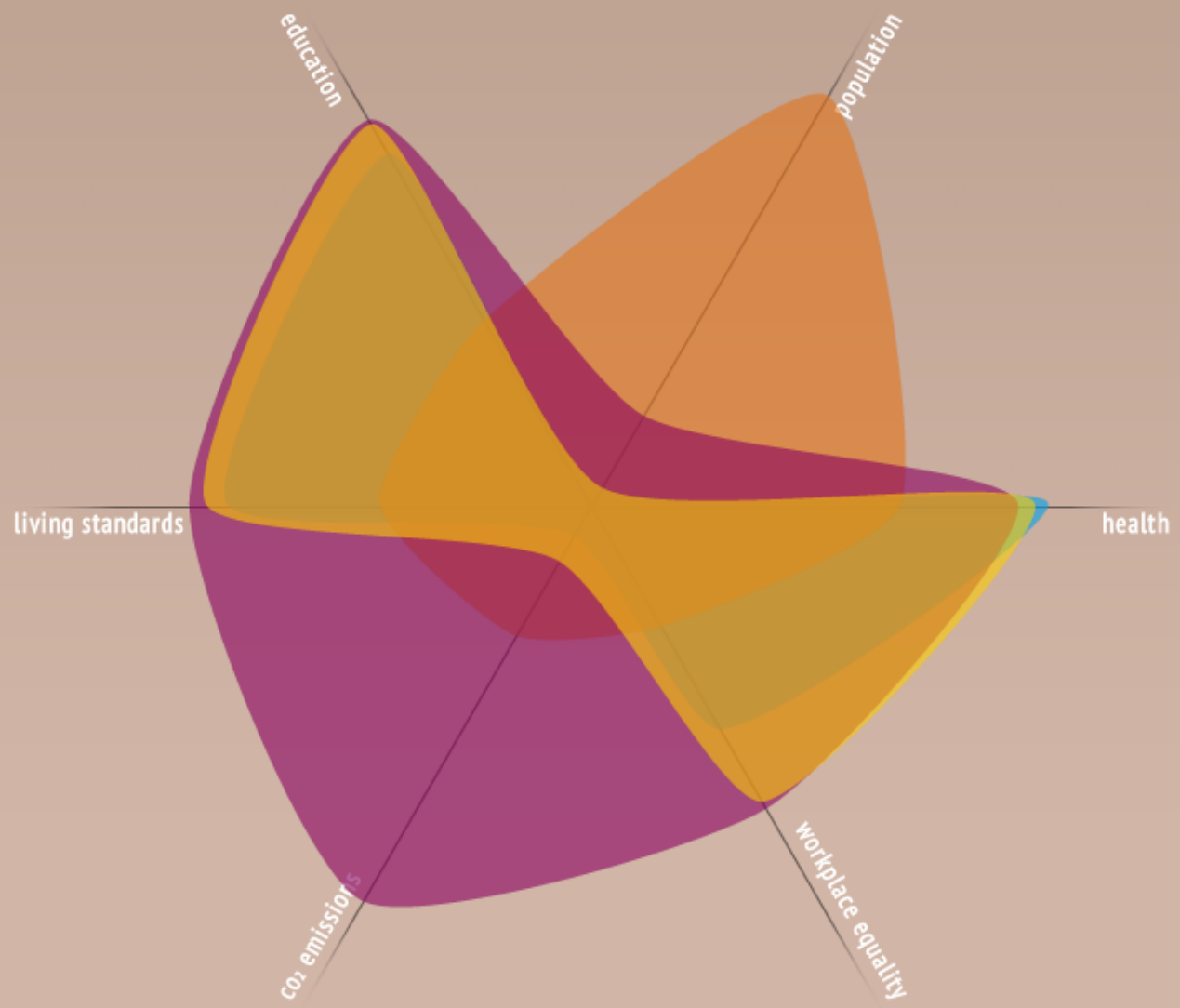
Click on a country box to know more about migration flow to/from that country.

Top migrant destination

see more

USA	42,788,029
RUSSIAN FED.	12,270,388
GERMANY	10,758,061
SAUDI ARABIA	7,288,900
CANADA	7,202,340
UNITED KINGDOM	6,955,738
SPAIN	6,900,547
FRANCE	6,684,842
AUSTRALIA	5,522,408
INDIA	5,436,012

worldshapin
compare countries through their shape



+ add country

- GERMANY
- USA
- INDIA
- ITALY
- WORLD

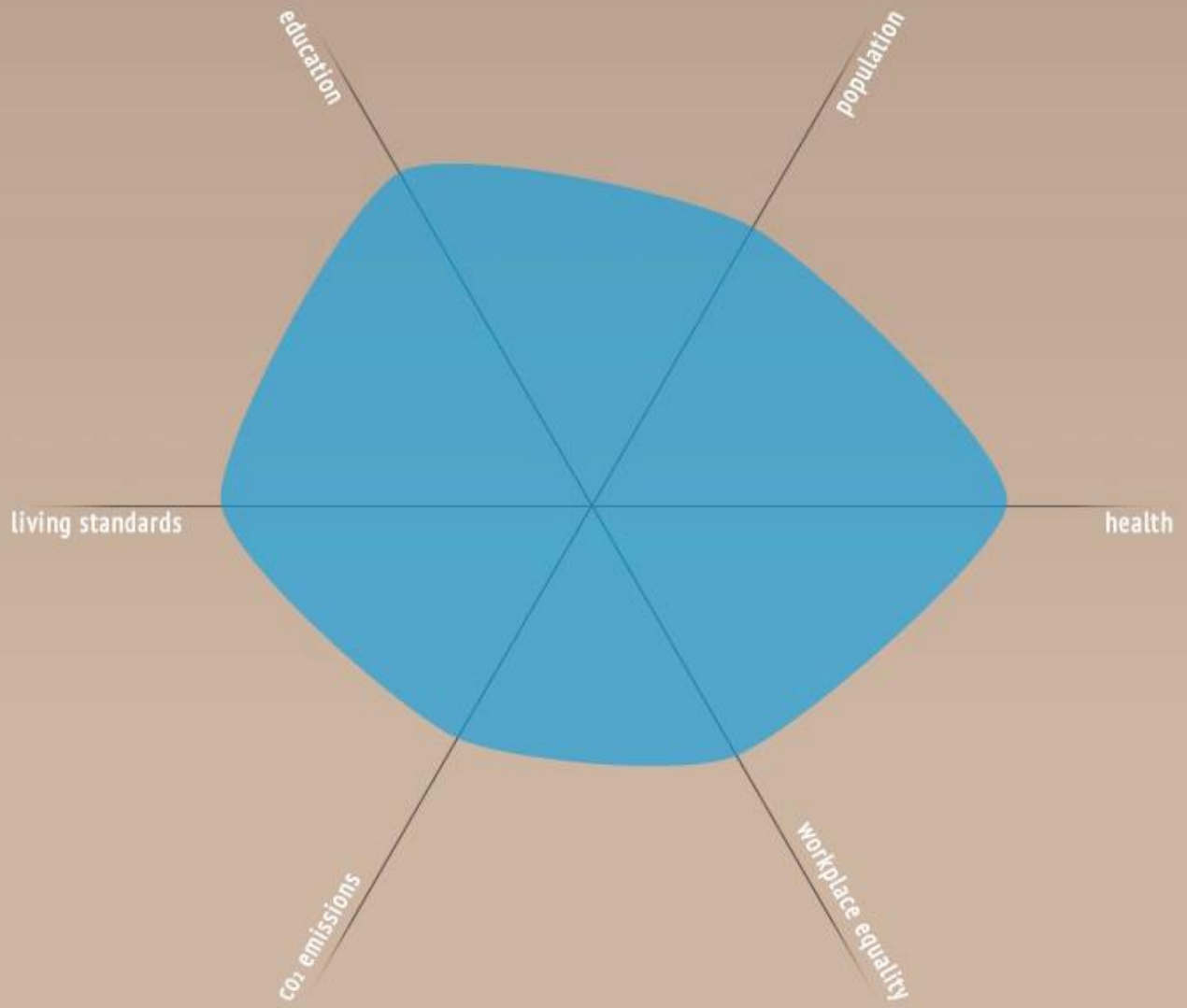
worldshap.in

drag me

1990 1995 2000 2005 2006 2007 2008 2009 2010 2011

worldshapin

compare countries through their shape



+ add country

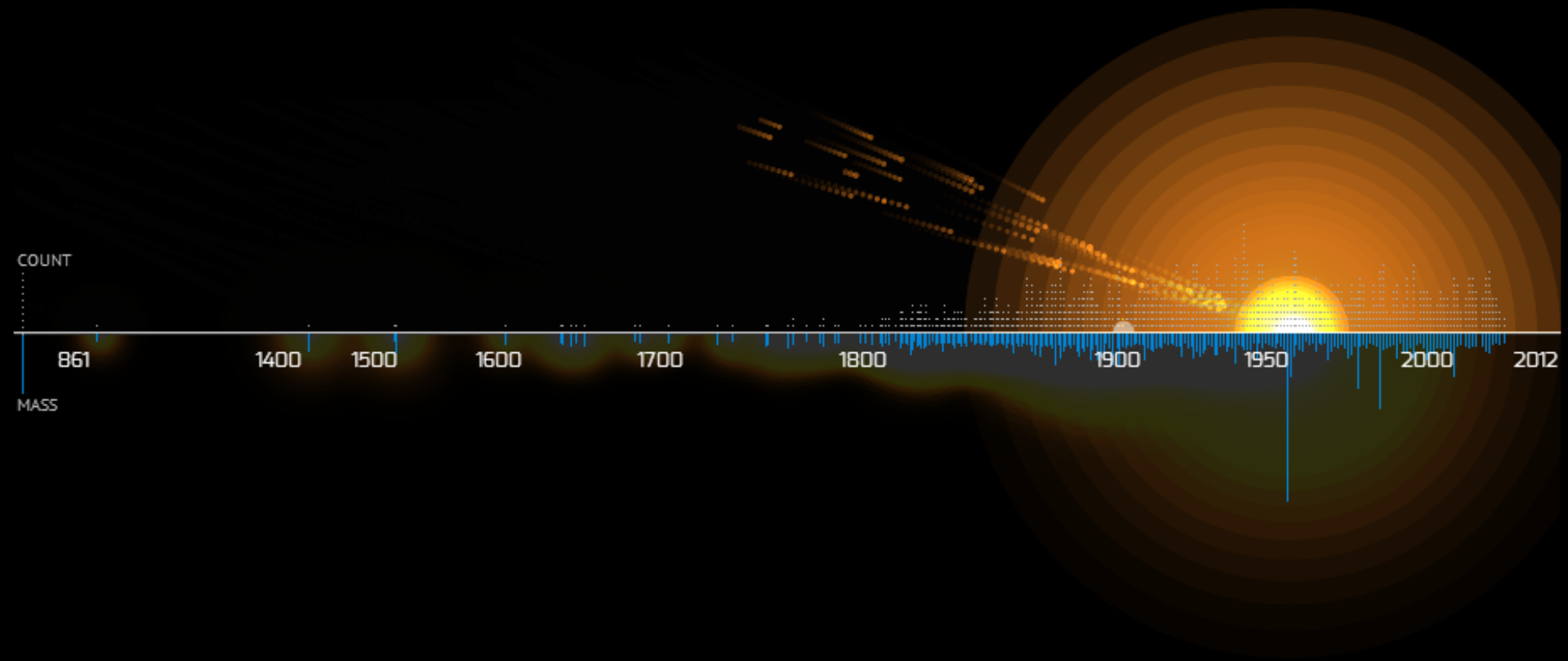
GERMANY

WORLD

> drag me

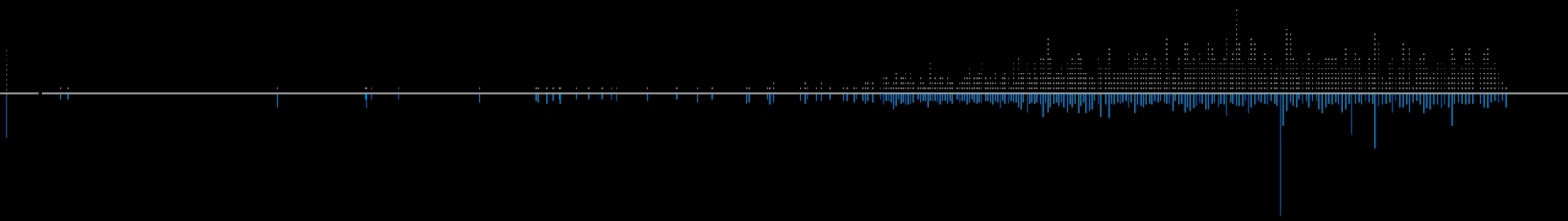
1980 1985 1990 1995 2000 2005 2006 2007 2008 2009 2010 2011

BOLIDES



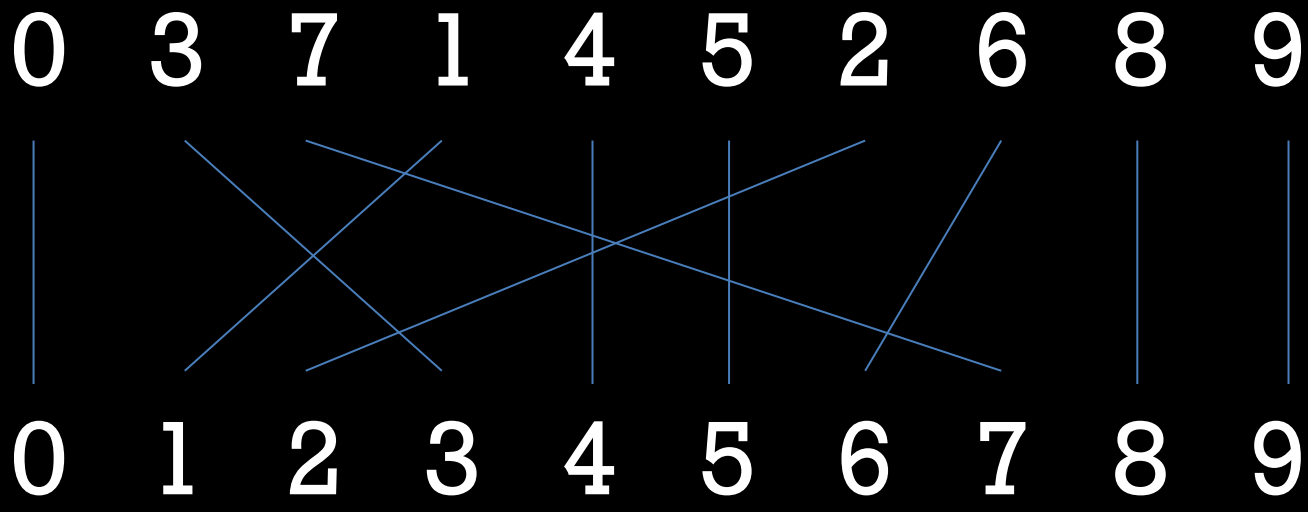
THOUSANDS OF METEORITES HAVE COLLIDED WITH THE EARTH SINCE 2500 BC.
34,513 HAVE BEEN RECORDED. ONLY 1,042 HAVE BEEN SEEN FALLING.

