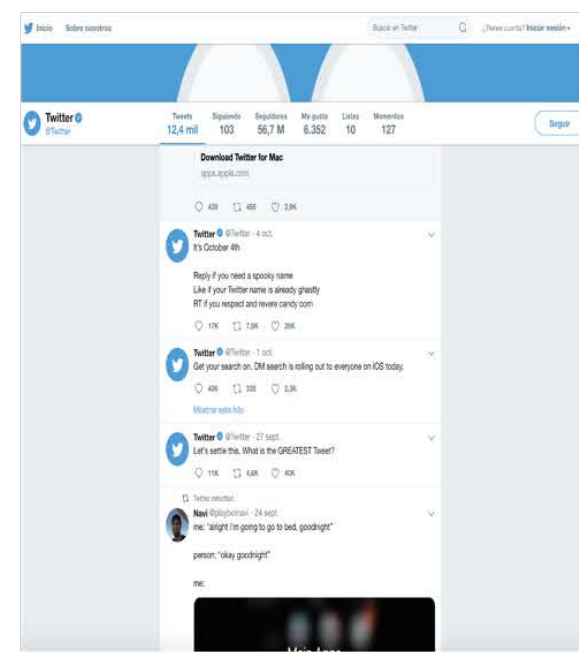
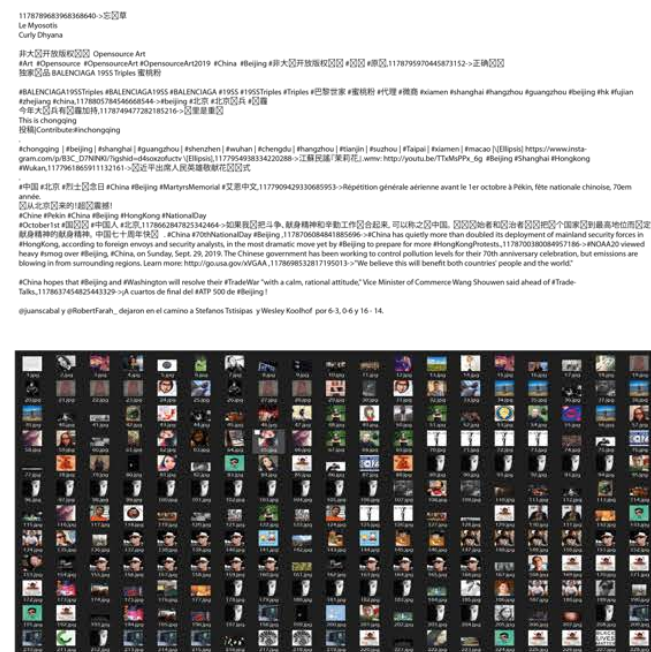




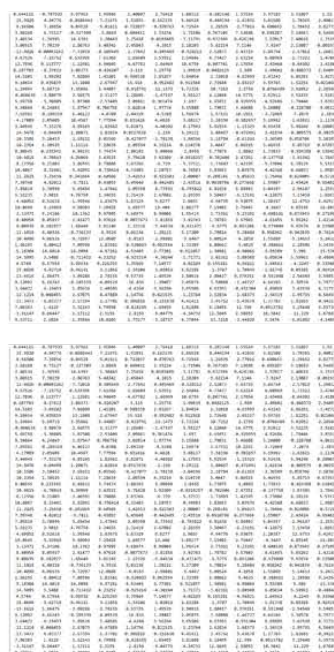
Self Organizing Maps



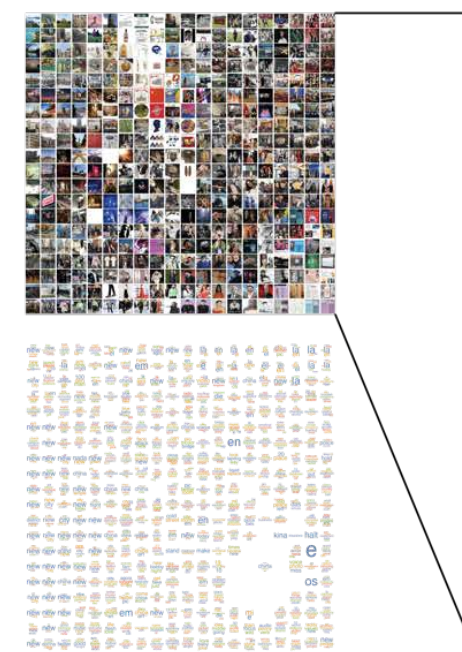
Define your project, and start the crawling process



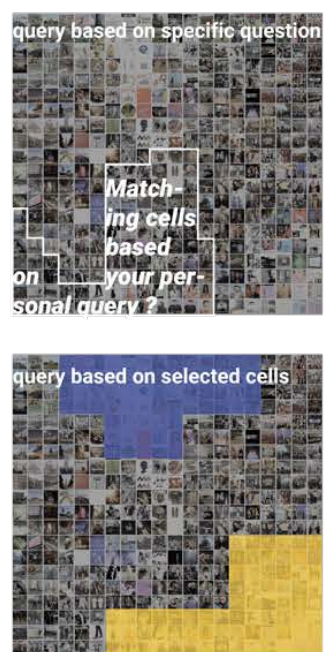
You collected data in two formats



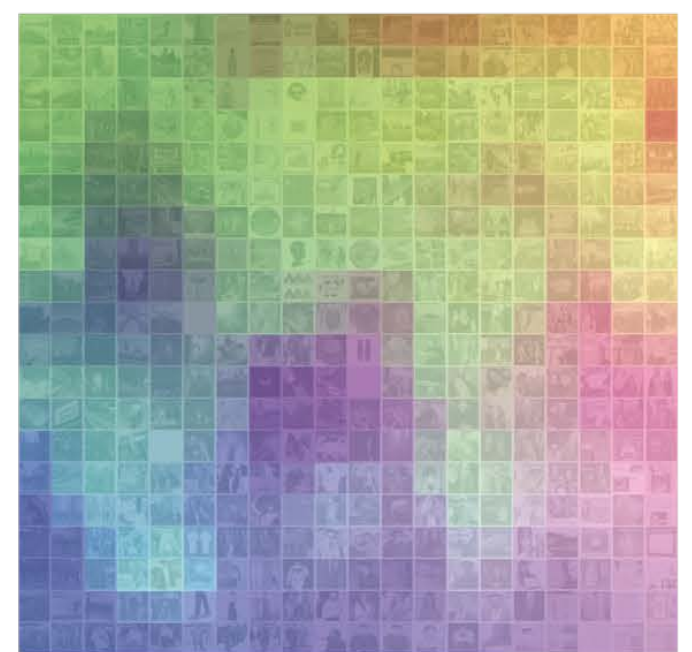
Transform one of the two formats to its numerical representation



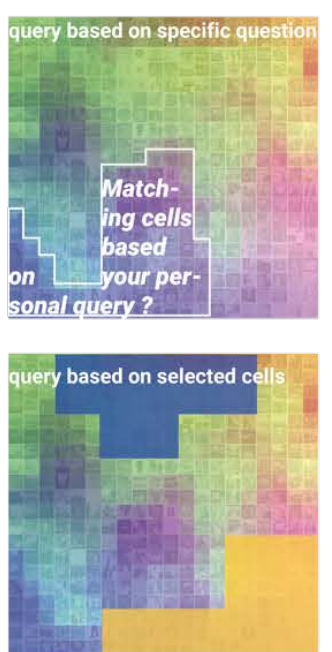
Train and render the SOM



Choose one way of filtering the SOM



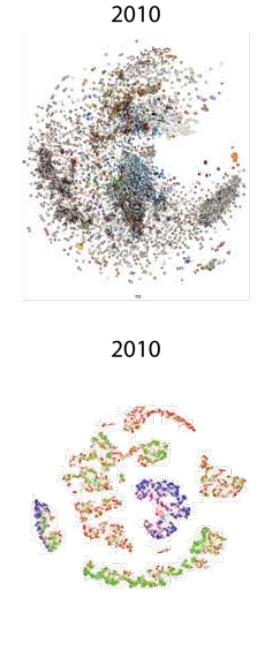
Render the SOM by its weights, assigning colors to each cell



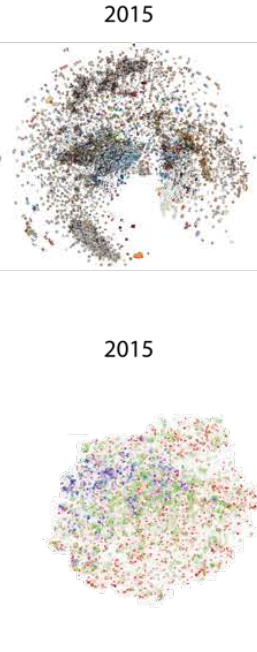
query based on specific question



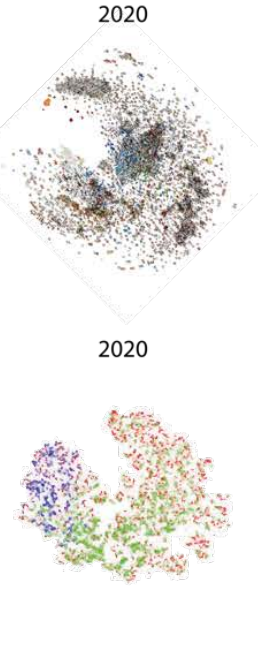
render back to space



render by time



2015



2020

FEATURE VECTORS AND EUCLIDEAN DISTANCE

A reminder from the last lecture

Feature Vector

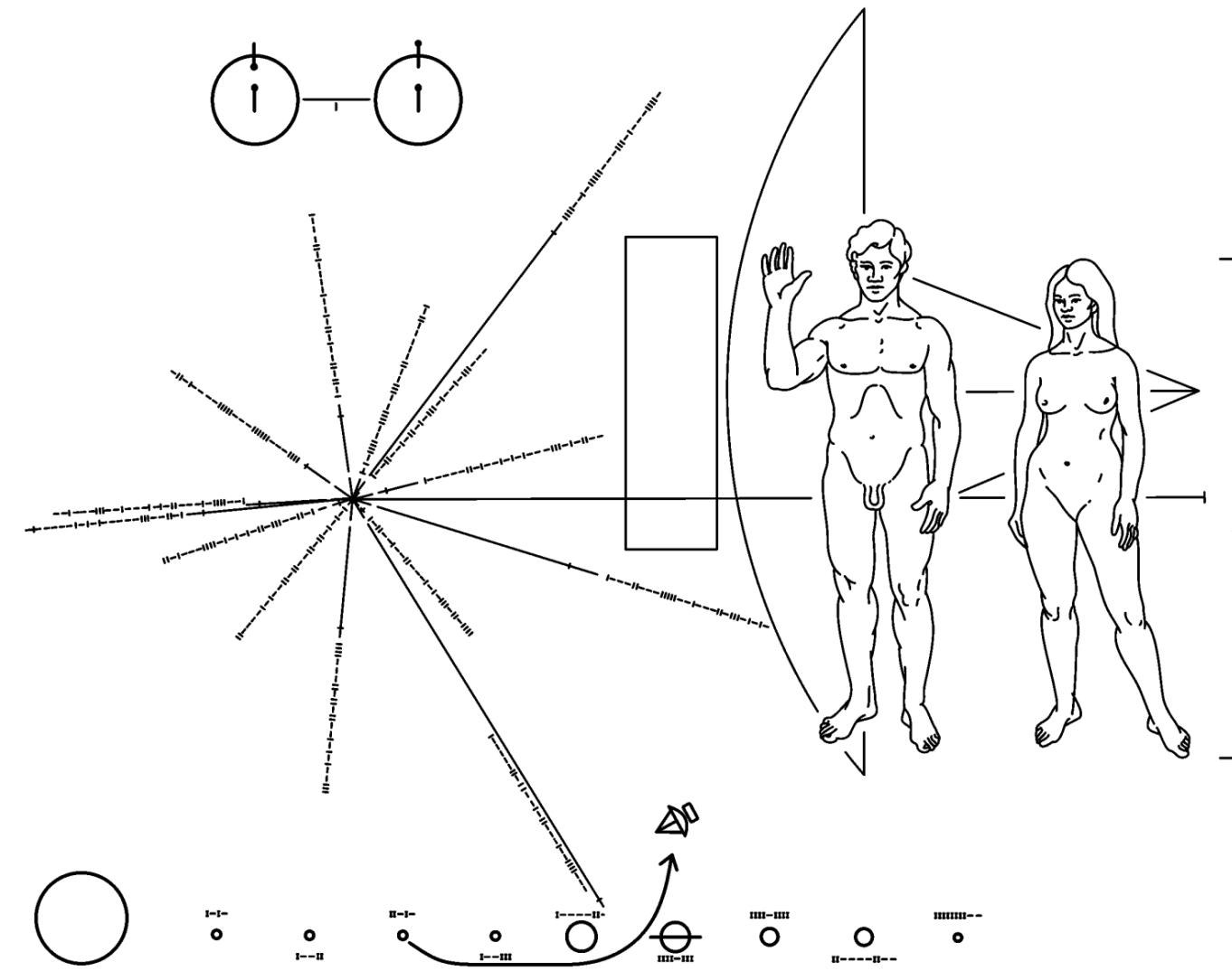
Numerical features that represent some object



An apple

(color, size, weight, sweetness)

(0 red, 12.3 cm, 180 g, 2 very)



(sex, age, weight, height)

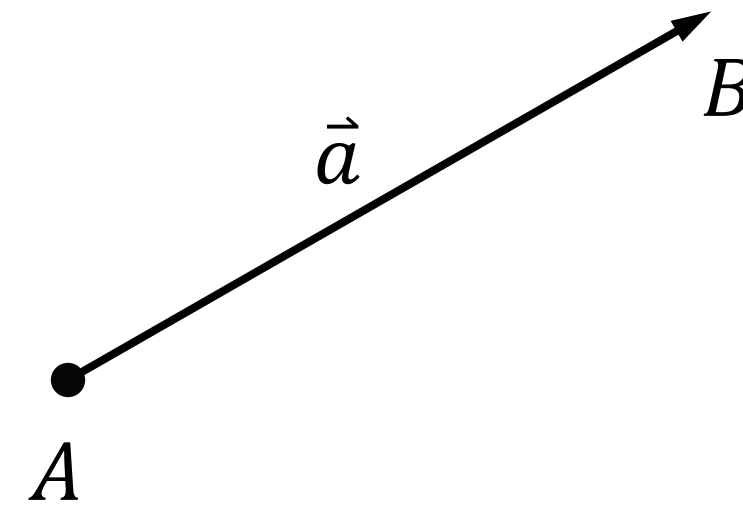
(0 male, 25, 70 kg, 182 cm)

@Pioneer plaque

A person

Euclidean distance

distance between two points in Euclidean space



$$\|AB\| = \sqrt{(B_1 - A_1)^2 + (B_2 - A_2)^2 + \dots + (B_n - A_n)^2} = \|\vec{a}\|$$

Feature Vector + Euclidean Distance

A Common Ground for Comparing Objects



A

(color, size, weight, sweetness)

(0 red, 12.3 cm, 180 g, 2 very)



B

(color, size, weight, sweetness)

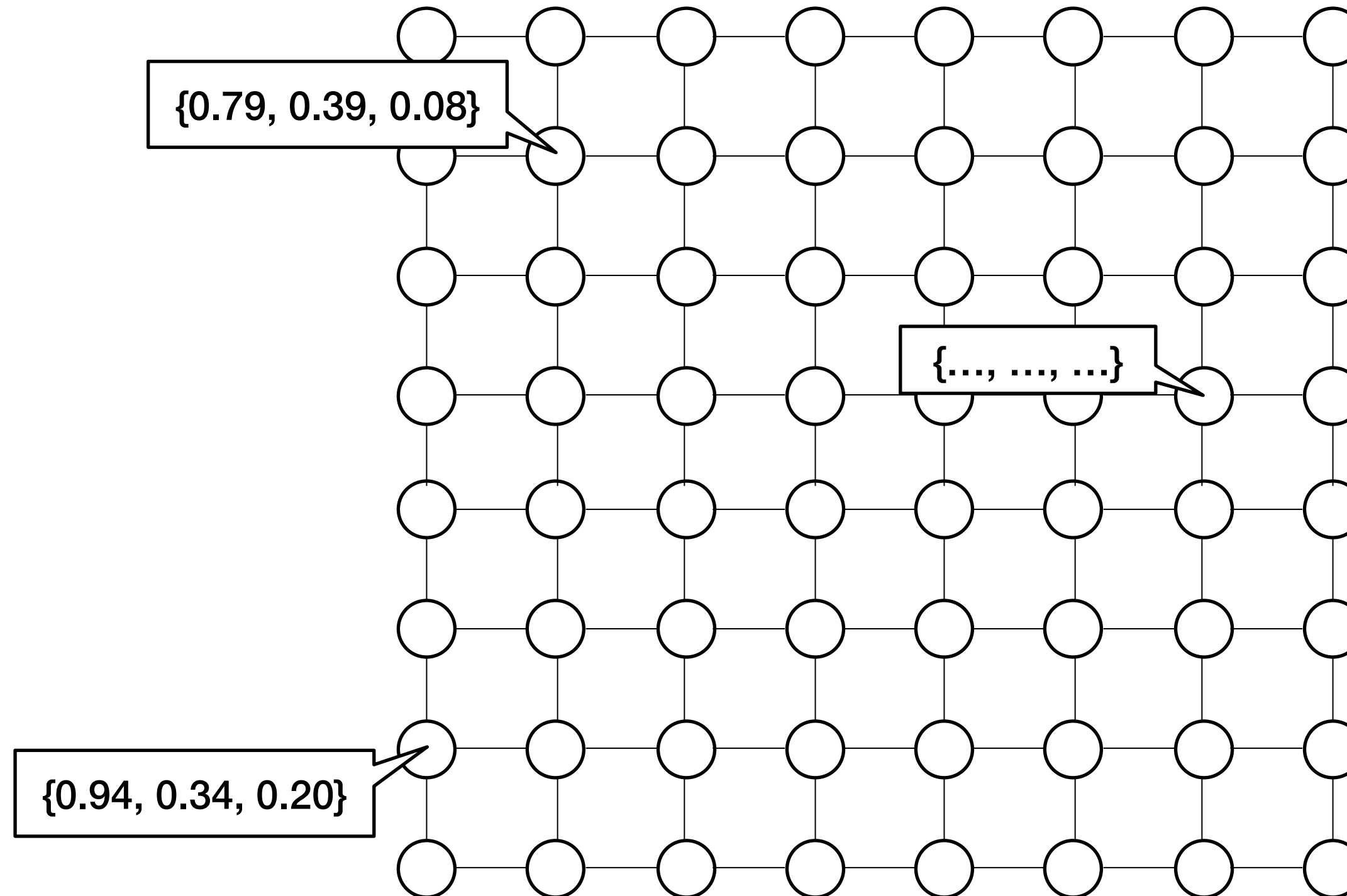
(1 orange, 11.7 cm, 170 g, 1 yes)

$$\|AB\| = \sqrt{(1 - 0)^2 + (11.7 - 12.3)^2 + (170 - 180)^2 + (2 - 1)^2} = 10.1173..$$

SELF-ORGANIZING MAP (SOM)

Self-organizing map

Kohonen, 1982

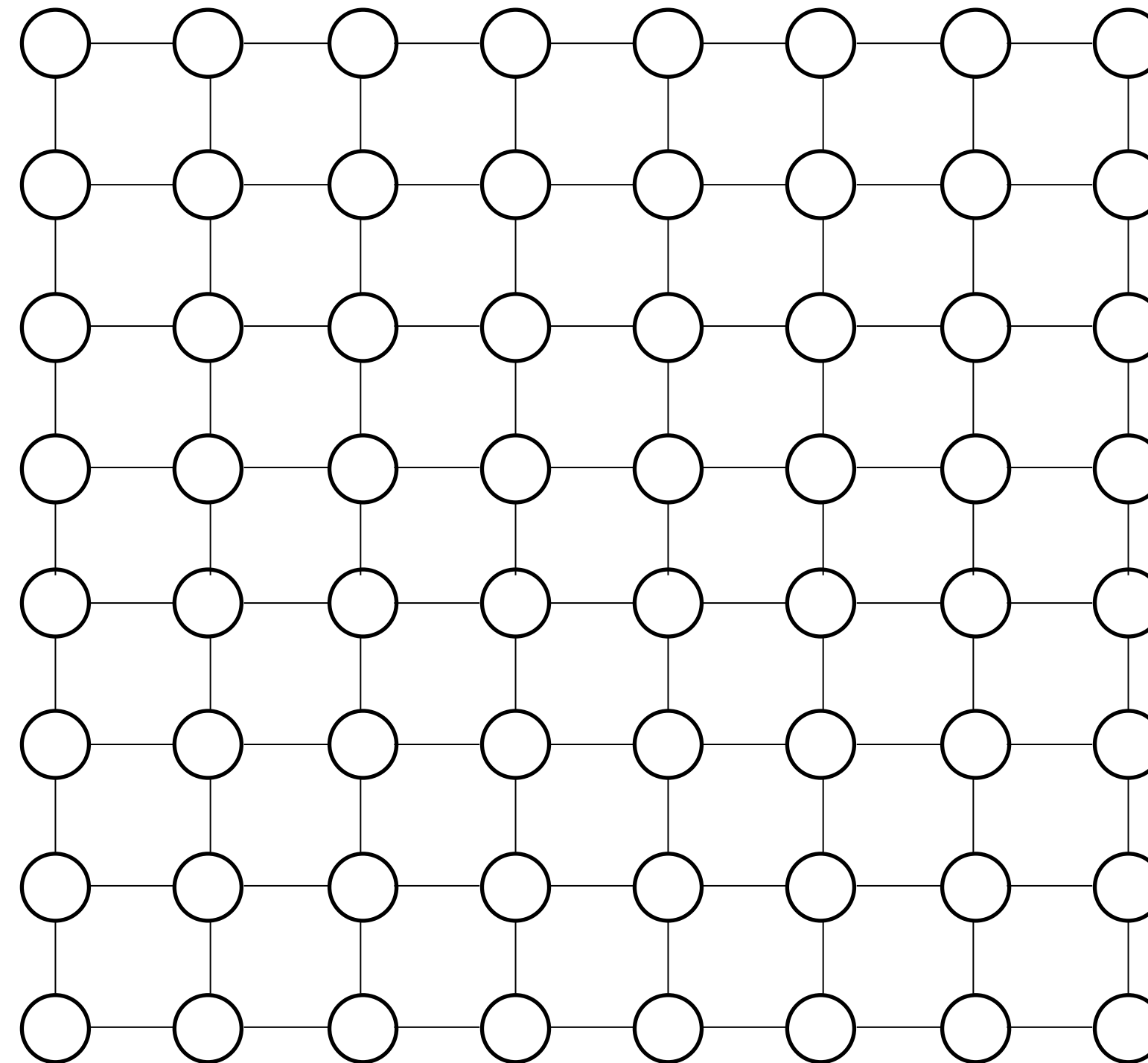


SOM is a grid of feature vectors (cells / units)
above is an example of 8 x 8 x 3 SOM
where 8 x 8 is the size, 3 is the dimensionality of feature vectors