bolid.es



VISUALIZING SORTING ALGORITHMS

SORTING ALGORITHM
a computational process used
to organize elements of
a sequence in a certain order


0 3 7 1 4 5 2 6 8 9
0 1 2 3 4 5 6 7 8 9

it all started when…

SILBERSCHATZ / GALVIN / GAGNE

TANENBAUM
WOODHULL
OPERATING SYSTEMS
Design and Implementation
Second Edition
CD ROM Included
Prentice Hall

Tanenbaum
MODERN OPERATING SYSTEMS
SECOND EDITION
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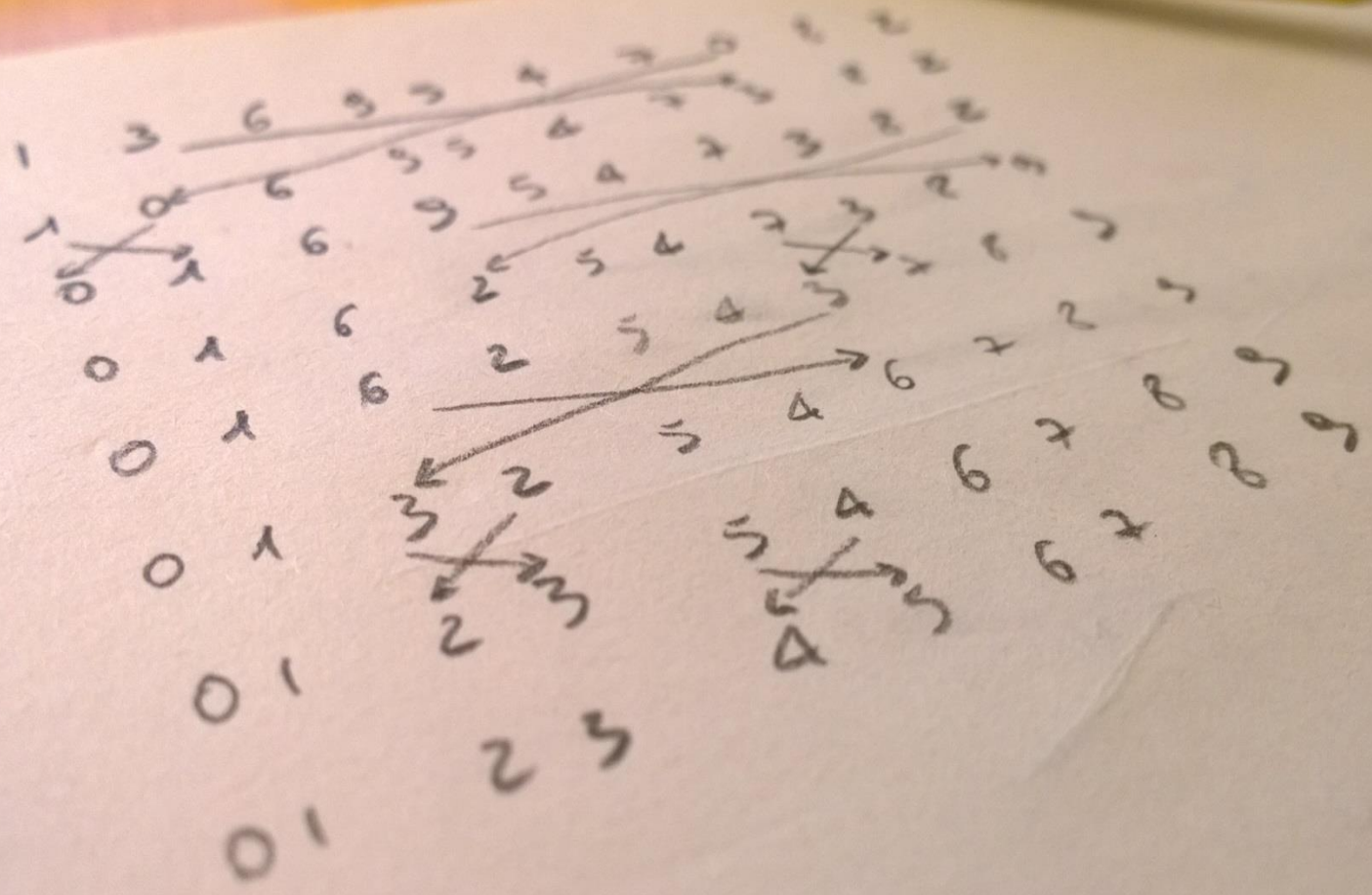
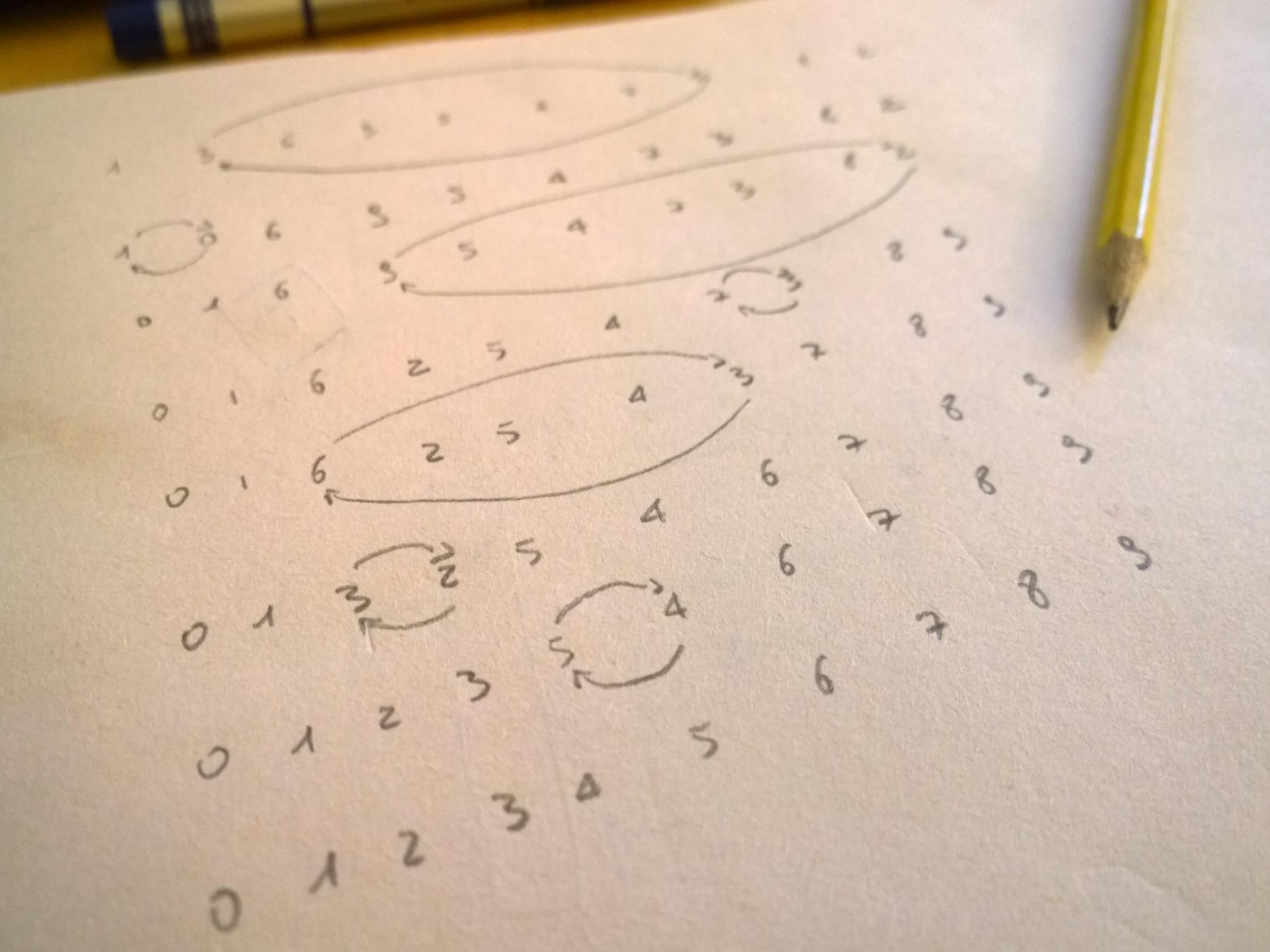
Updated and Revised
KNUTH
The Art of Computer Programming
Fundamental Algorithms
VOLUME 1
Third Edition
Addison Wesley

Updated and Revised
KNUTH
The Art of Computer Programming
Seminumerical Algorithms
VOLUME 2
Third Edition
Addison Wesley

Updated and Revised
KNUTH
The Art of Computer Programming
Sorting and Searching
VOLUME 3
Second Edition
Addison Wesley

Second Edition
Patterson
Hennessy
Computer Organization & Design
THE HARDWARE/SOFTWARE INTERFACE
Morgan Kaufmann





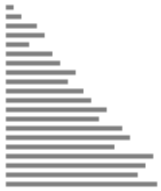
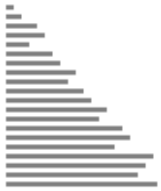
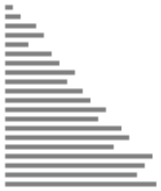
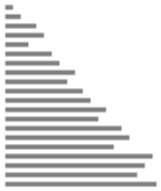
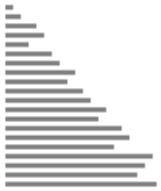
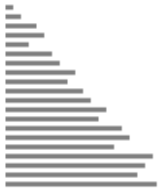
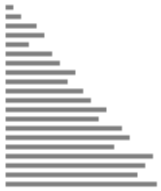
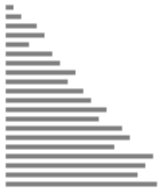
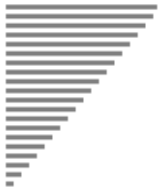
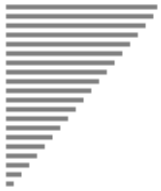
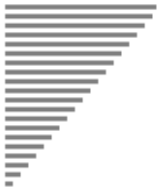
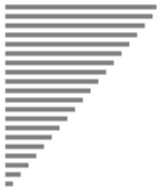
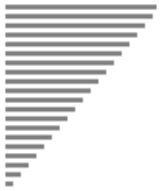
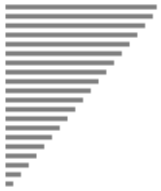
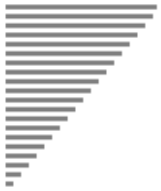
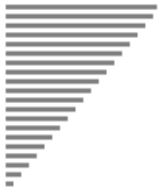
HOW CAN WE SHOW SORTING ALGORITHMS?

Sorting Algorithm Animations

Problem Size: 20 · 30 · 40 · 50 Magnification: 1x · 2x · 3x

Algorithm: Insertion · Selection · Bubble · Shell · Merge · Heap · Quick · Quick3

Initial Condition: Random · Nearly Sorted · Reversed · Few Unique

	Insertion	Selection	Bubble	Shell	Merge	Heap	Quick	Quick3
Random								
Nearly Sorted								
Reversed								
								

sorting-algorithms.com

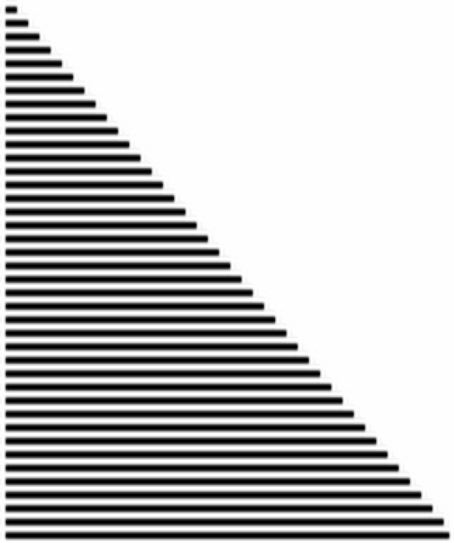
« Back to all algorithms and all initial conditions

Quick Sort (3 Way Partition)

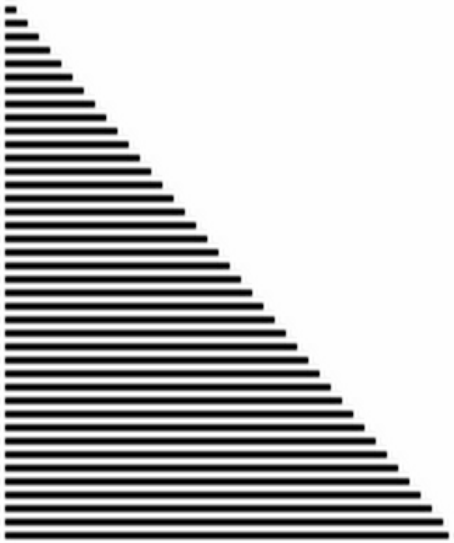
Problem Size: 20 · 30 · 40 · 50 Magnification: 1x · 2x · 3x

Algorithm: Insertion · Selection · Bubble · Shell · Merge · Heap · Quick · Quick3

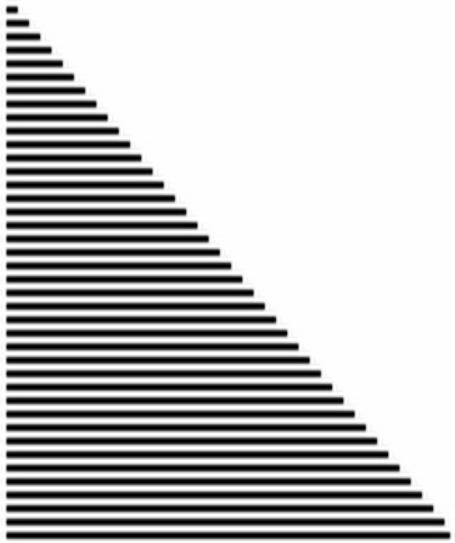
Random



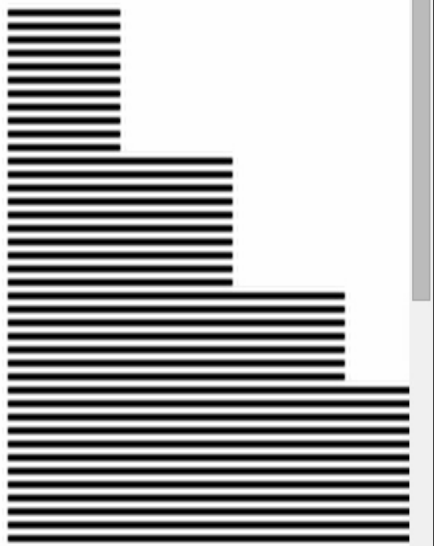
Nearly Sorted



Reversed



Few Unique



Algorithm

```
# choose pivot
swap a[n,rand(1,n)]

# 3-way partition
i = 1, k = 1, p = n
while i < p,
```

Directions

- Click on above to restart the animations in a row, a column, or the entire table.
- Click directly on an animation image to start or restart it.
- Click on a problem size number to reset all animations.

sorting-algorithms.com

cocktailsort

combsort

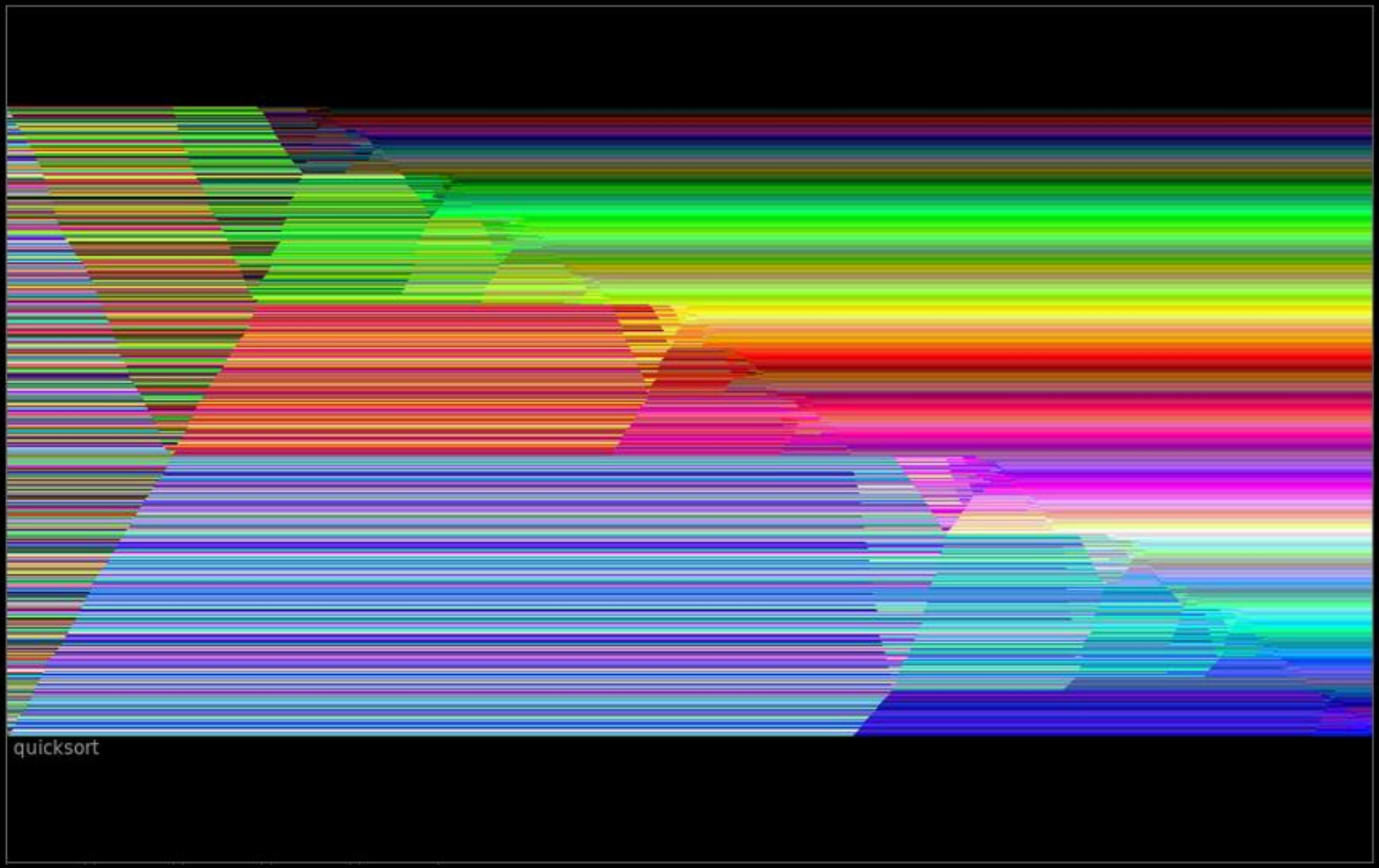
cyclesort

gnomesort

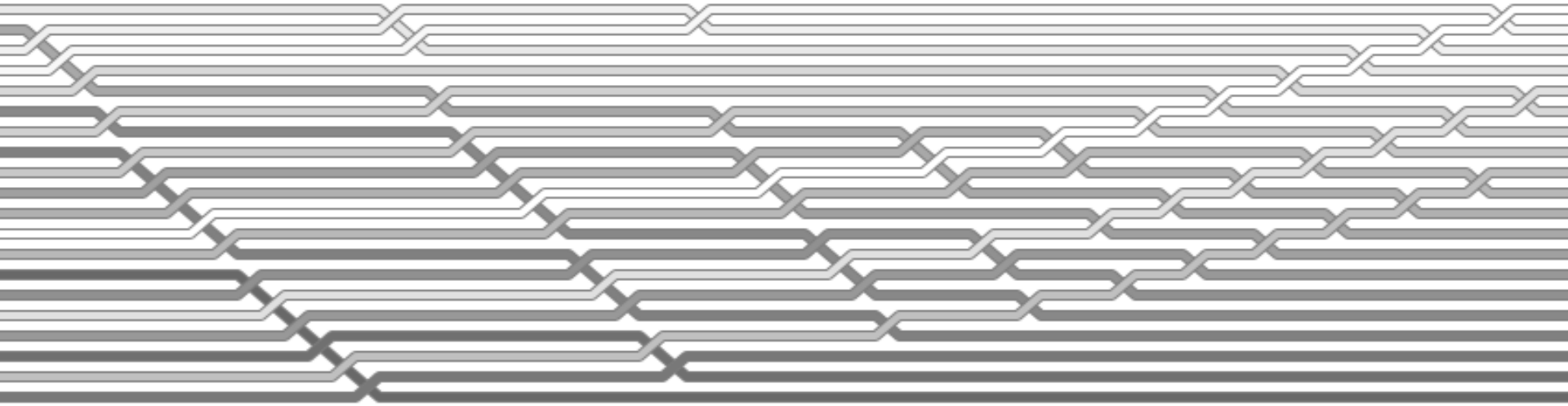
heapsort

insertionsort

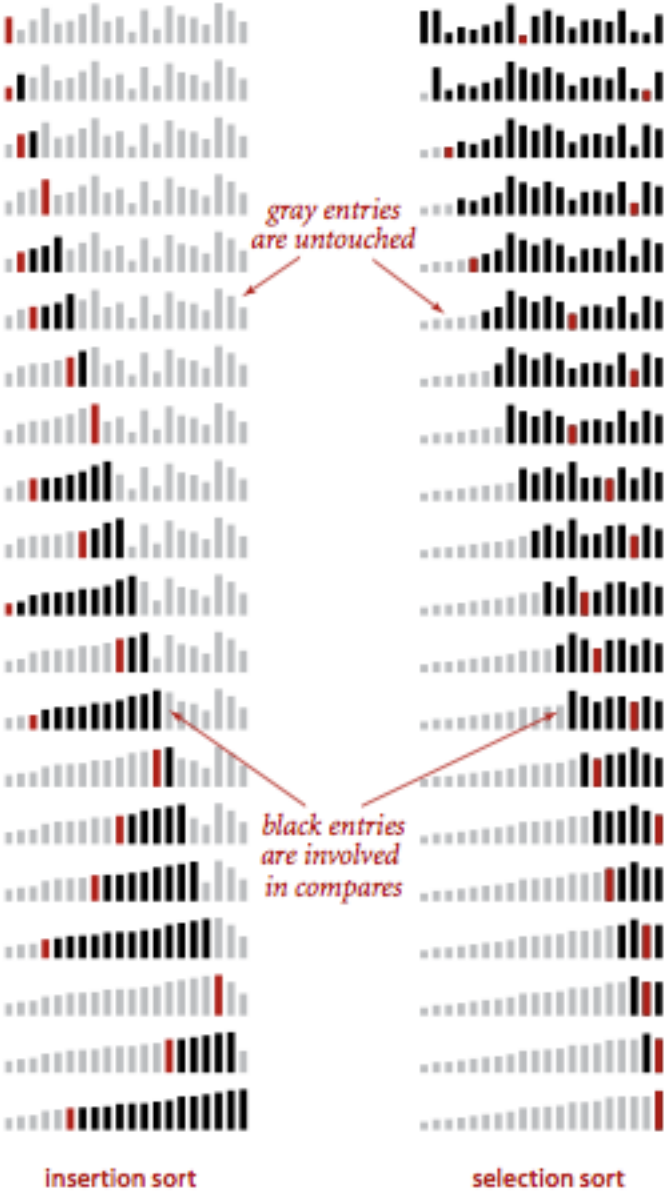
sortvis.com



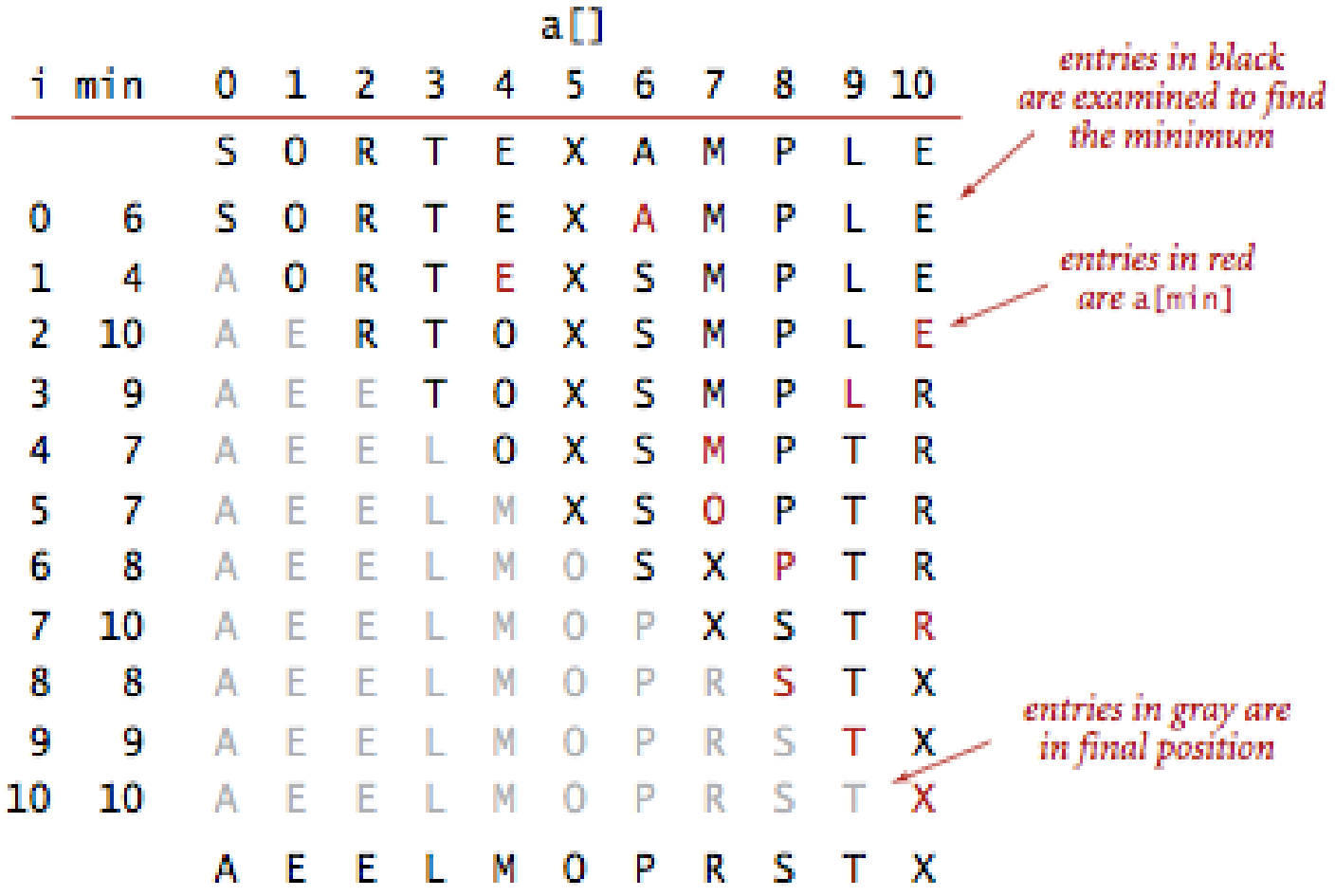
sortvis.com - quicksort



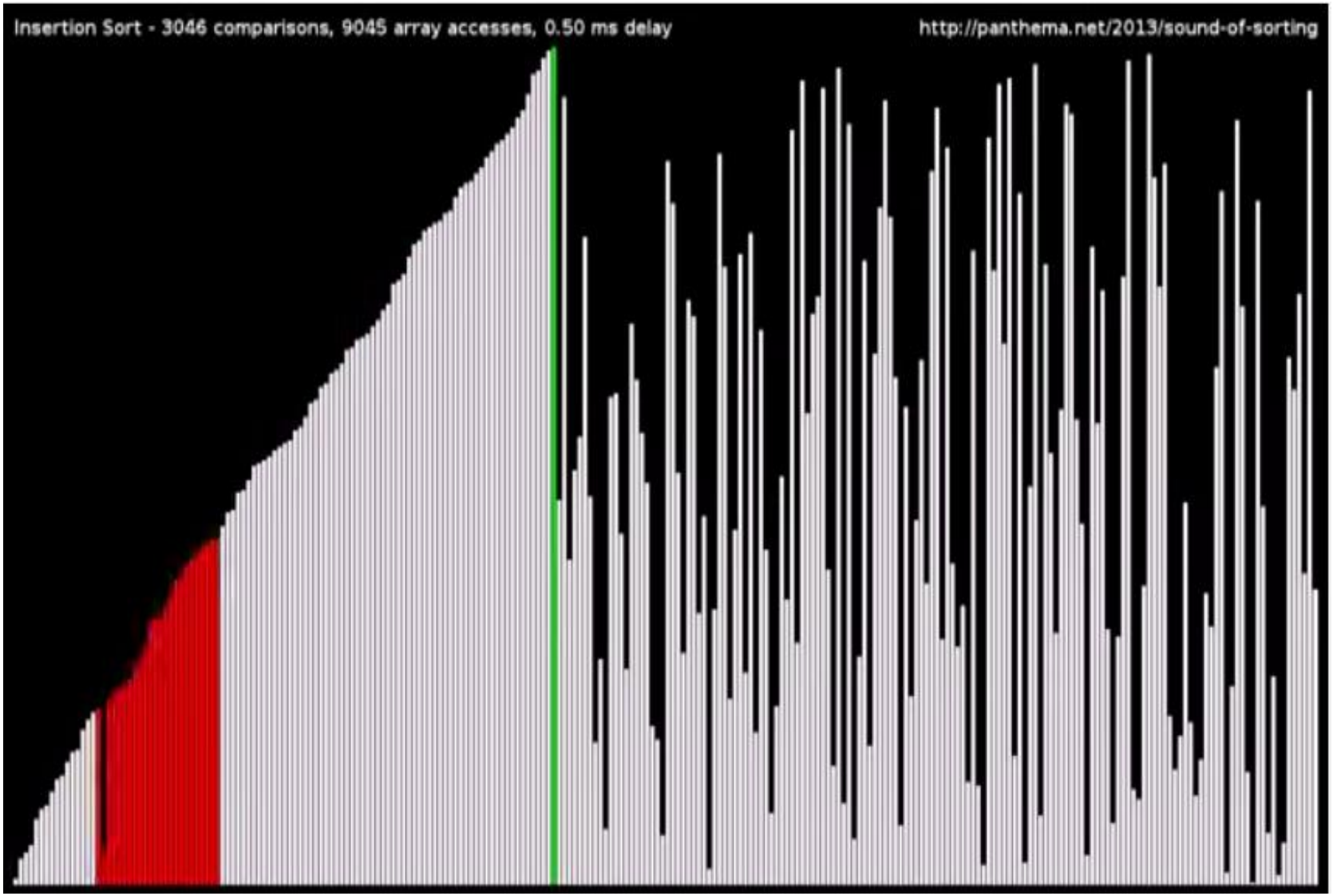