WHAT DOES SOM DO

A Projection from Given Data on Regular Grid

A “compressed” representation of our data



Each SOM cell represents a cluster of similar items from our dataset

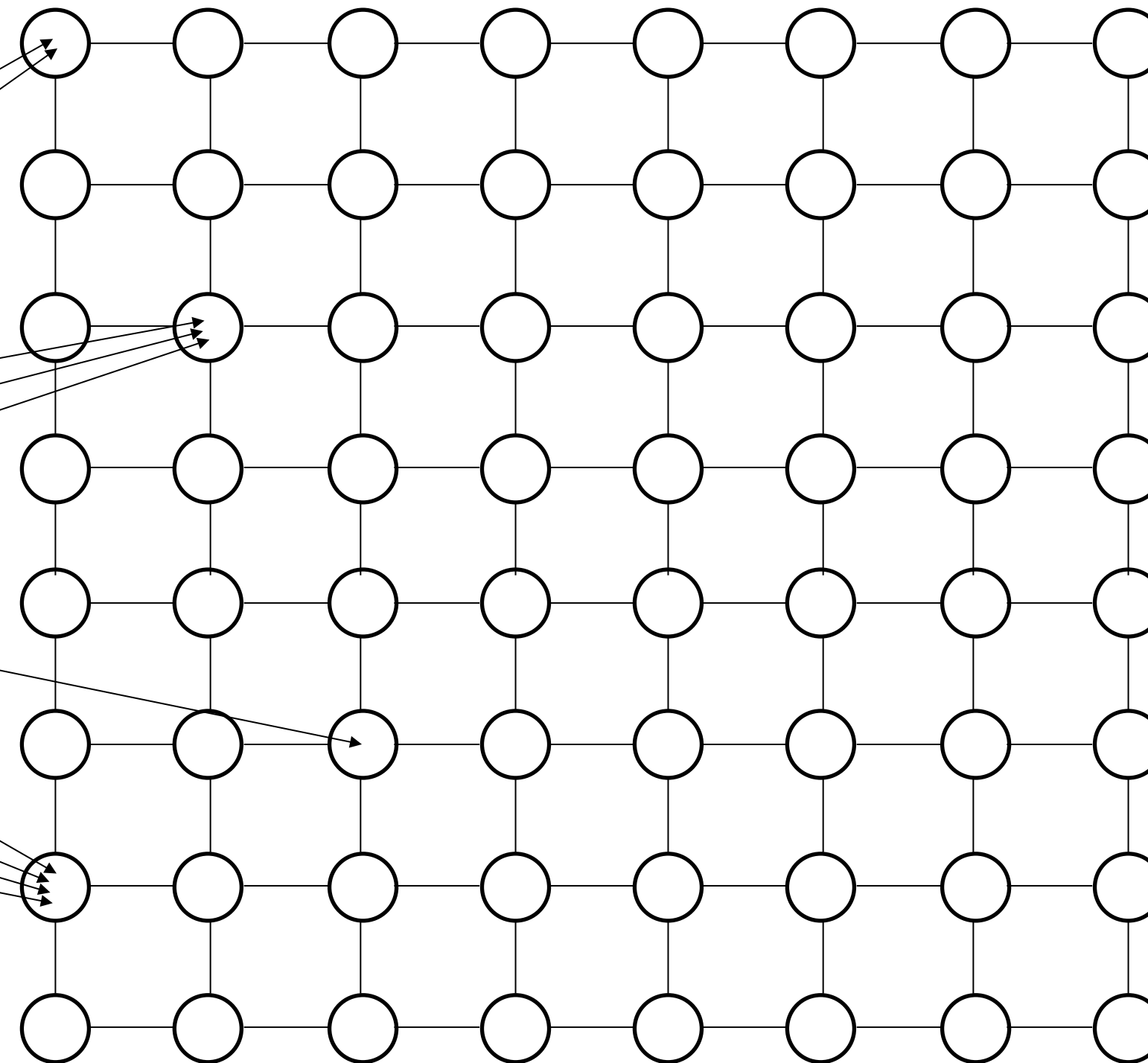
A Projection from Given Data on Regular Grid

A “compressed” representation of our data

Our Dataset

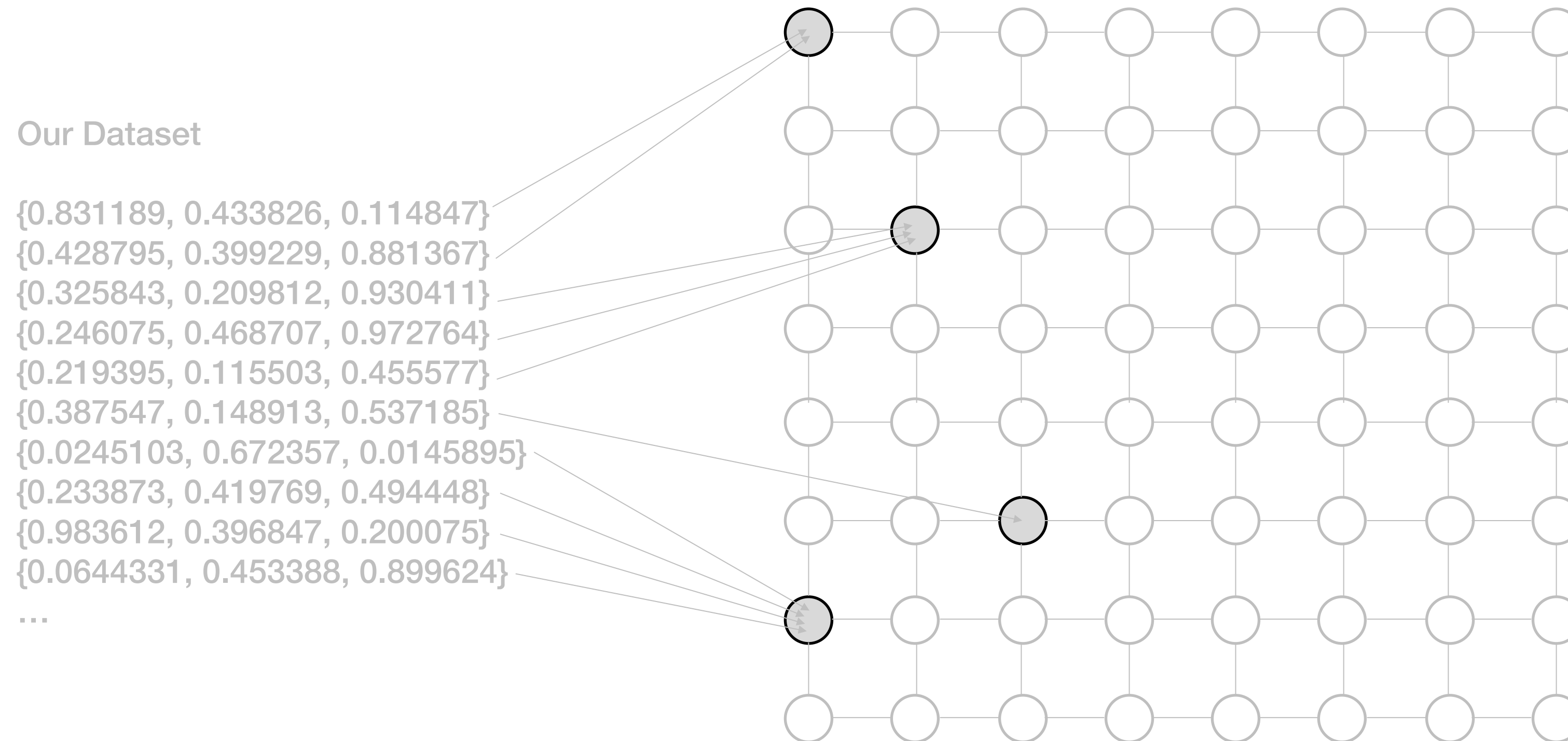
- {0.831189, 0.433826, 0.114847}
- {0.428795, 0.399229, 0.881367}
- {0.325843, 0.209812, 0.930411}
- {0.246075, 0.468707, 0.972764}
- {0.219395, 0.115503, 0.455577}
- {0.387547, 0.148913, 0.537185}
- {0.0245103, 0.672357, 0.0145895}
- {0.233873, 0.419769, 0.494448}
- {0.983612, 0.396847, 0.200075}
- {0.0644331, 0.453388, 0.899624}

...



Each SOM cell represents a cluster of similar items from our dataset

The Best Matching Unit (BMU)



For the items of our dataset, their corresponding SOM cells are called their BEST MATCHING UNIT

MORE IN DETAIL

Training the SOM

A Huge Dataset Impossible to Manage Manually

For example 100k feature vectors of apples

(color, size, weight, sweetness)



(0 red, 12.3 cm, 180 g, 2 very)



(1 orange, 11.7 cm, 170 g, 1 yes)

...

(..., ..., ..., ...)

But we know some of them are similar to each other

A Random SOM

Our dataset

{0.837001,0.727544,0.0394684,0.299028}

{0.684913,0.337634,0.892134,0.794974}

{0.178787,0.837747,0.2533,0.182625}

{0.352355,0.611677,0.643471,0.486624}

{0.0623343,0.330299,0.440126,0.550363}

{0.95928,0.453402,0.250339,0.138137}

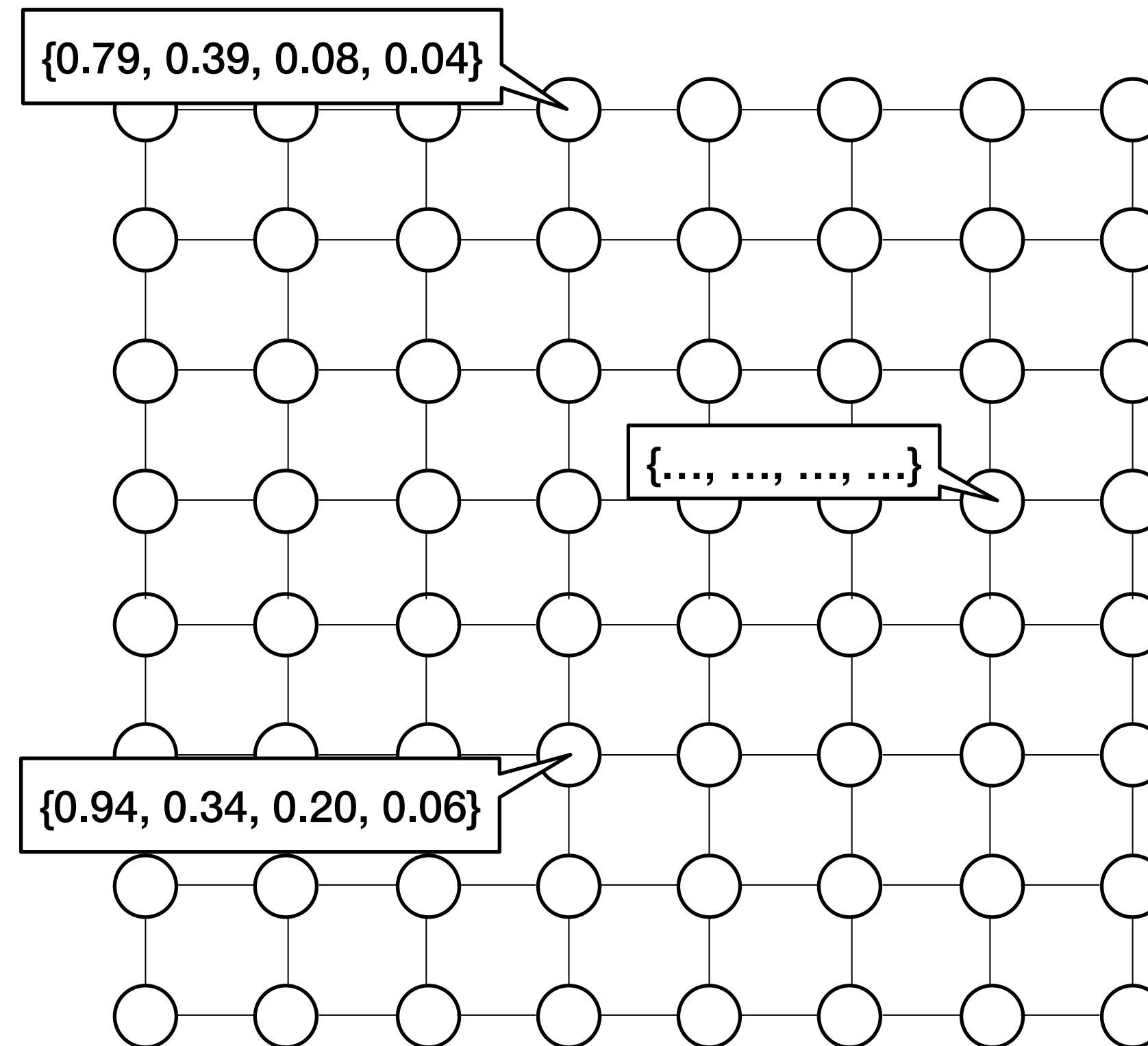
{0.906858,0.0194981,0.464387,0.836483}

{0.70246,0.532199,0.463251,0.0710004}

{0.84464,0.606172,0.864091,0.26712}

{0.427036,0.299789,0.128026,0.759577}

...