sortvis.com – bubblesort



aces of elementary sorting algorithms



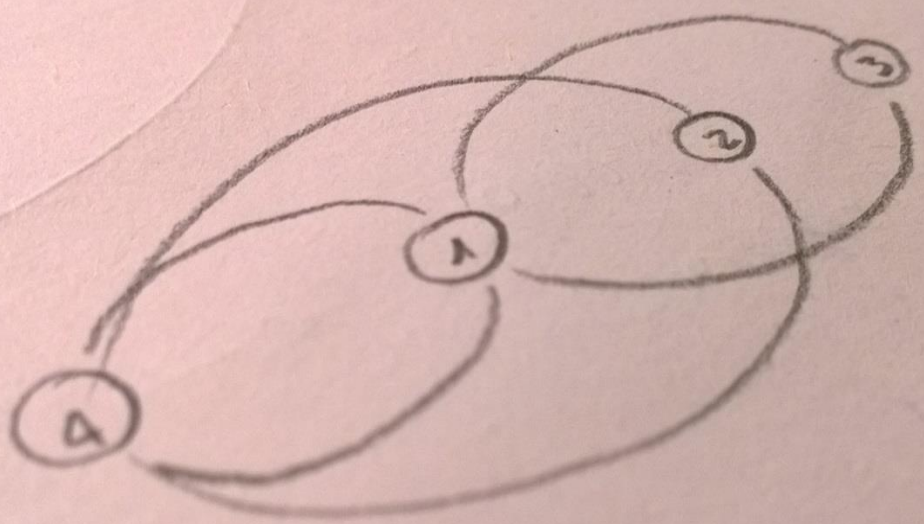
Trace of selection sort (array contents just after each exchange)



visualization + audibilization

sorting objects

EARLY PROTOTYPES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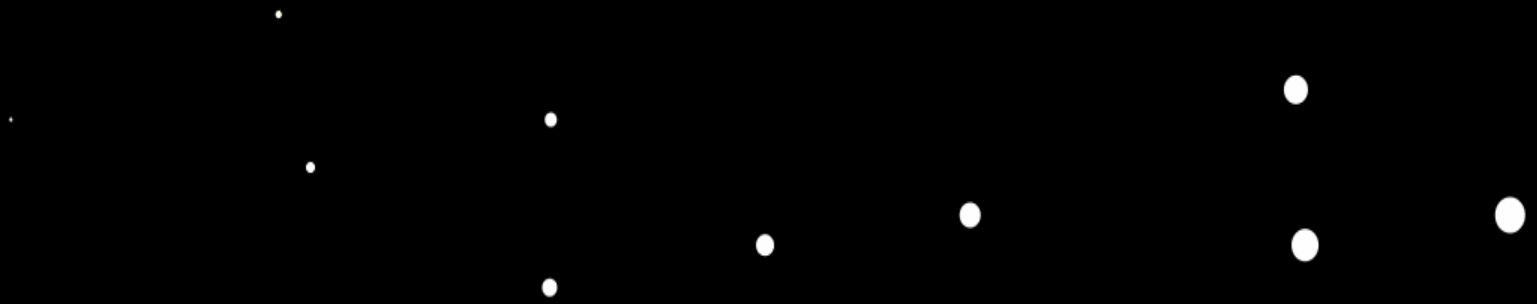
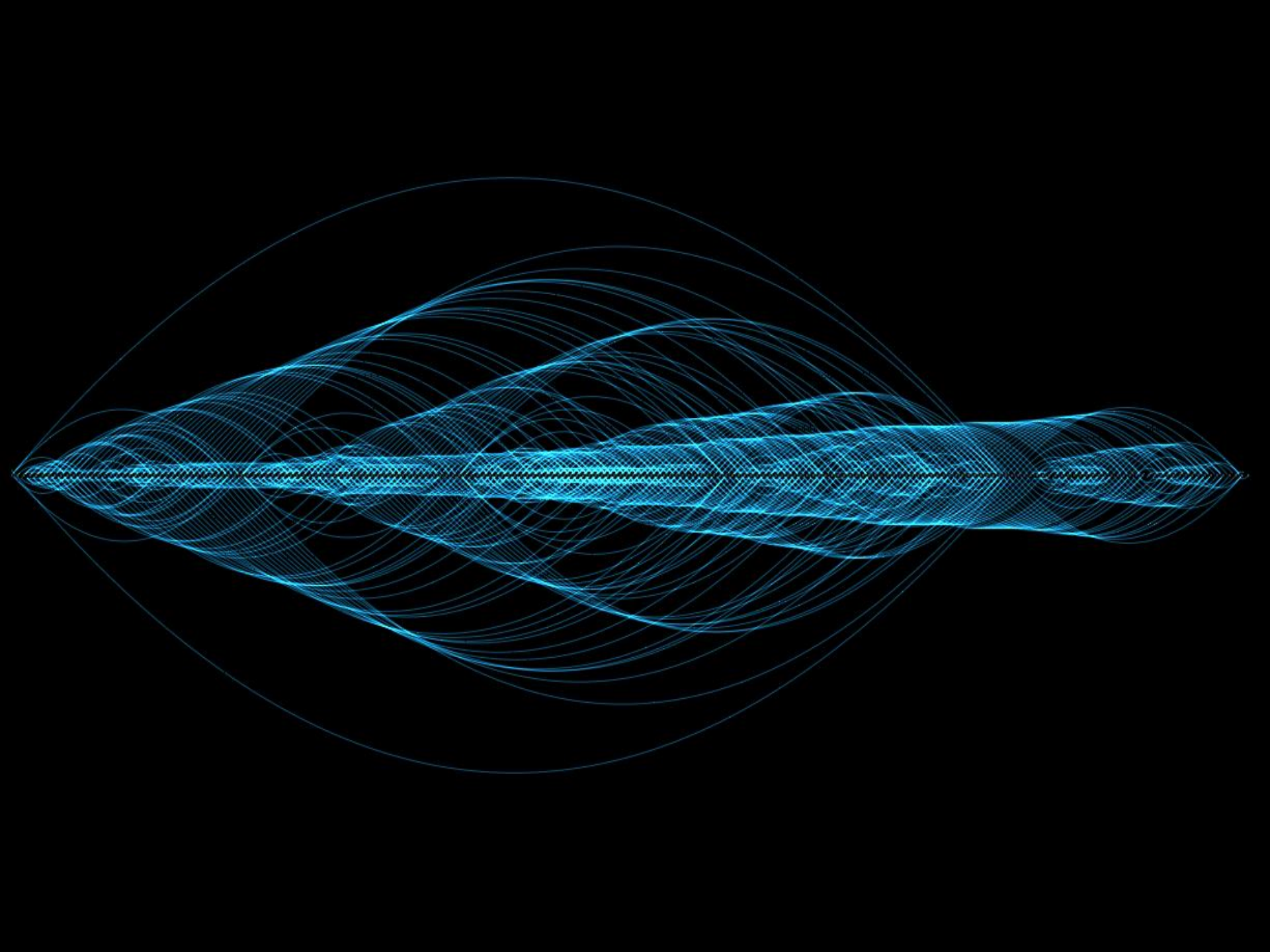
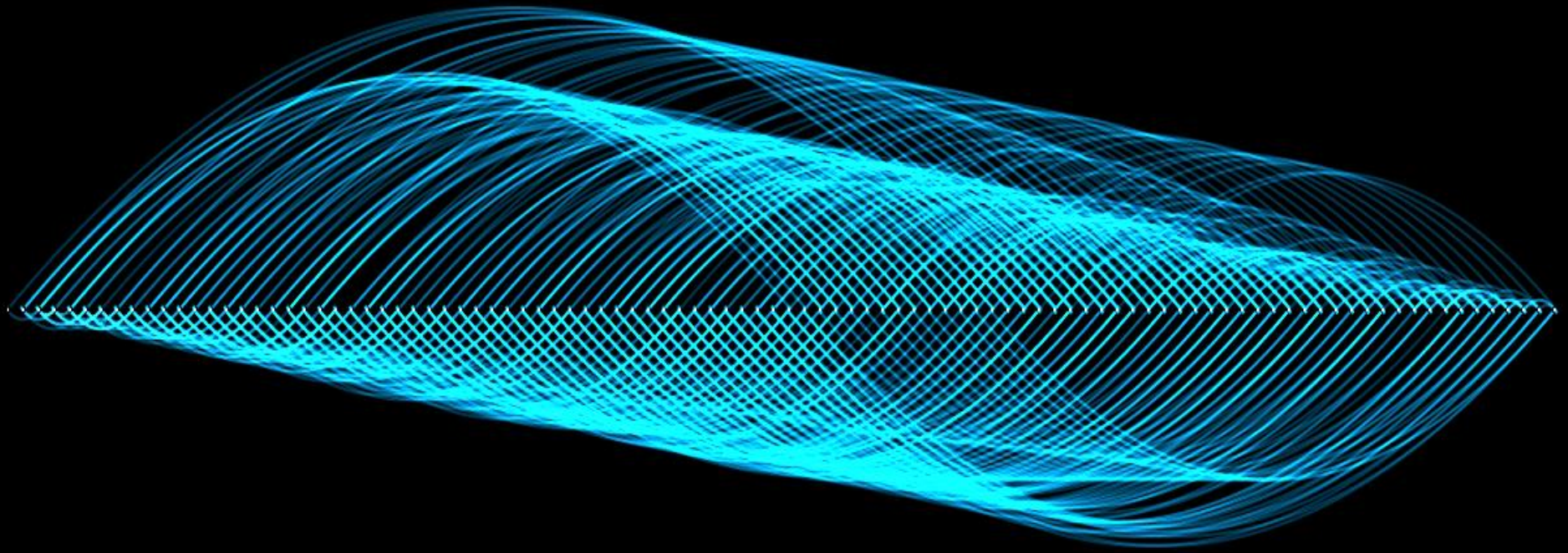
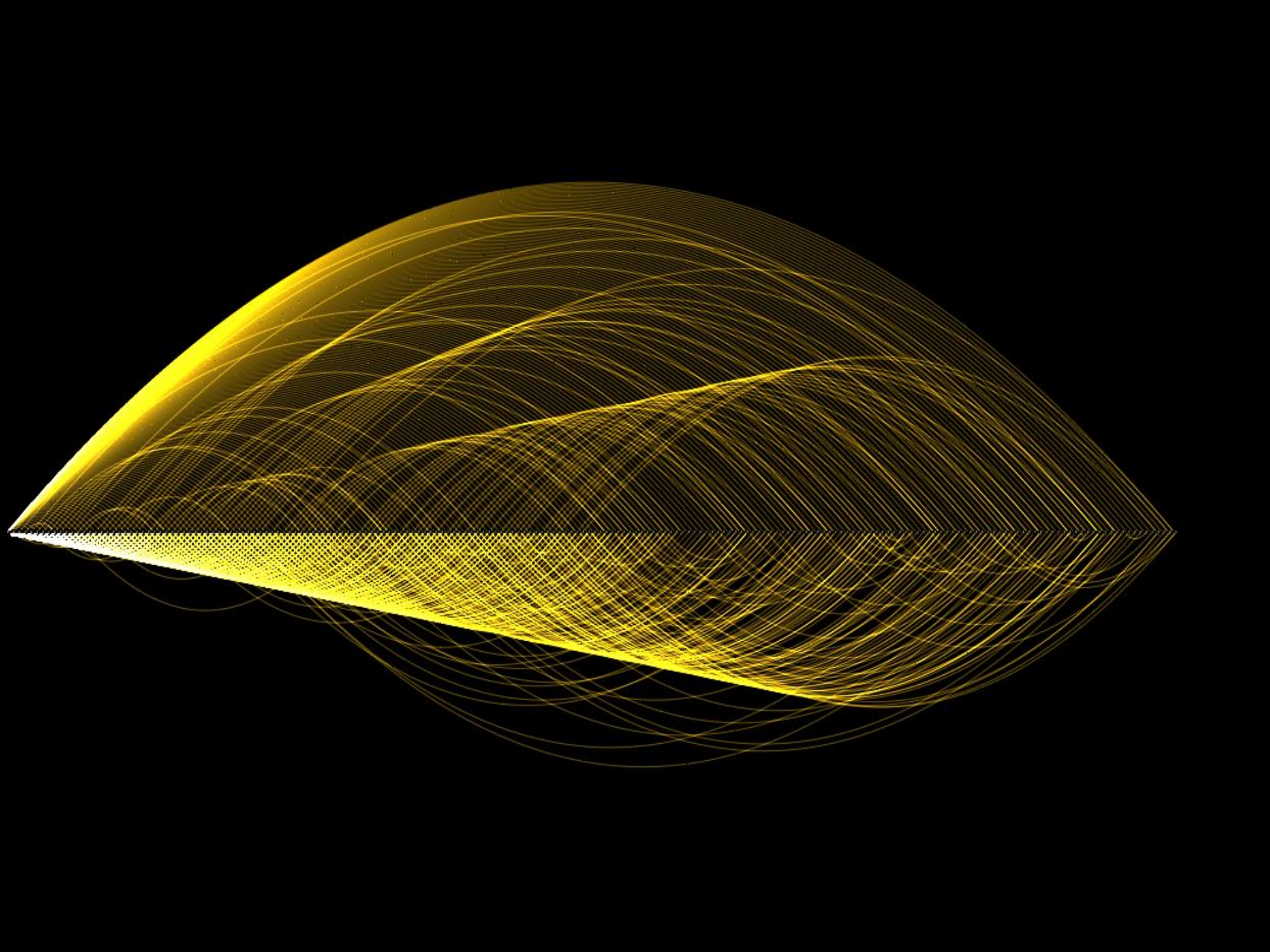
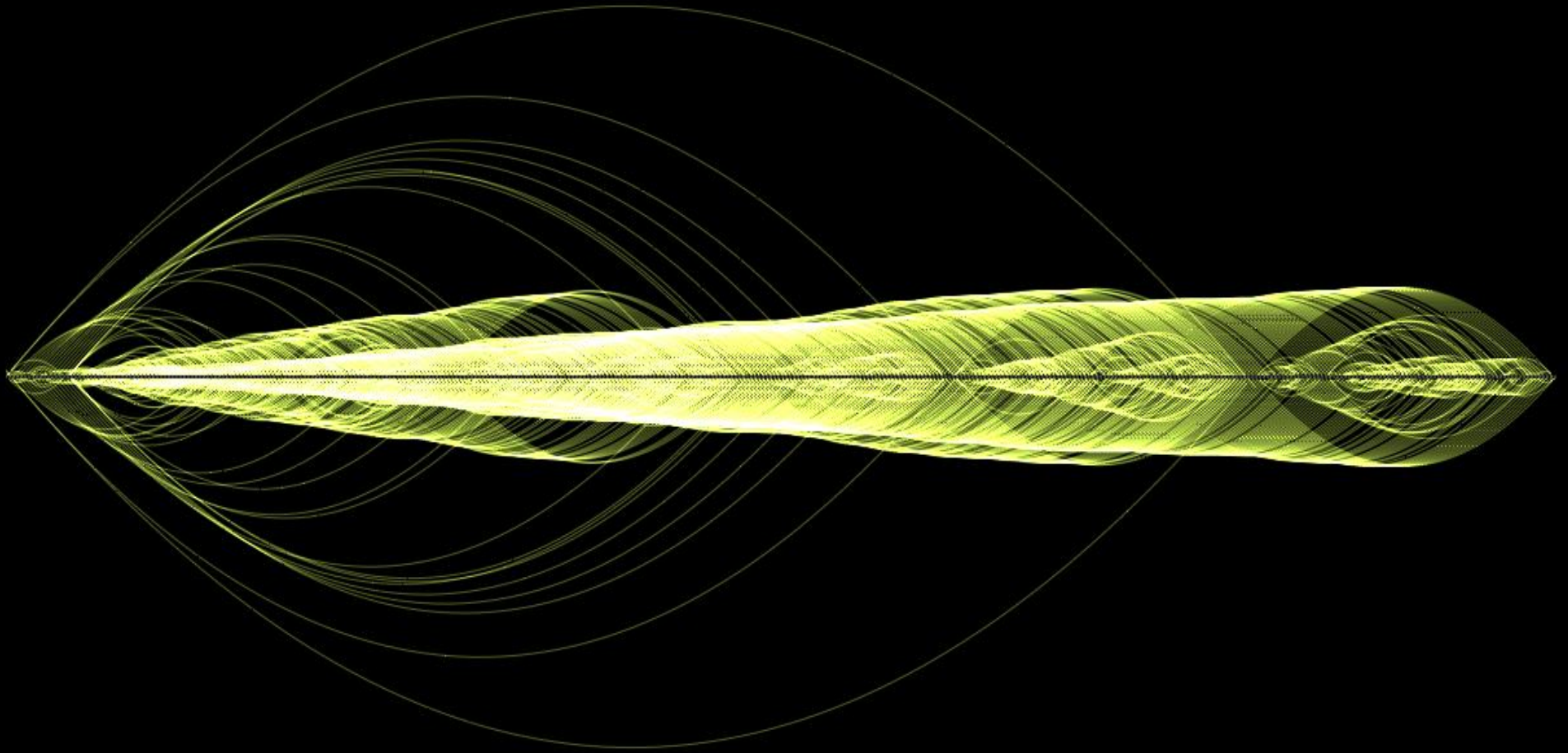
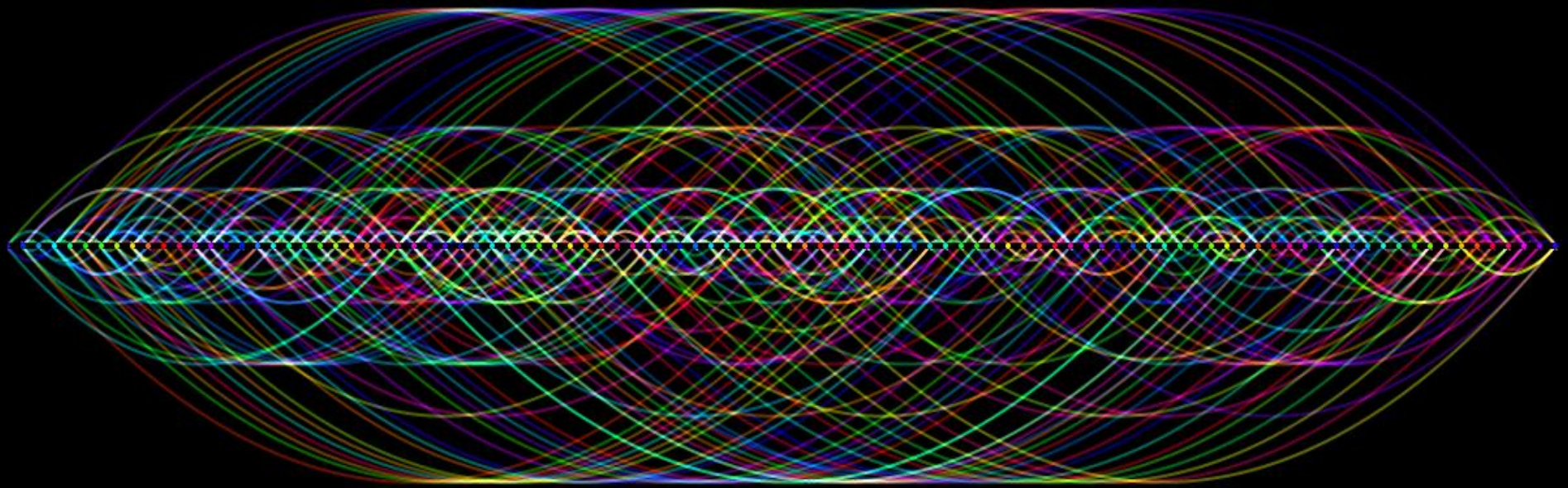