We create a SOM with its feature vectors randomly initialized

Find BMU

Our dataset

{0.837001,0.727544,0.0394684,0.299028}

{0.684913,0.337634,0.892134,0.794974}

{0.178787,0.837747,0.2533,0.182625}

{0.352355,0.611677,0.643471,0.486624}

{0.0623343,0.330299,0.440126,0.550363}

{0.95928,0.453402,0.250339,0.138137}

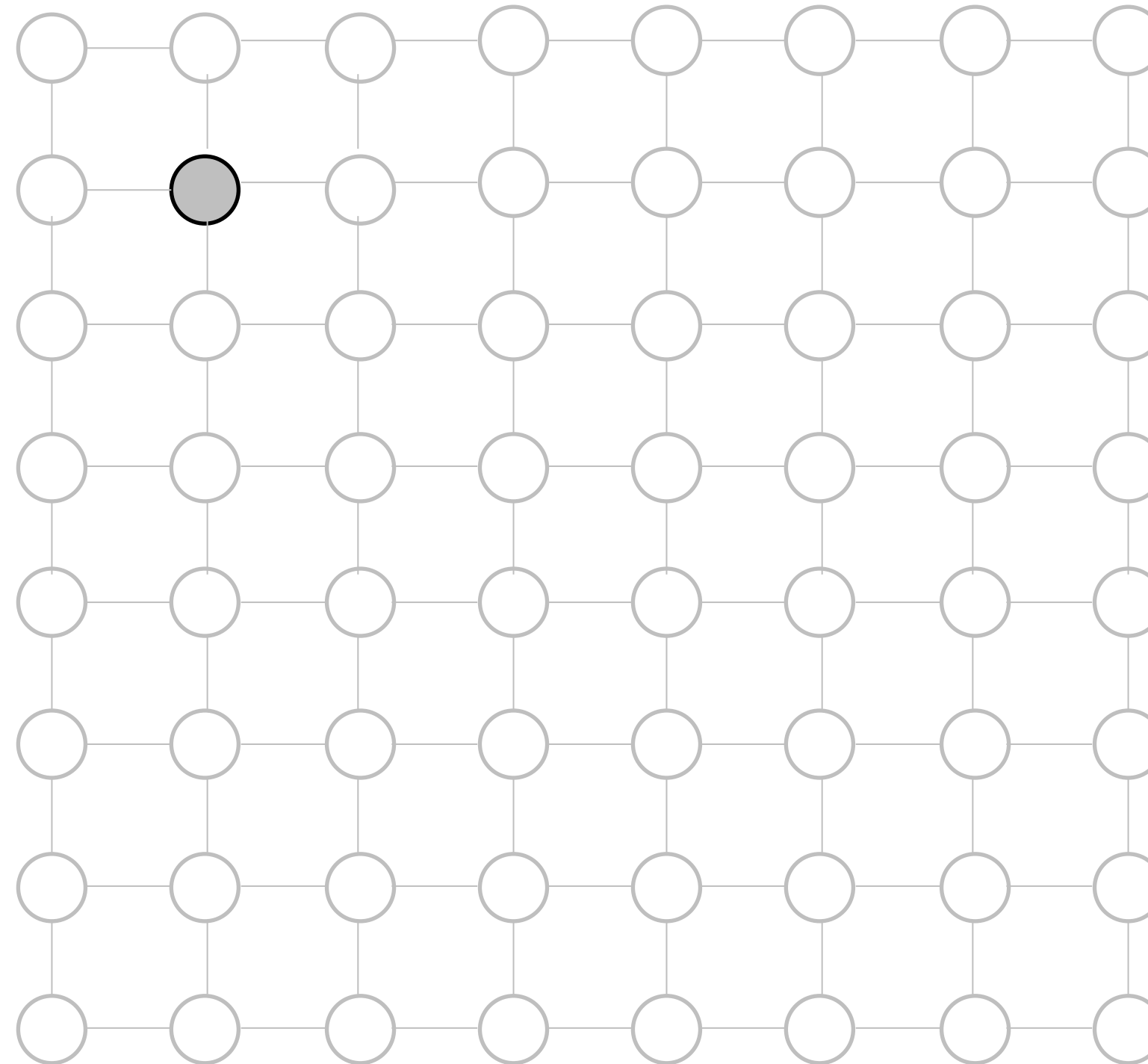
{0.906858,0.0194981,0.464387,0.836483}

{0.70246,0.532199,0.463251,0.0710004}

{0.84464,0.606172,0.864091,0.26712}

{0.427036,0.299789,0.128026,0.759577}

...



We randomly select one item from our dataset, find its BMU

Update BMU Feature Vector

“Stretching” the SOM in feature space

Our dataset

{0.837001,0.727544,0.0394684,0.299028}

{0.684913,0.337634,0.892134,0.794974}

{0.178787,0.837747,0.2533,0.182625}

{0.352355,0.611677,0.643471,0.486624}

{0.0623343,0.330299,0.440126,0.550363}

{0.95928,0.453402,0.250339,0.138137}

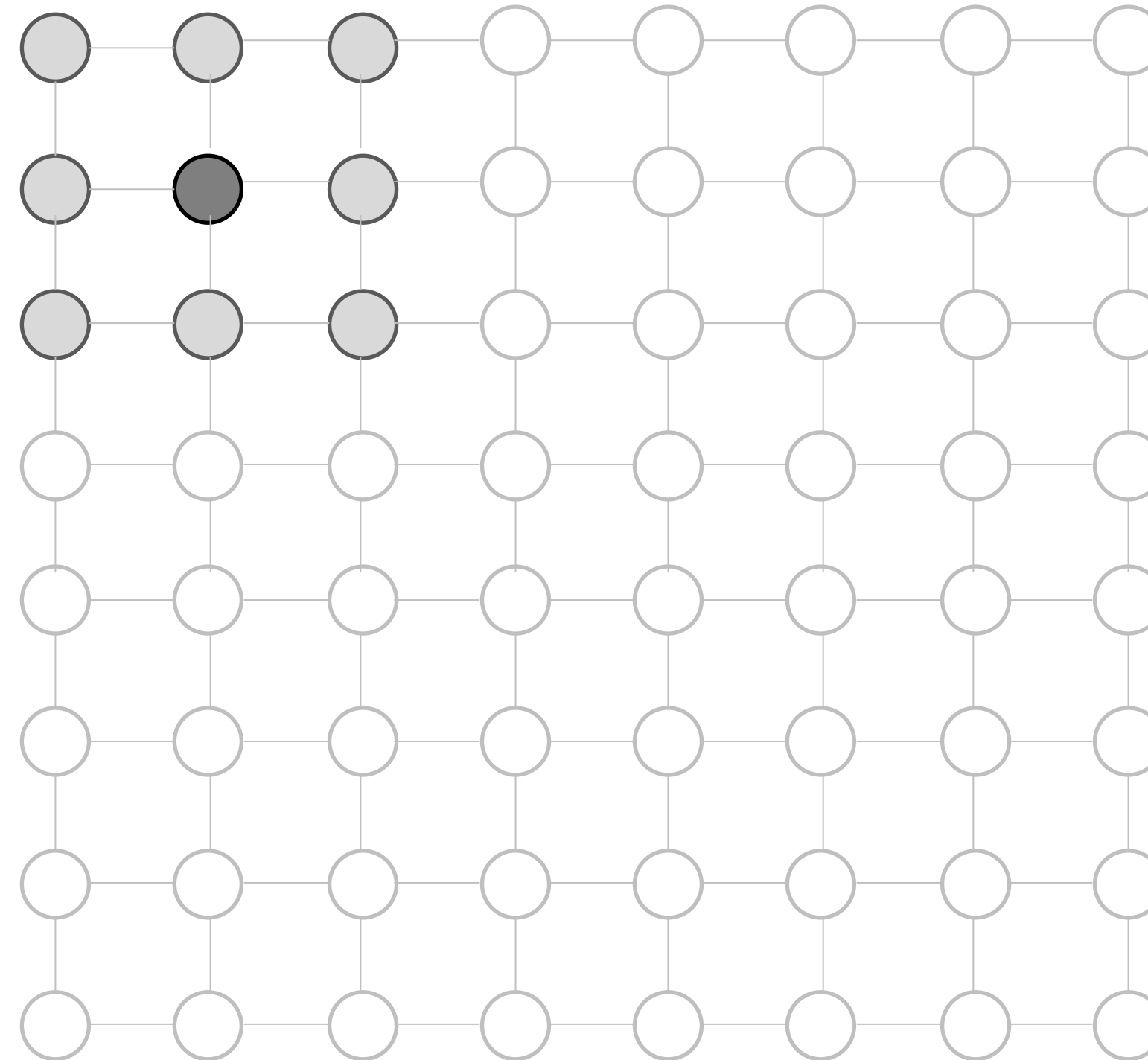
{0.906858,0.0194981,0.464387,0.836483}

{0.70246,0.532199,0.463251,0.0710004}

{0.84464,0.606172,0.864091,0.26712}

{0.427036,0.299789,0.128026,0.759577}

...



We update the BMU and its neighbors' feature vectors so that they are similar to our selected element
The update is stronger to the BMU than to its neighbors

Update BMU Feature Vector

“Stretching” the SOM in feature space

Our dataset

{0.837001,0.727544,0.0394684,0.299028}

{0.684913,0.337634,0.892134,0.794974}

{0.178787,0.837747,0.2533,0.182625}

{0.352355,0.611677,0.643471,0.486624}

{0.0623343,0.330299,0.440126,0.550363}

{0.95928,0.453402,0.250339,0.138137}

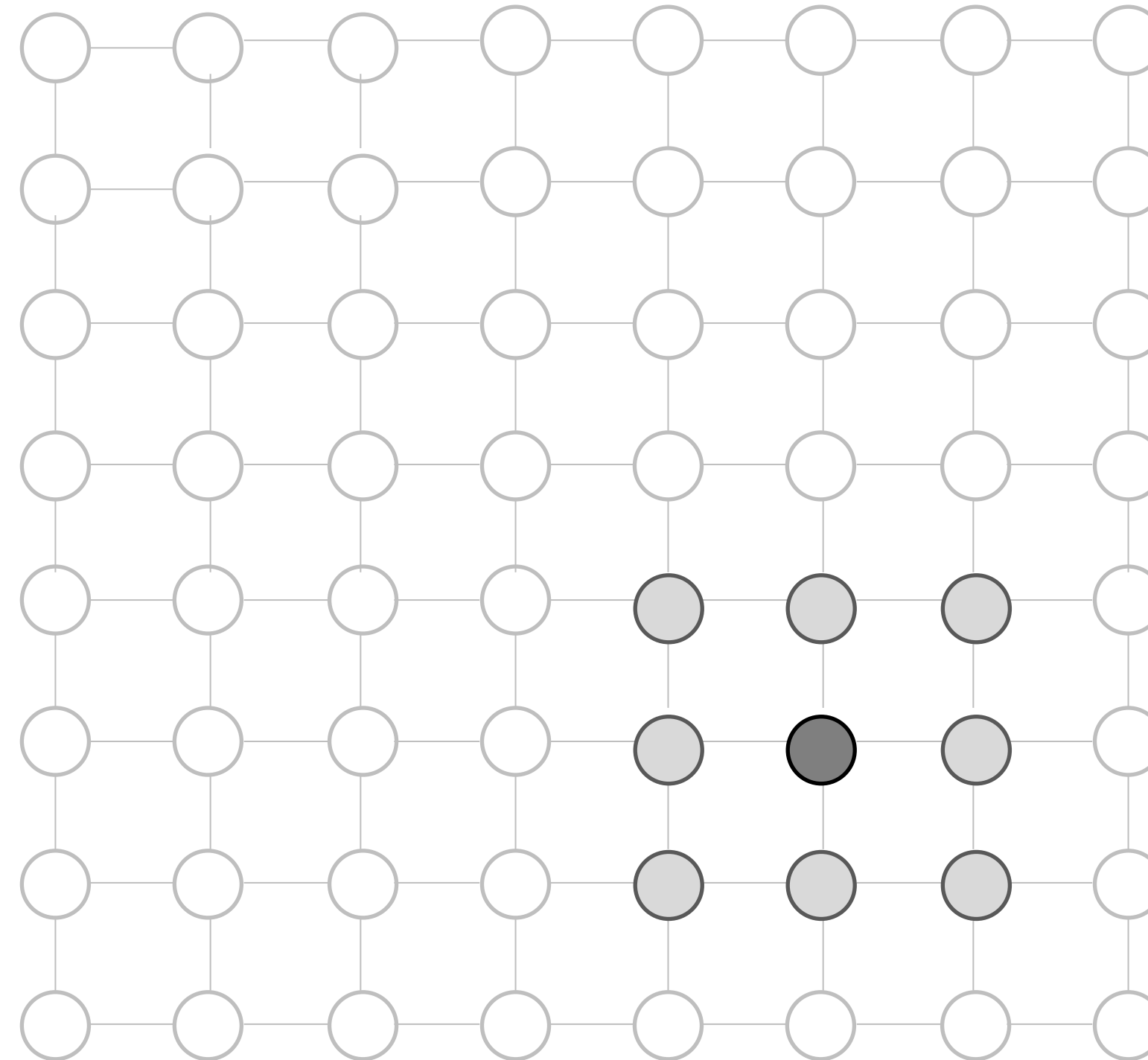
{0.906858,0.0194981,0.464387,0.836483}

{0.70246,0.532199,0.463251,0.0710004}

{0.84464,0.606172,0.864091,0.26712}

{0.427036,0.299789,0.128026,0.759577}

...