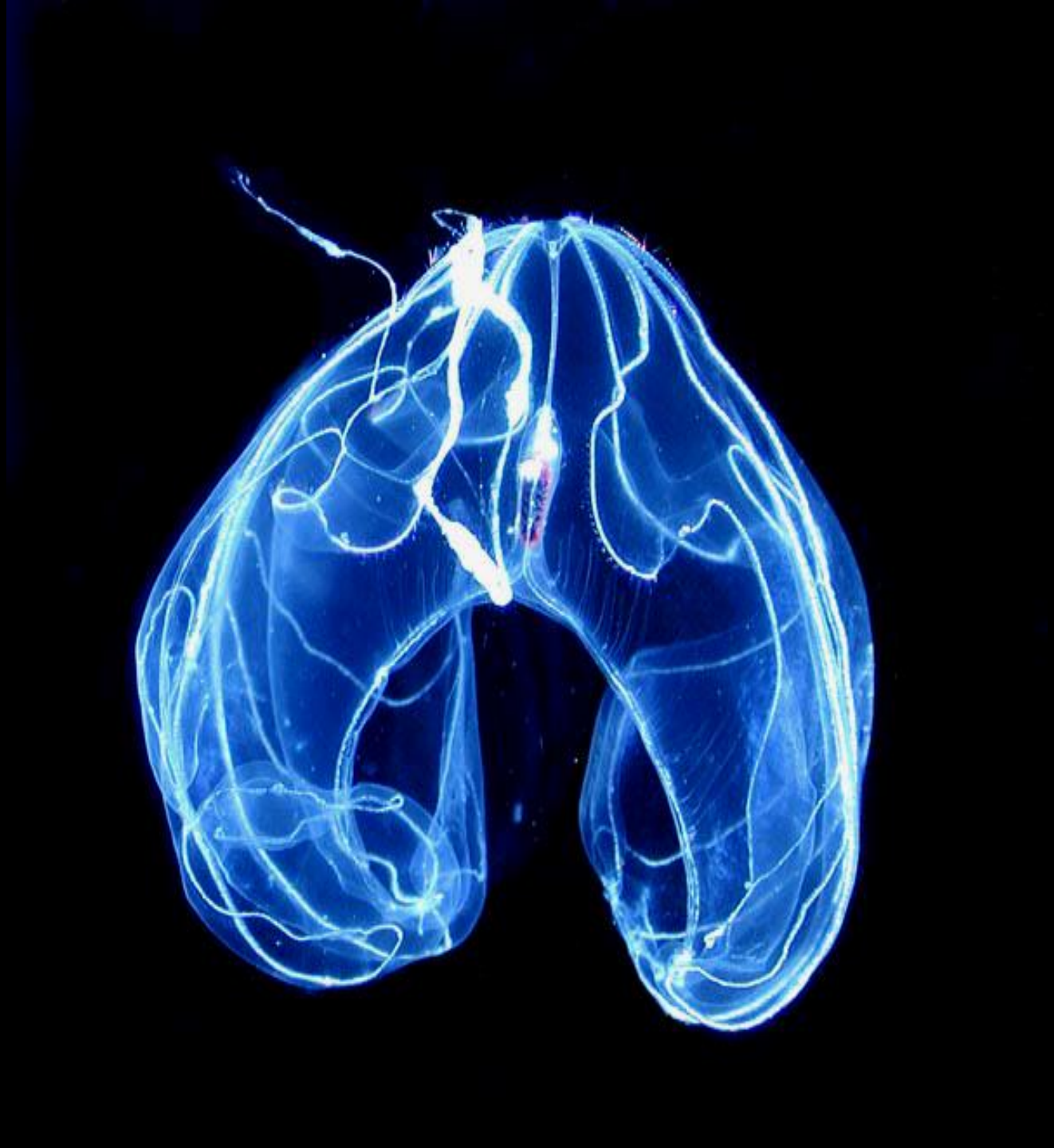




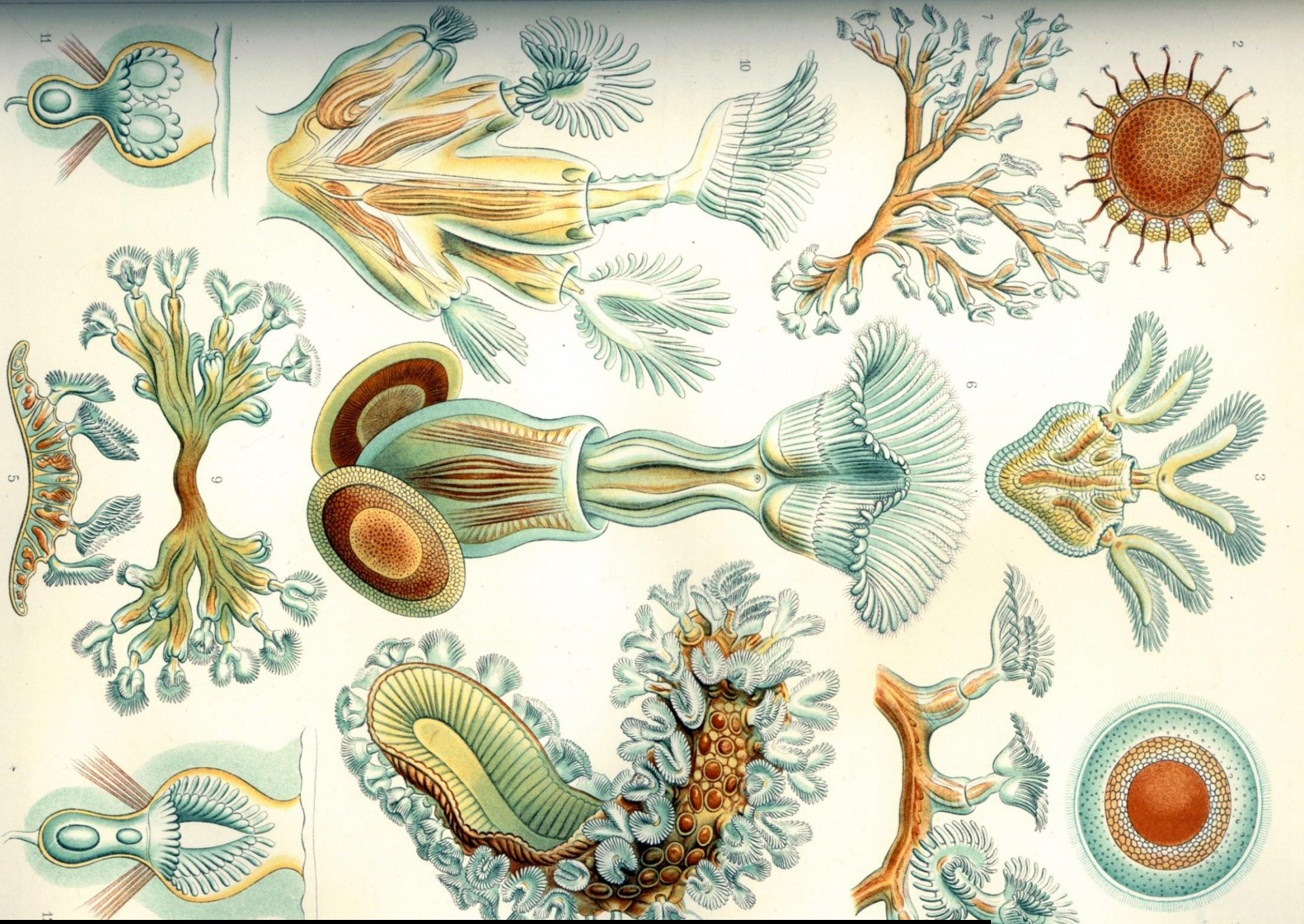








Kunstformen der Natur (1904, Ernst Haeckel, Art forms of nature)



Kunstformen der Natur (1904, Ernst Haeckel, Art forms of nature)

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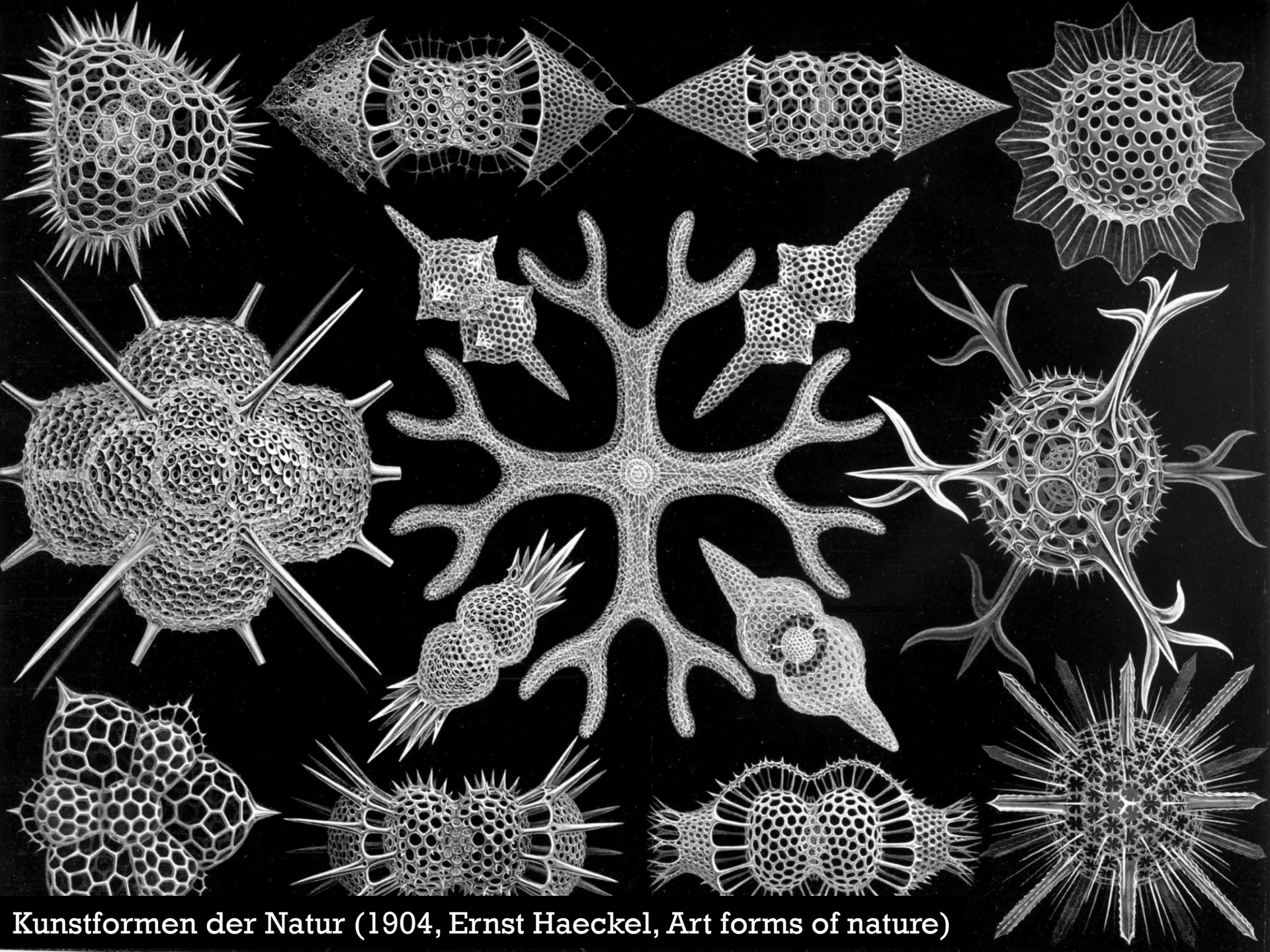

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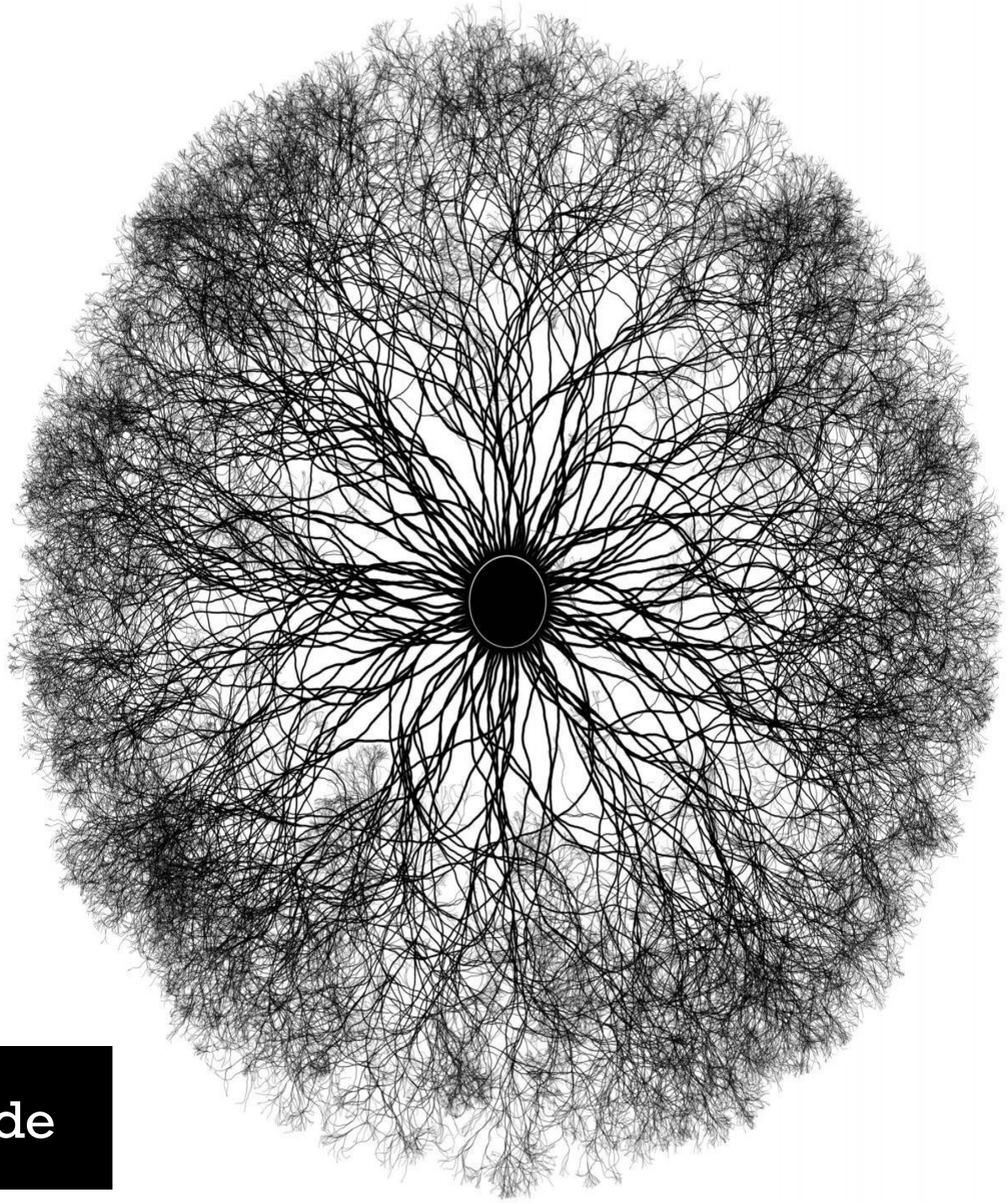

Art from code

learning computer science

the beauty of computer science

the beauty of computer science

+

art of coding OR the coding of art

the beauty of computer science

+

art of coding OR the coding of art

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learning sorting algorithms better

the beauty of computer science

+

art of coding OR the coding of art

+

learning sorting algorithms better

+

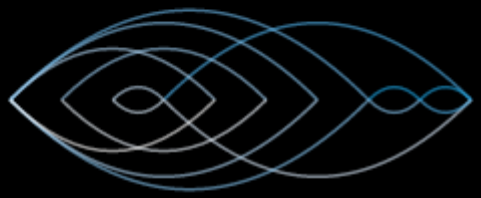
exploration with data visualization

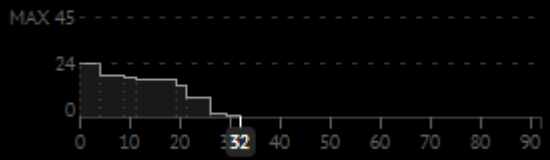
SORTING

www.sorting.at

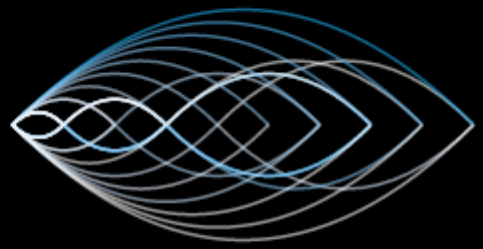
SORTING

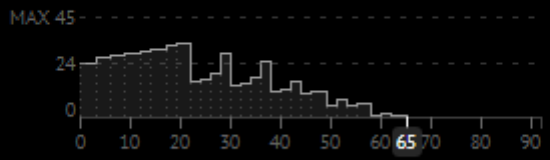
QUICK SORT
10 randomly ordered elements



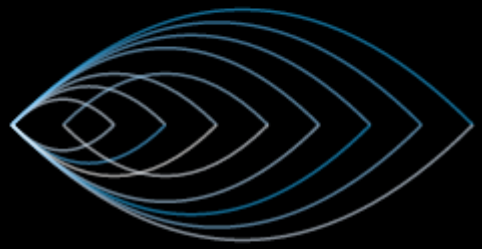


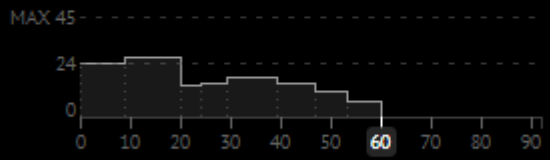
HEAPSORT
10 randomly ordered elements





CYCLESORT
10 randomly ordered elements





SELECTIONSORT
10 randomly ordered elements

MERGE SORT (IN-PLACE)
10 randomly ordered elements

COMBSORT
10 randomly ordered elements

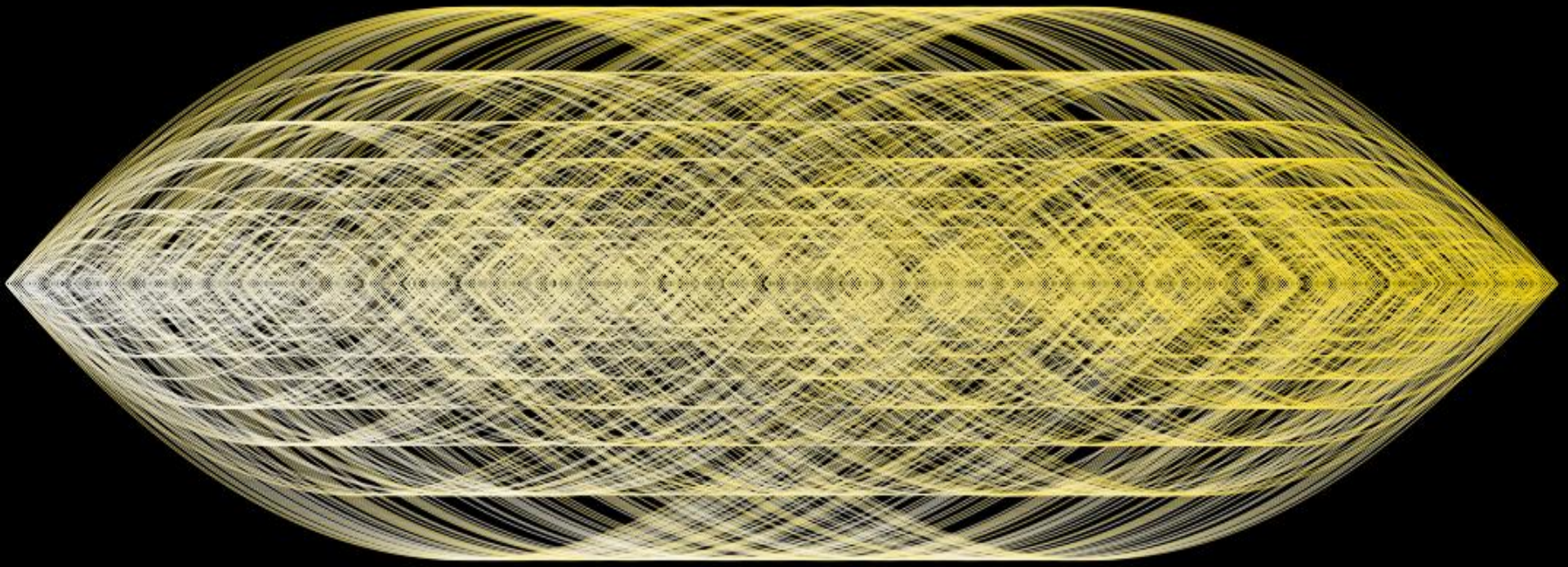
bubble sort O(n^2)

if the list is already sorted O(n)

always compare elements next to each other

also known as the “sinking sort”, “it has only a catchy name” (Donald Knuth)