We move to another randomly selected item, and repeat the process

Update BMU Feature Vector

“Stretching” the SOM in feature space

Our dataset

{0.837001,0.727544,0.0394684,0.299028}

{0.684913,0.337634,0.892134,0.794974}

{0.178787,0.837747,0.2533,0.182625}

{0.352355,0.611677,0.643471,0.486624}

{0.0623343,0.330299,0.440126,0.550363}

{0.95928,0.453402,0.250339,0.138137}

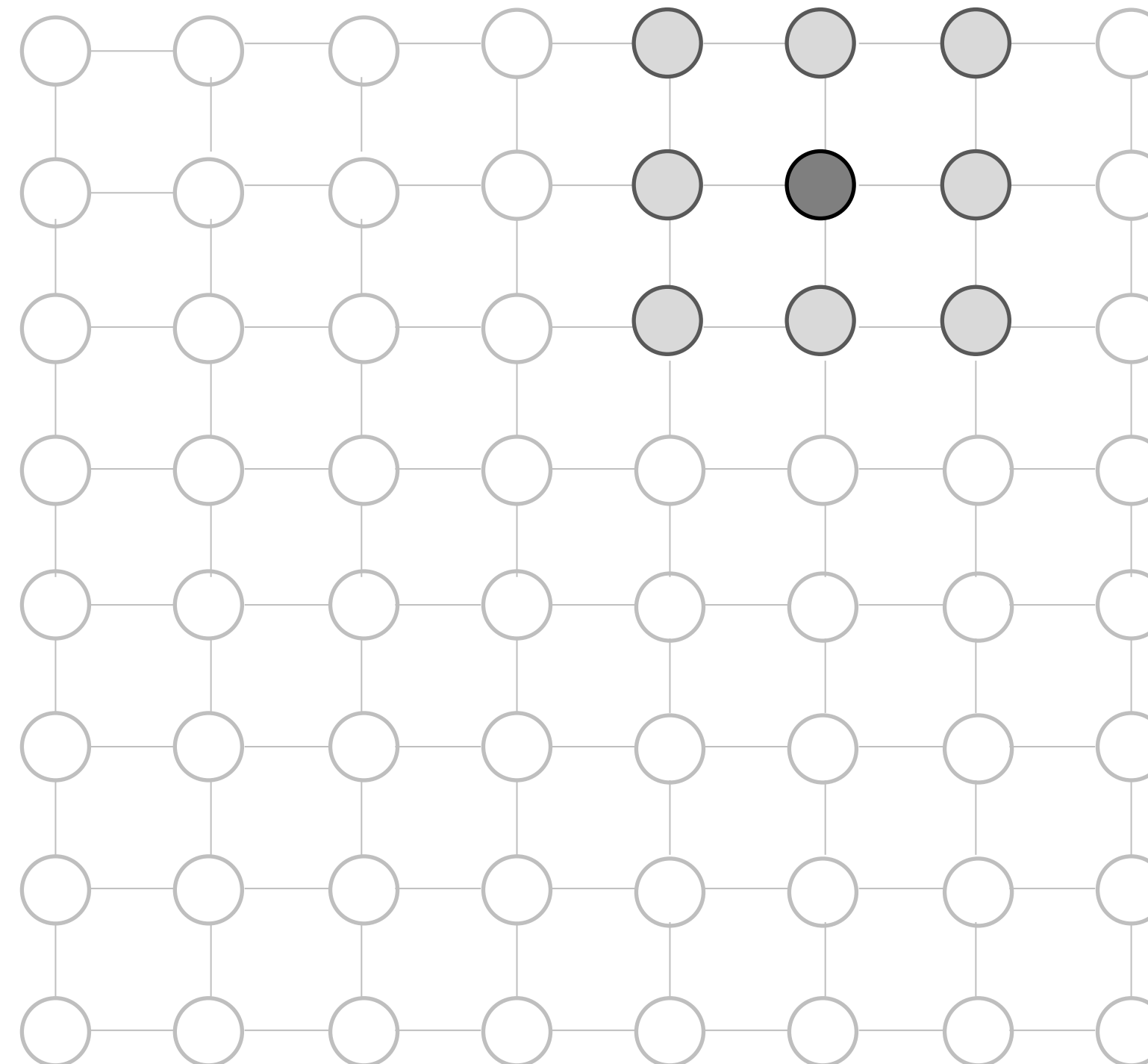
{0.906858,0.0194981,0.464387,0.836483}

{0.70246,0.532199,0.463251,0.0710004}

{0.84464,0.606172,0.864091,0.26712}

{0.427036,0.299789,0.128026,0.759577}

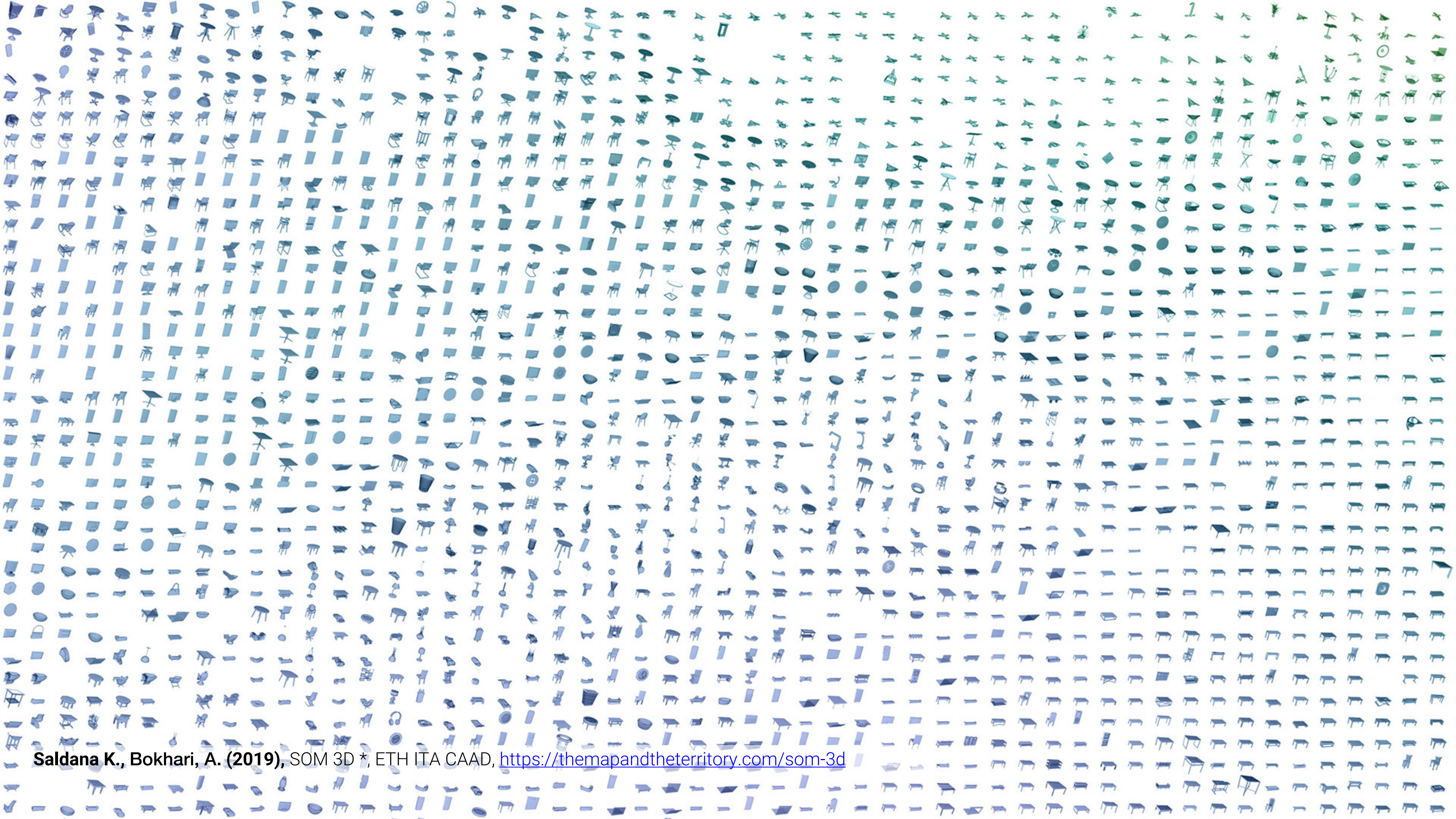
...



Repeating the process over the entire dataset called an Epoch
We do many Epochs with the radius of neighbor cells decreasing

EXAMPLES OF SOMS ON DIFFERENT TYPES OF DATA

We can render SOM cells by the items they contain

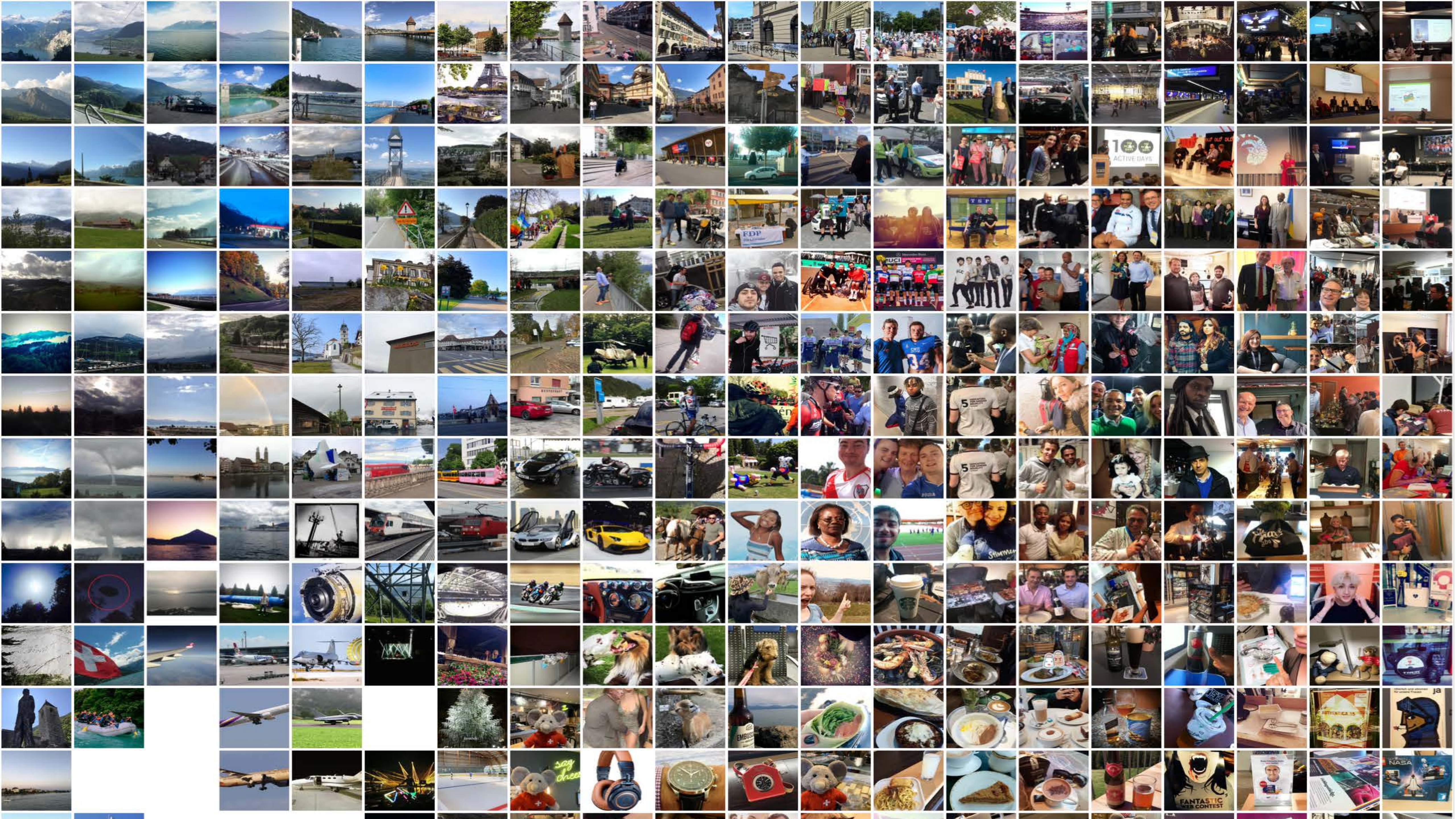




Alvarez D., Saldana K., (2017), City of indexes, Elective course 2017, ETH ITA CAAD Praxis 2018

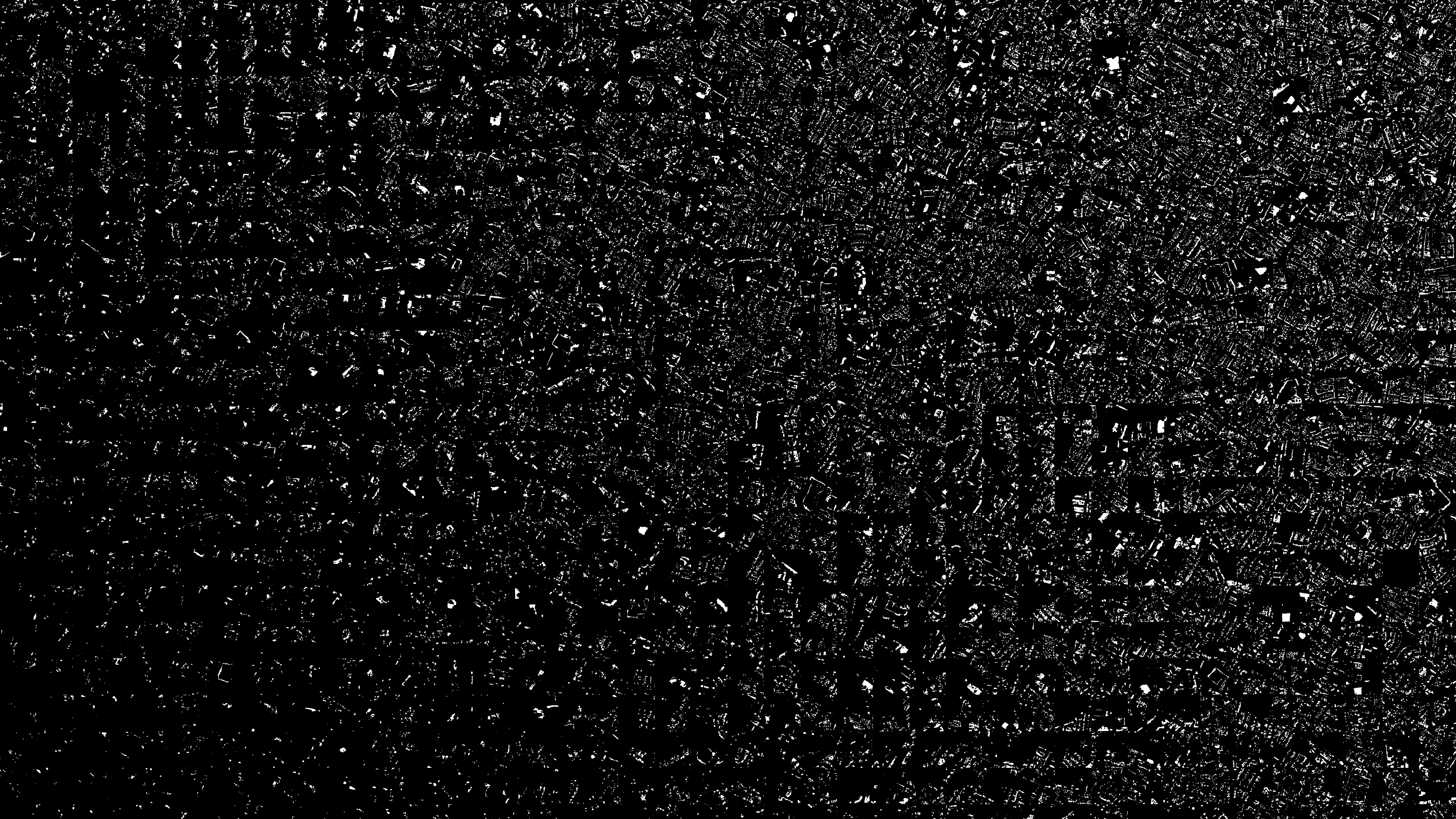


Alvarez D., Saldana K., (2017), City of indexes, Elective course 2017, ETH ITA CAAD Praxis 2018



program development	please email academic peace	bird ecology station subscribe	blog center college park	research student	campus university	student	development and journal the institute	annual debt publication outlook	health safety	human right city new	smuggling development and secretariat strategy	client	contact world research meet	program	video read population right	organization	development world member committee	project	
student model school	community foundation religious hub	president university	community	research	student school	participate space club selfivity	policy	court is national kb	director program safety emergency	US government victim protection	house people	right people advocacy street	work food people community	world water support donate	contact publication environmental life	education woman foundation people	social community work	marketing people board award	development system community water
student	and day homeless hurricane	project support health approach	learning world survey overview	school change program	university research	science	television issue employee health	program	organization state	army local band upper	country	costal	community	support help	program	health	method name leave field	people	
school	don not student found	oil division workplace mount	center	school	education student school social	gallery charity disabled annual	research round table study	report news	capacity building easter magazine		chairman award life provide	mapping cookie impact aim	policy dialogue network environment	development	donate event program social	solidarity worker sub country	organization child	community program school development	health development
school high school		community	community development and donate board	program introduce report middle	work contact case author	world	undergrad uels student opportunity know	news	worker right assistance human	information development system	world work organization	institute state peace conflict	national publication read resource	right healthcare child worker	poverty group	work community	provide community child program	community review	medical work
world peacekeeping center office	project	university student research	secretary general press staff	human	street job learn news	briefing reel crisis study	program	advocacy prevention board save	following red news values	home service family war	new	ethnic population post patient	service funding annual contact	work people partner	company project research team	program	development provide	organization level value	
organization community program	development	project community program	program research group work	division program congress injury	community	general	fundra child meal year		policy refugee centre training	contact habitat valley agency	people country food	people	solution development country work	world	organization refugee	organization life	leadership donation ocean climate	community	service
child program development	organization community	high school	member	young	work	state country development and agency	project area	country	development information member	humanitarian	world humanitarian medical	conflict	small	development organization	work world	country	health community charity school	humanitarian work	child
work team	community	time solution change team	member people organization	women youth making difference	organization	health care	partner organization refugee	information work	development	training	country people disaster	people	work	project education state community	board support humanitarian director	case south saint event	organization country aid program	personnel people relief transport	services
education school	organization	organization	oxford promote stolen group		work	network	services project	connect people head read	school center disaster	food people deliver organization	health work people later	holiday customer resident apply	support conflict sub region	work society		life community	support program	resource education foundation bill	world
project work national	people		policy	post	workshop report network				news page water	real			ent business		people	project program	contact campaign people local	policy	

Saldana K. (2020), Enhancing Disaster Response with Architectonic Capabilities by Leveraging Machine and Human Intelligence Interplay, ESREL, 2020





Saldaña K., Ohlbrock O., D'Acunto .P, Moosavi V., (2020), Beyond Typology Beyond Optimization, International Journal of Architectural Computing