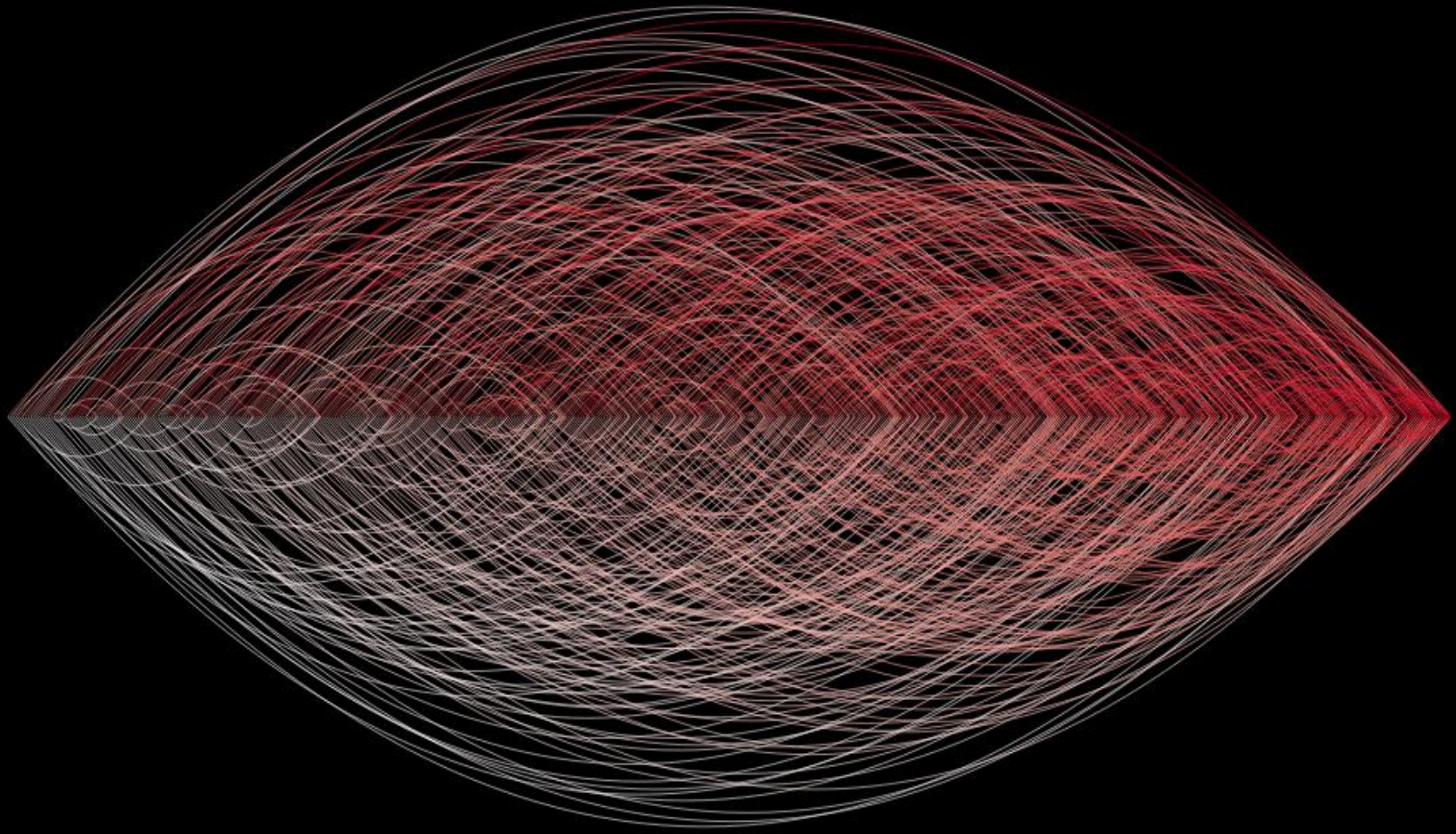
comb sort O(n^2)



improves bubblesort by eliminating turtles and rabbits

gap between compared elements is bigger than 1 and shrinks at every iteration

selection sort O(n^2)



search for the smallest element and put it in first position

inefficiently looks for element to be positioned at their right position in the list

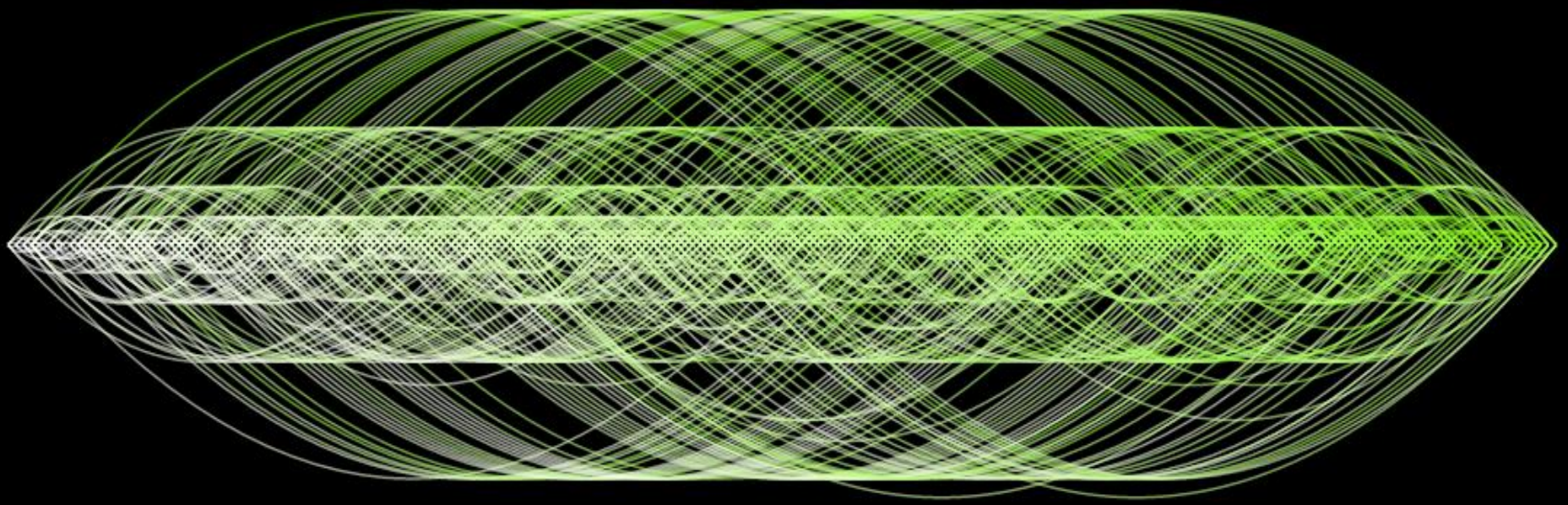
only n swaps, therefore is useful where swapping is expensive

insertion sort O(n^2)

makes space to the current item by moving larger items to the right

shifting all elements is expensive

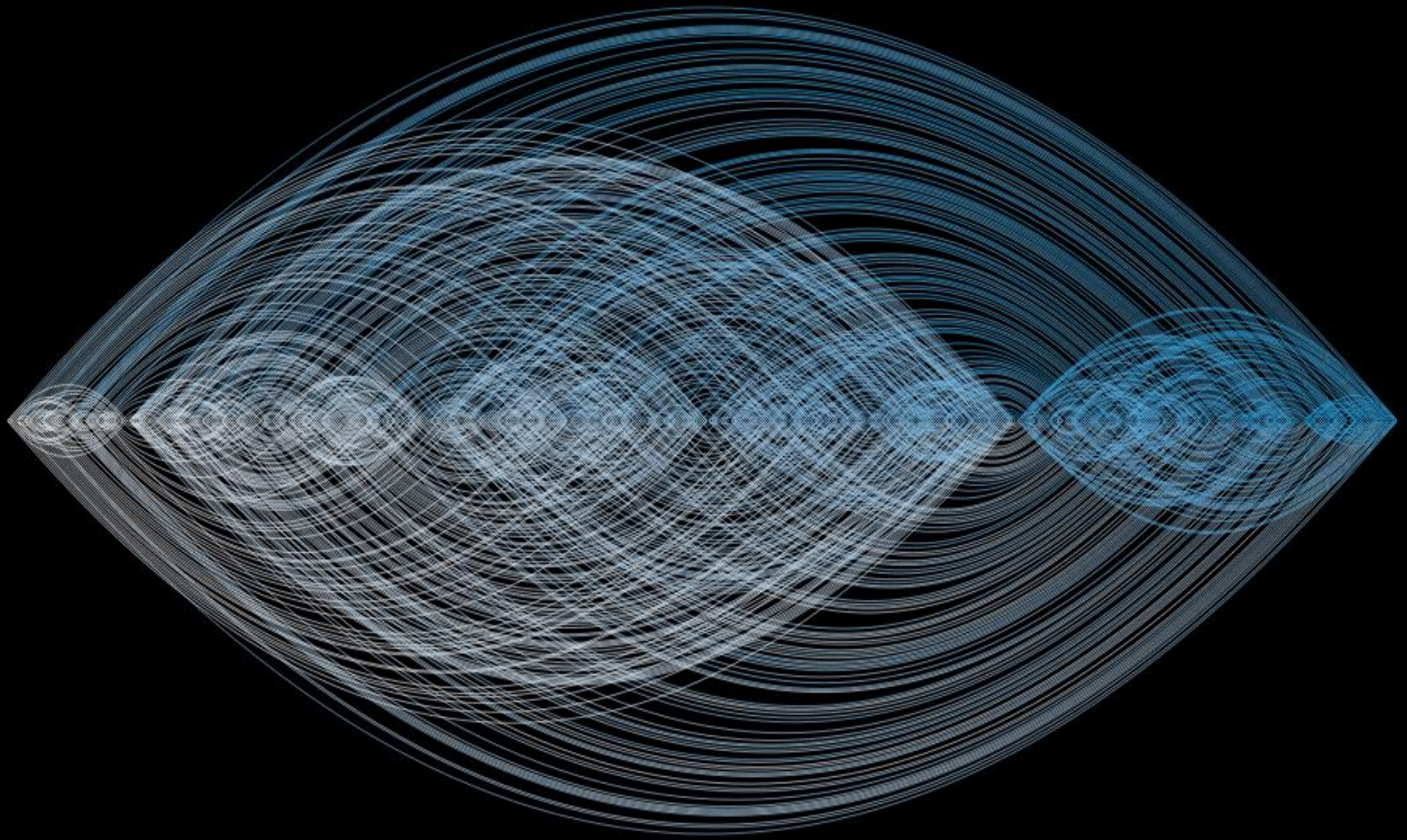
shell sort $O(n \log^2 n)$ – $O(n^{3/2})$



variant of insertion sort based on pre-defined gaps

works on shrinking gaps, complexity based on the gaps

quick sort O(n log n)

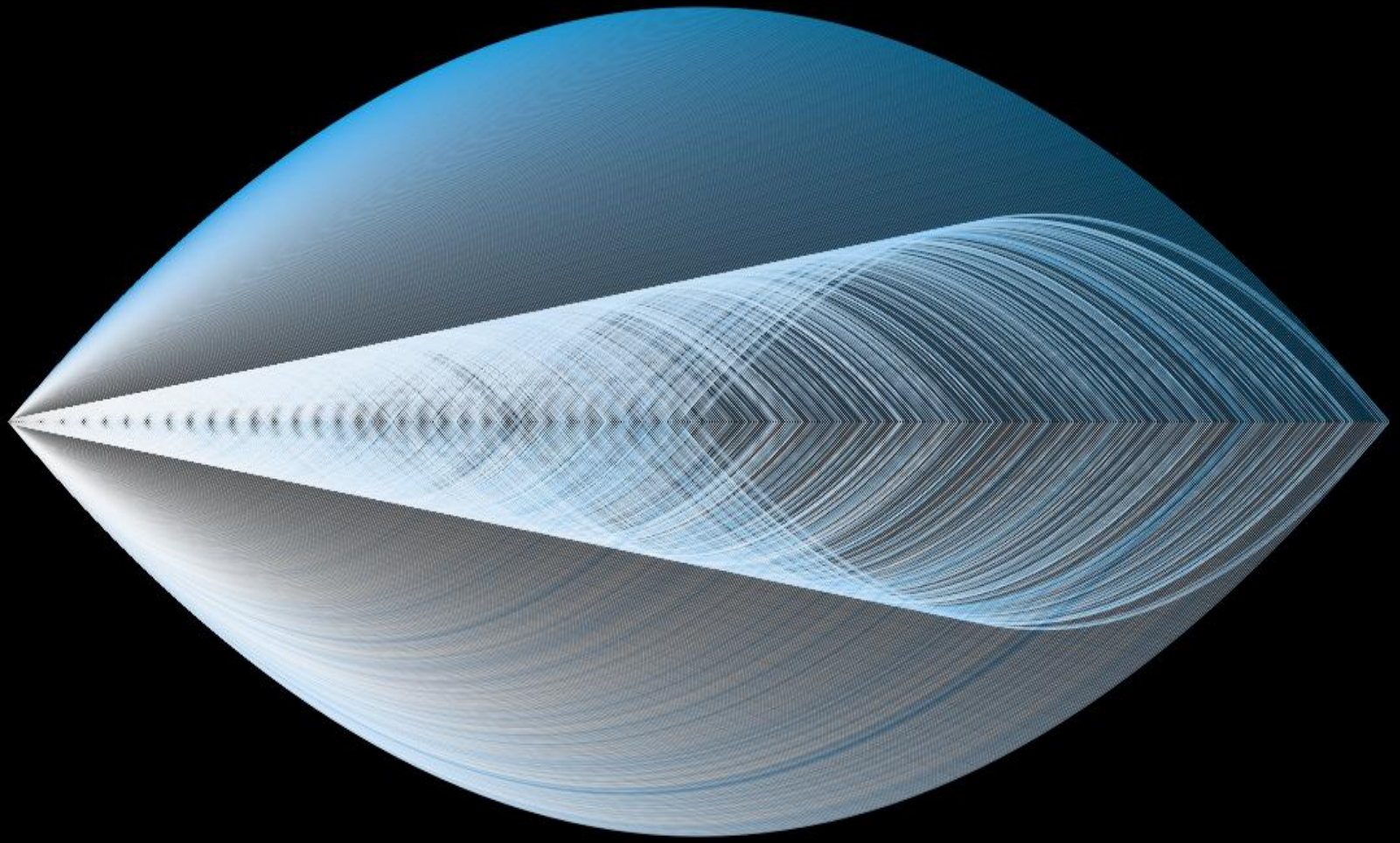


divide and conquer algorithm

based on partioning and pivot selection

all elements smaller than the pivot are moved before it, greater after it

heap sort O(n log n)



improved selection sort by selecting largest element and placing at the end

uses a heap (b-tree) to rearrange the list

finding the next largest element takes O(log n)

inversions count

An inversion is a pair of positions in a sequence where the elements there located are out of their natural order.

It indicates the distance of that sequence from being sorted.