SOM ON TWEETS

Demonstration with the previous collected tweets

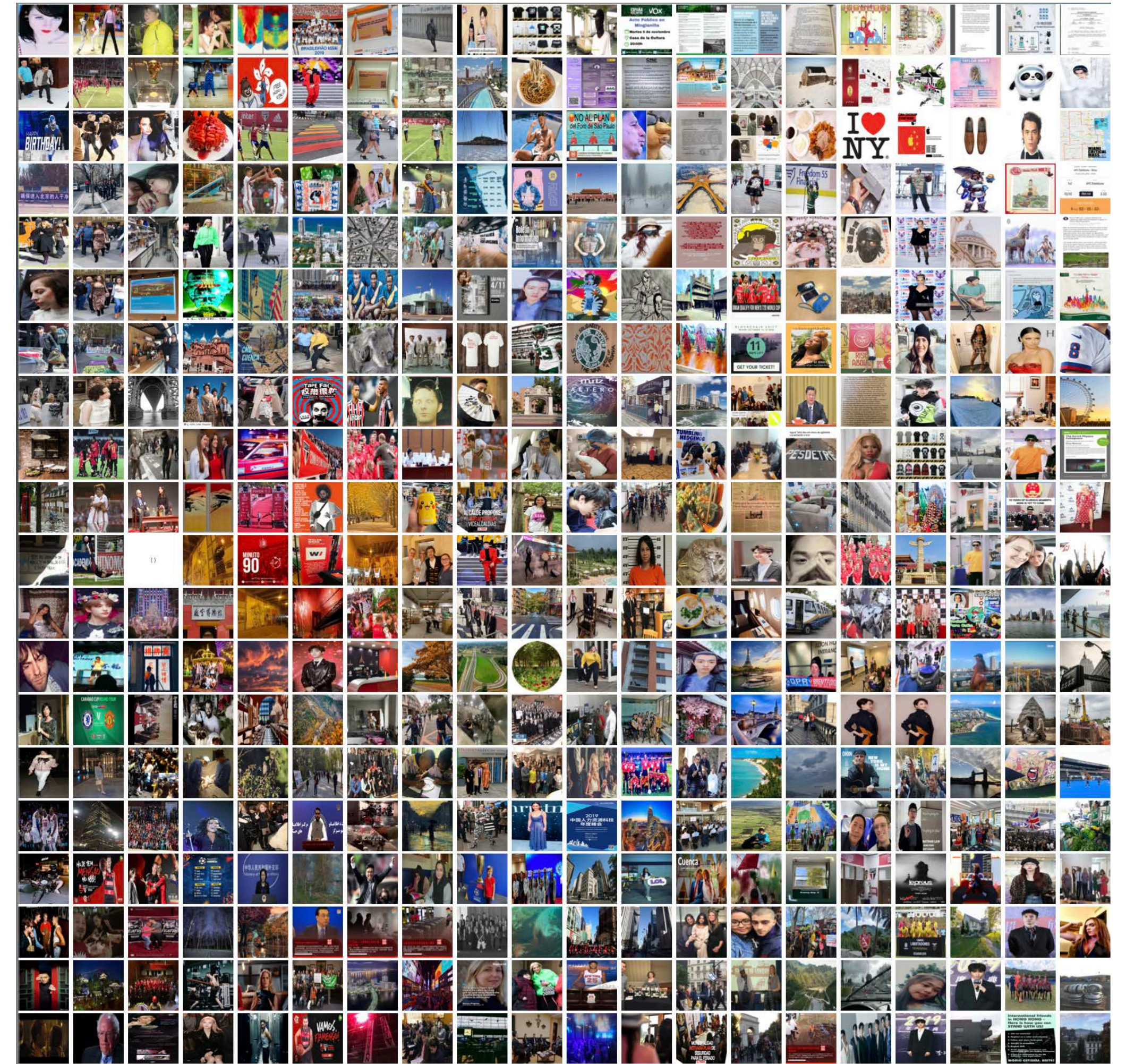
image

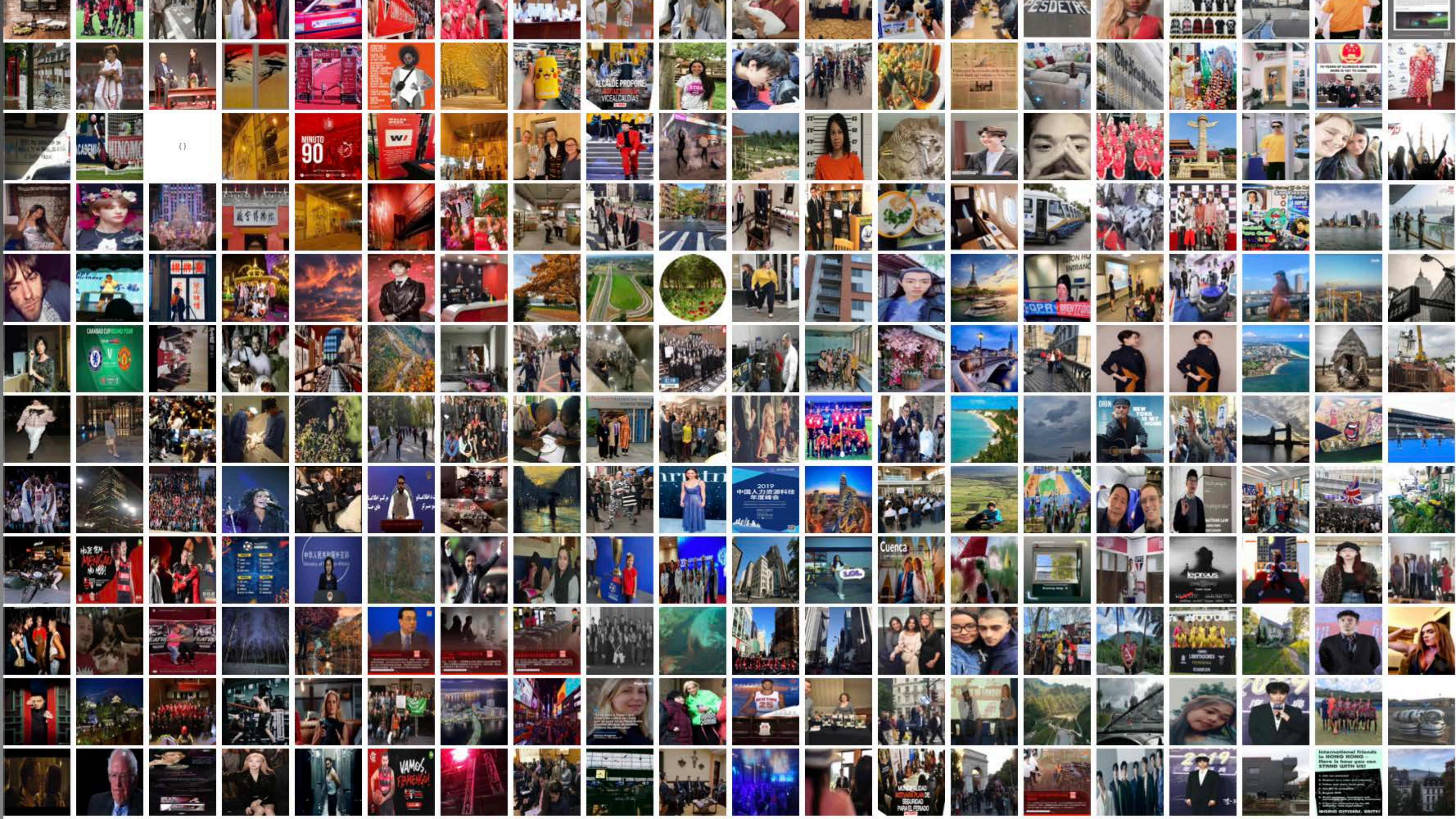


-> "colors"

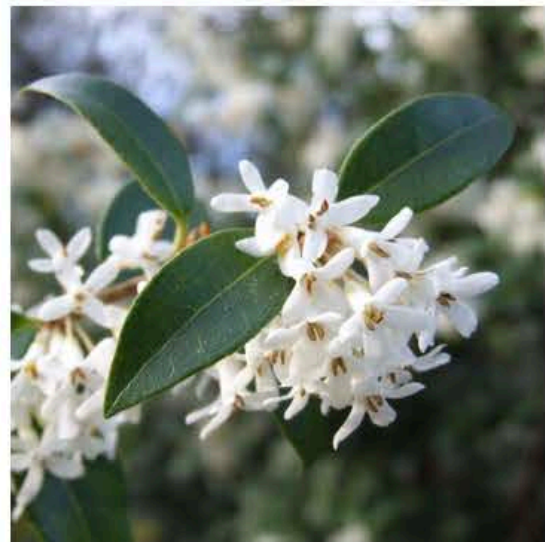


1600	0	1600	0	1600
0	1600	0	1600	0
1600	0	1516	84	1536
64	1600	0	1562	38
1477	123	1494	106	1558
42	1600	0	1600	0
1600	0	1600	0	1512

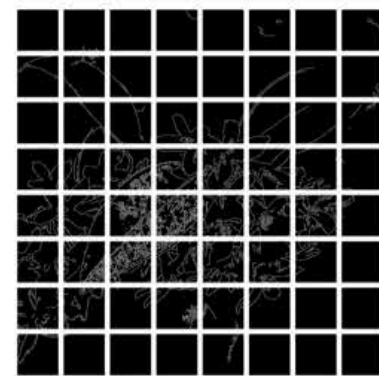




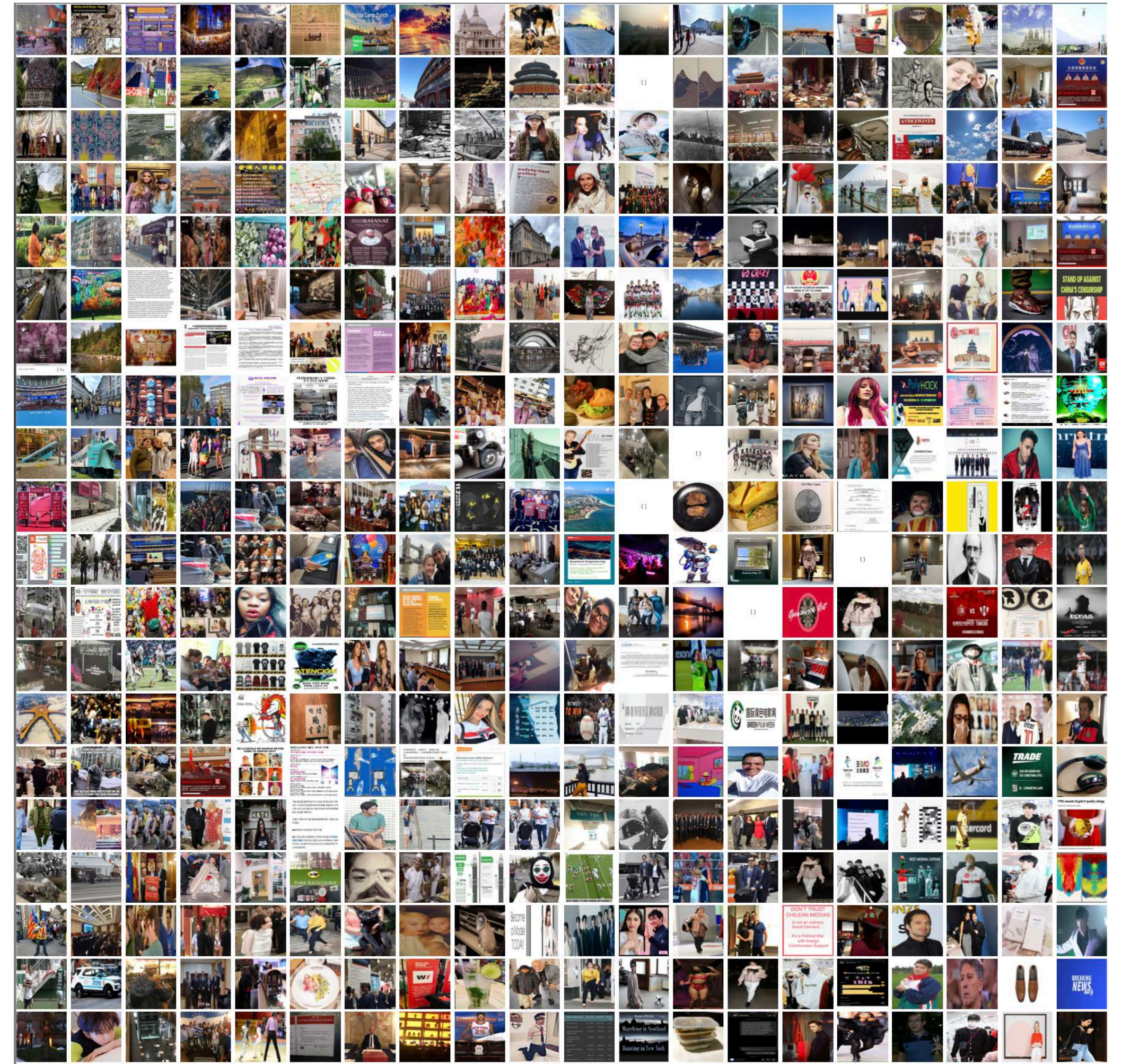
image

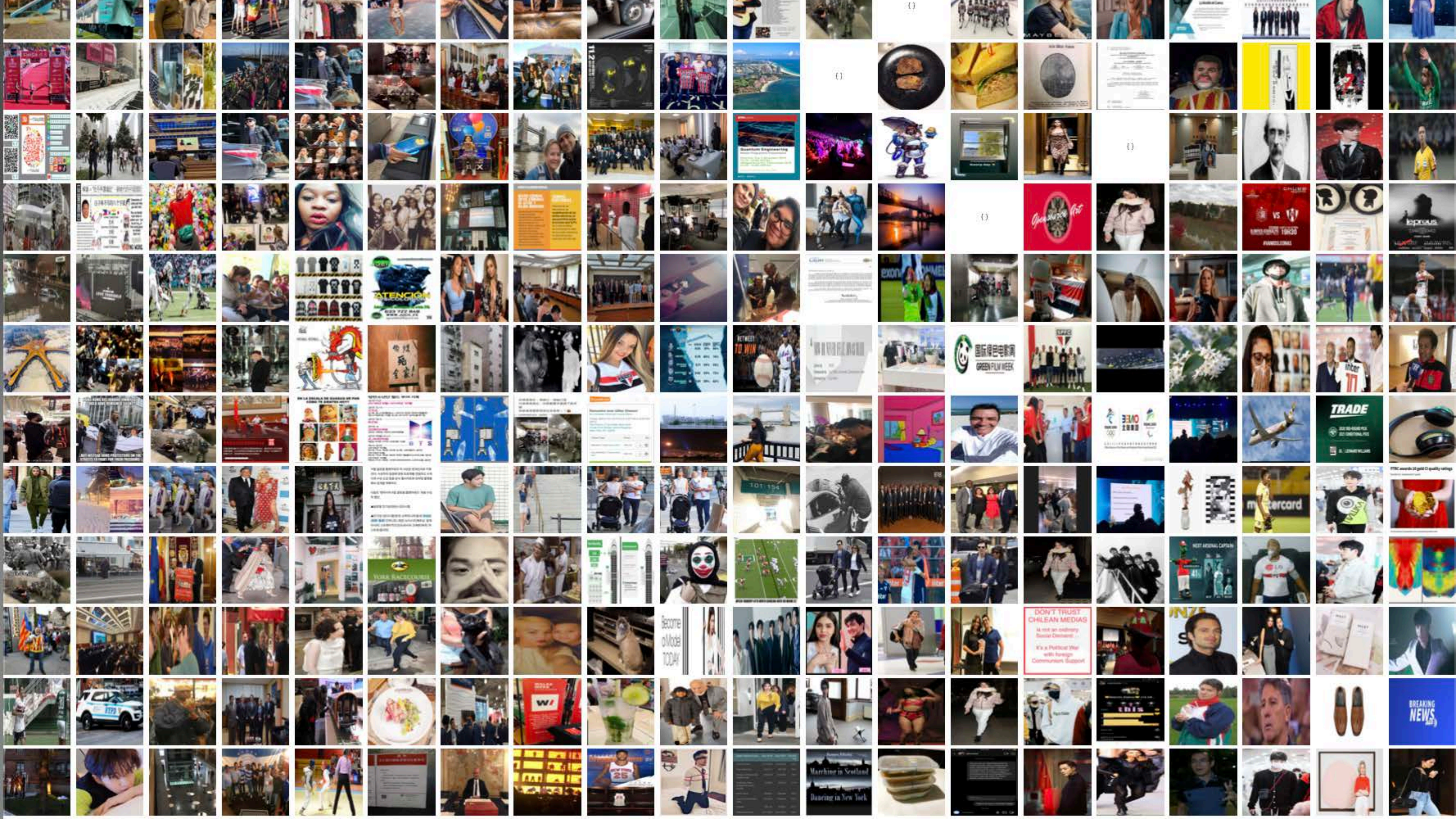


-> "edges"

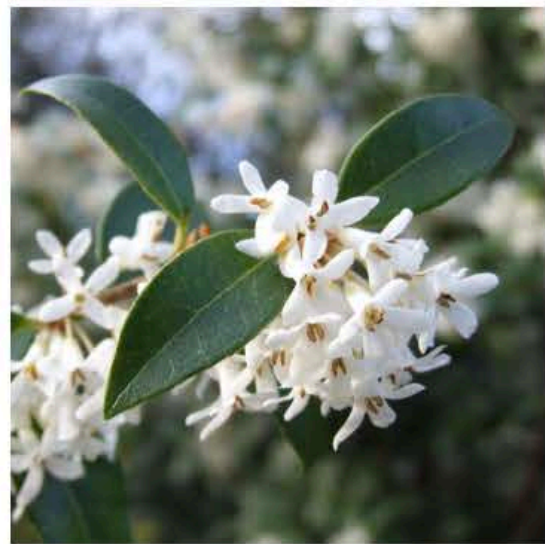


0.439216	0.470588	0.541176
0.694118	0.733333	0.862745
0.780392	0.811765	0.898039
0.733333	0.741176	0.74902
0.462745	0.490196	0.458824
0.505882	0.533333	0.458824
0.662745	0.694118	0.701961