A pair of elements (A[i] , A[j]) of a sequence A is called an inversion if i<j and A[i]>A[j].

inversions count

0 3 7 1 4 5 2 6 8 9

inversions count

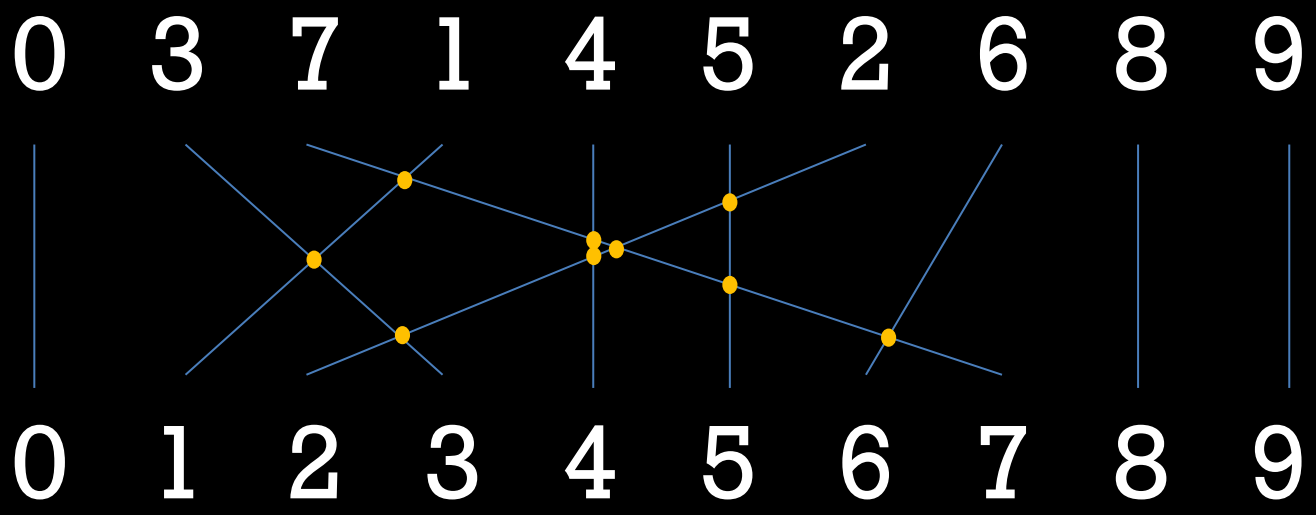
0 3 7 1 4 5 2 6 8 9

(3,1),(3,2),(7,1),(7,4),(7,5),(7,2),(7,6),(4,2),(5,2)

inversions count

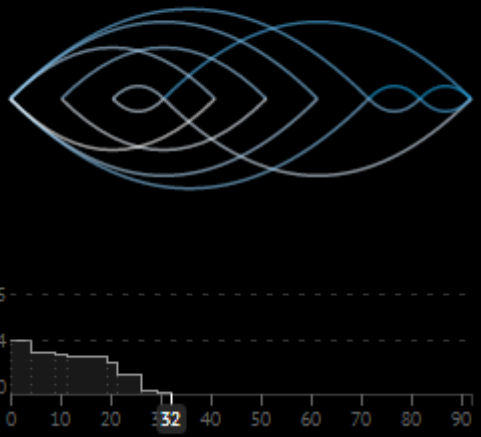
0 3 7 1 4 5 2 6 8 9

(3,1),(3,2),(7,1),(7,4),(7,5),(7,2),(7,6),(4,2),(5,2)



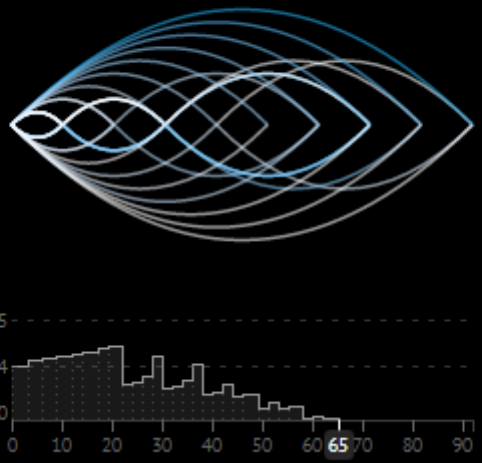
QUICK SORT

10 randomly ordered elements



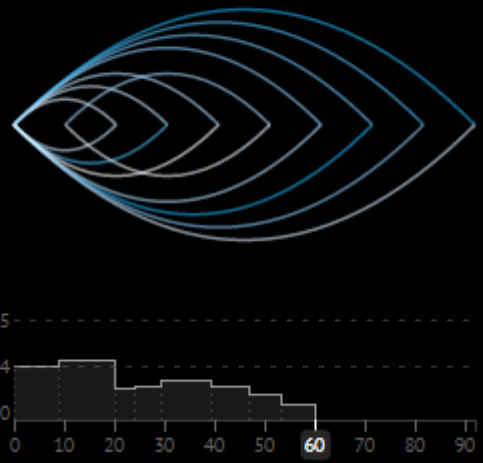
HEAPSORT

10 randomly ordered elements



CYCLESORT

10 randomly ordered elements



based on require.js and D3.js

asynchronous code loading

```
{
        “name” : “Bubble Sort”,
        “complexity“ : “O(n²)”,
        “wiki” : “http://en.wikipedia.org/wiki/Bubble_sort”,
        “code” : function() {
                var steps=[];
                function bubblesort(array) {
                        //sorting code
                        //save each step
                }

                return function(array) {
                        bubblesort(array);
                        return steps;
                }

        }
}
```

3 D3 TIPS

d3.timer

to repeat batch of operations with requestAnimation frame
prevent path rendering from locking up the UI

```
d3.timer(function(elapsed){
        element
                .selectAll("path")
                        .attr("d",function(d,i){
                                //evaluate path_coordinates
                                return path_coordinates;
                        })
                        //evaluate flag of end of loop
                        return flag;
})
```

attrTween(t) + stroke-dashoffset

to animate the drawing

The attrTween operator is used when you need a custom interpolator, such as one that understands the semantics of SVG path data

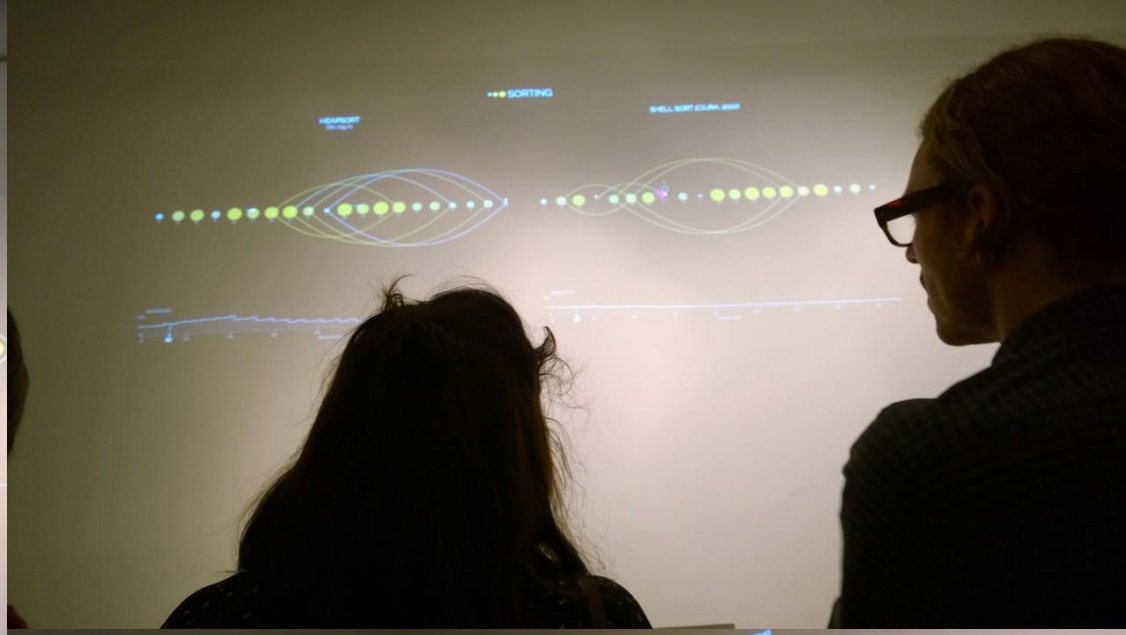
```
.transition()
.duration(DURATION)
        .attrTween("stroke-dashoffset",function(d,i){
                var len = this.getTotalLength();
                return function(t) {
                        return len*(1-t);
                }
        })
```

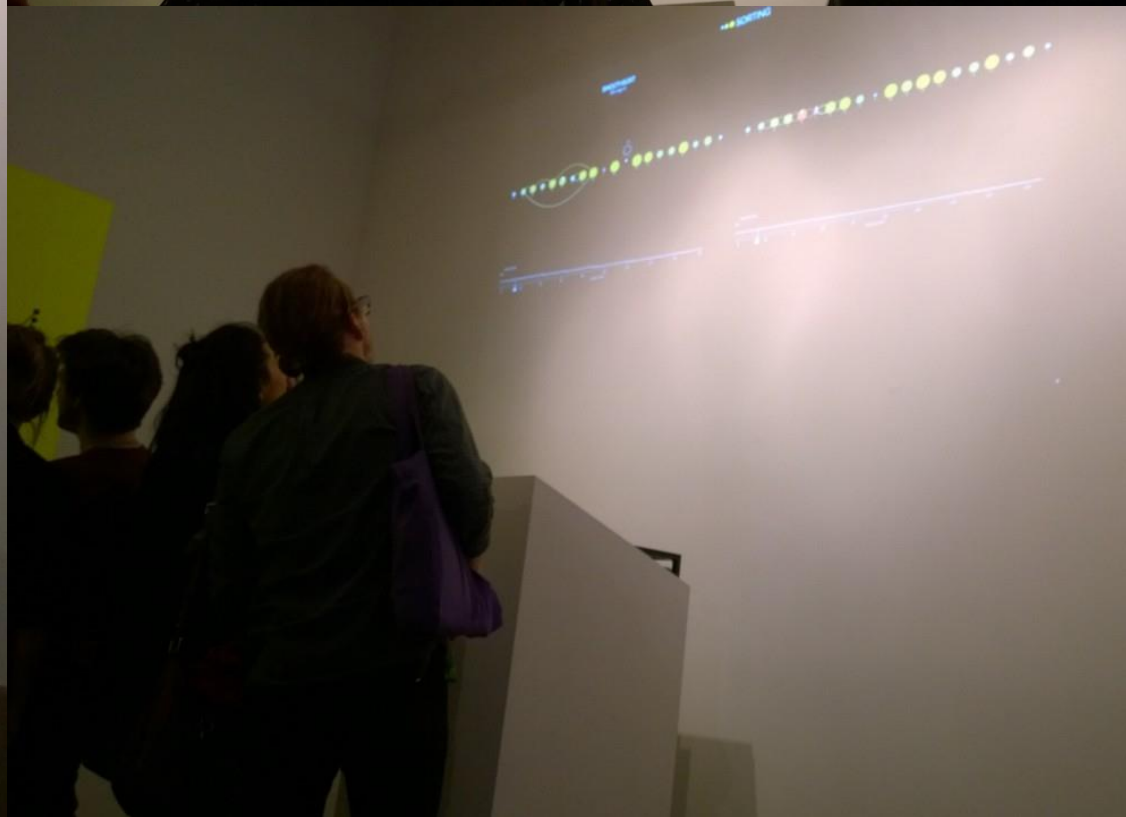
attrTween(t) + path.getPointAtLength(len*t)

to animate along a path

```
.transition()
.duration(DURATION)
        .attrTween("transform",function(d){
                return function(t){

                        var len = path.getTotalLength();
                        var p = path.getPointAtLength(len*t);

                        return "translate("+p.x+","+p.y]+")";

                }
        })
```


SORTING
HEAPSORT
SHELL SORT (KNUTH, 1973)


SORTING
HEAPSORT
SHELL SORT (CIURA, 2001)


SORTING

and now
the best interpretation of
sorting algorithms EVER

Quick-sort with Hungarian ("Csángó") folk dance

Quick-sort with Hungarian (Küküllőmenti legényes) folk dance

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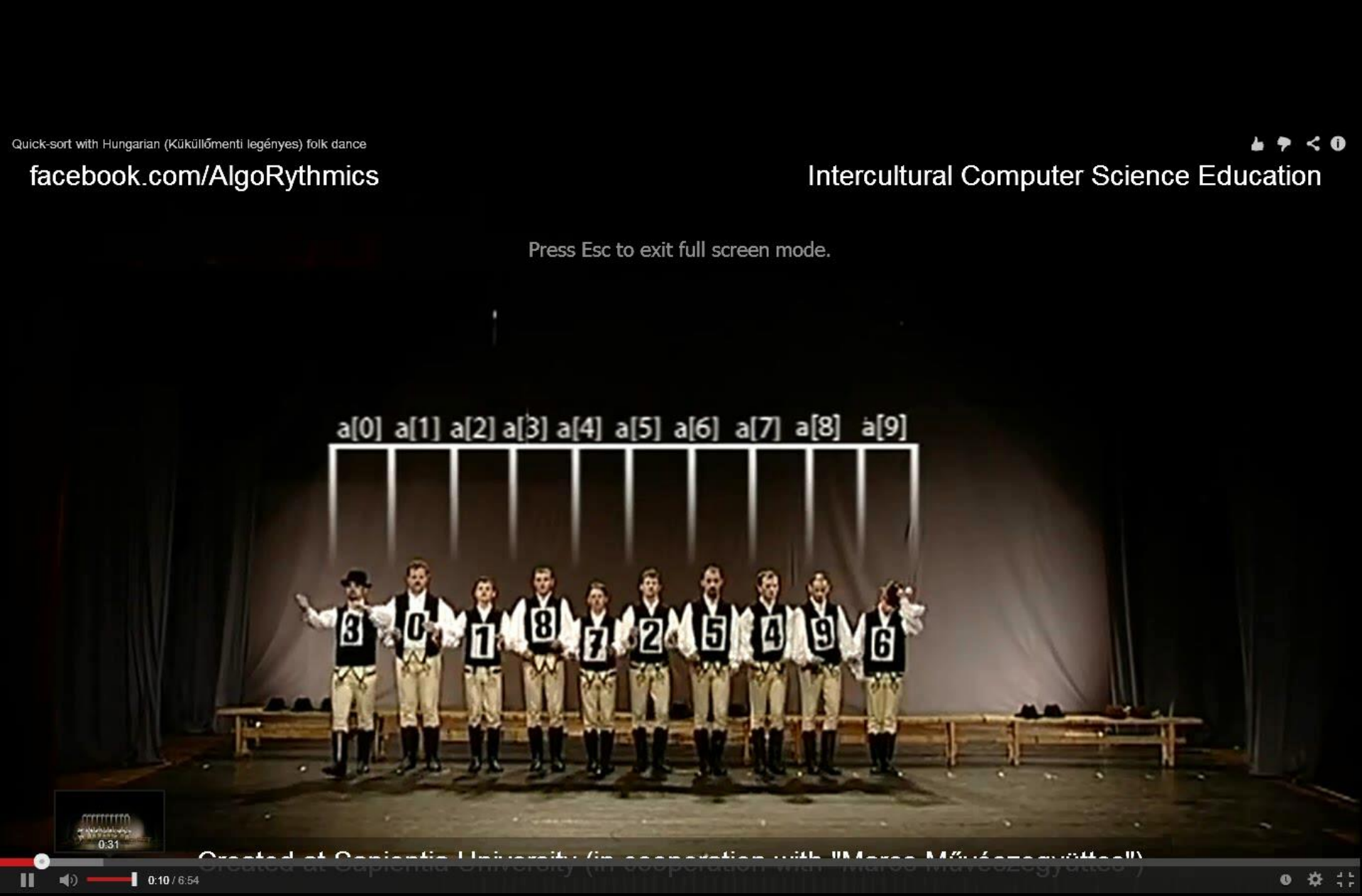
Intercultural Computer Science Education

Press Esc to exit full screen mode.



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