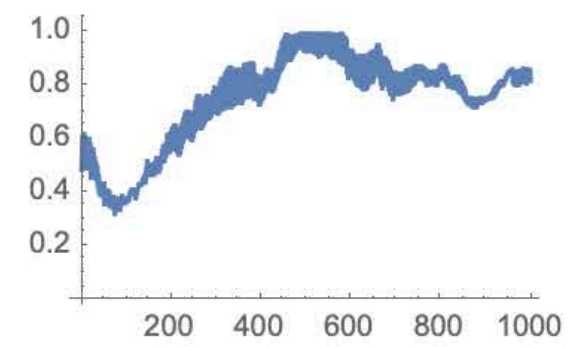




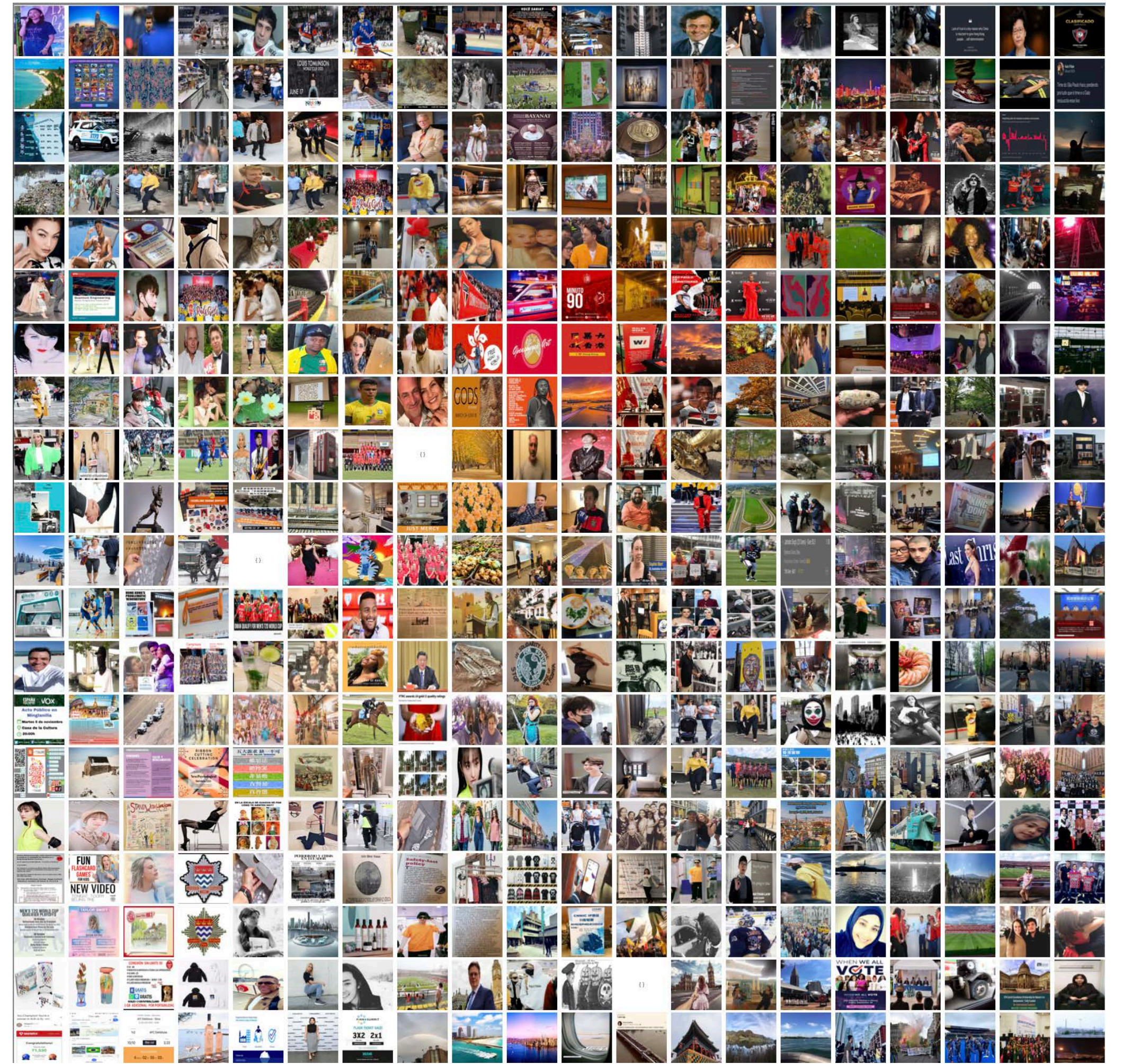
image

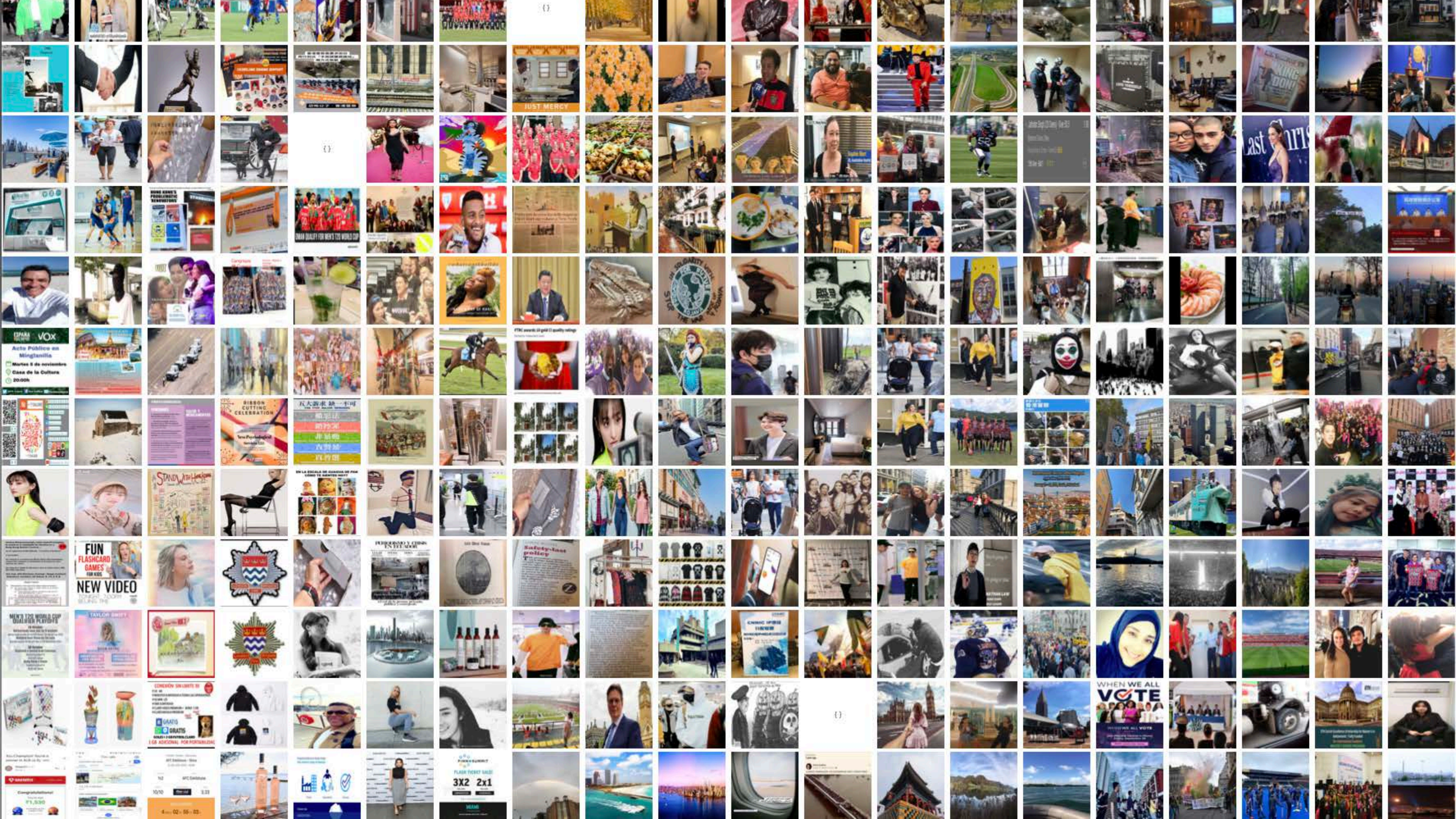


-> "fourier"



$311.196 + 0. i$	-2.8447
$-2.8447 - 8.53134 i$	-18.802
$0.0507741 - 1.67722 i$	-0.85581
$11.2859 + 32.356 i$	2.20177
$1.98793 + 0.293197 i$	-2.4941
$1.08693 - 0.0374585 i$	-0.72863
$-7.28062 + 7.17637 i$	0.61670





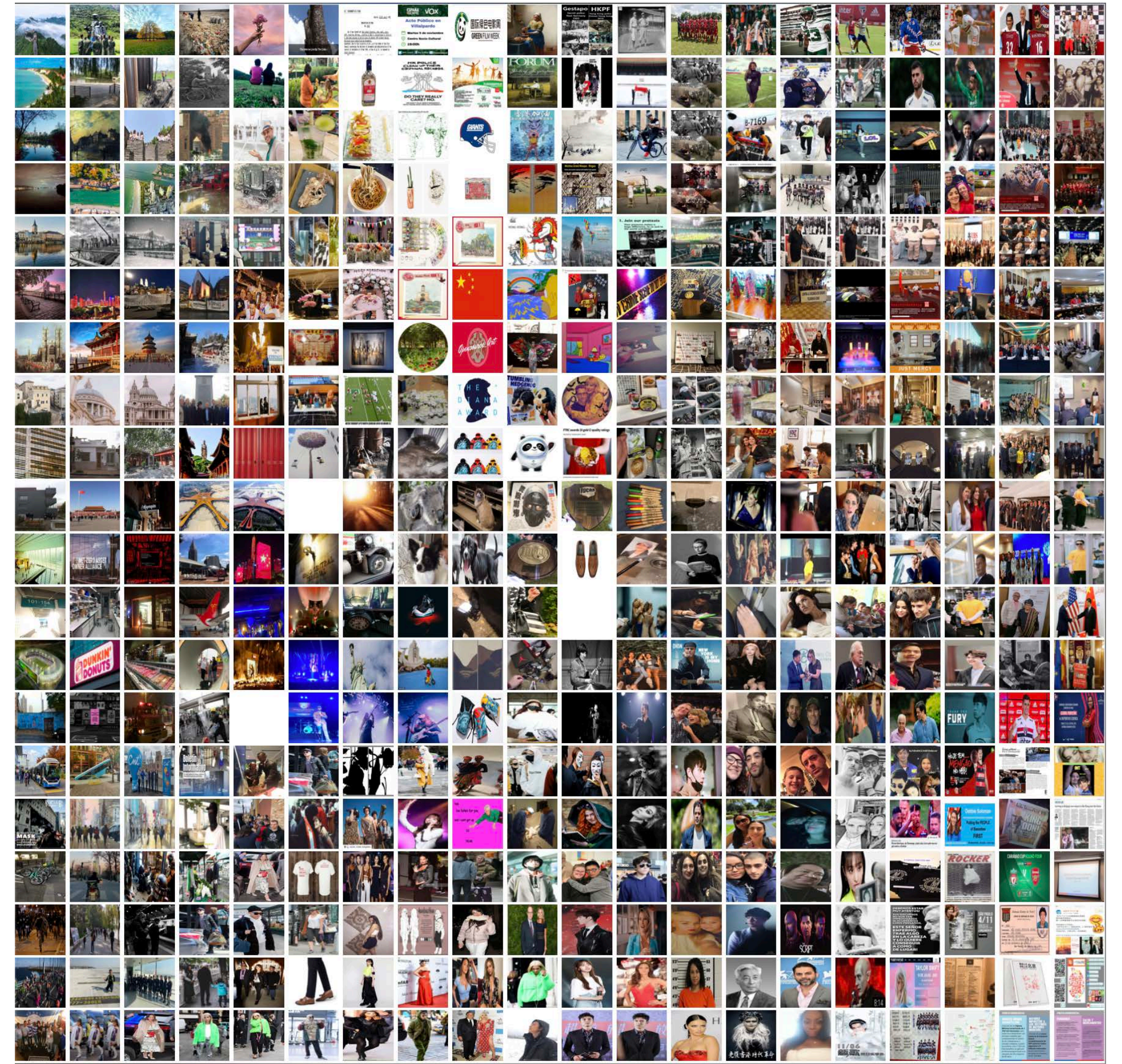
image

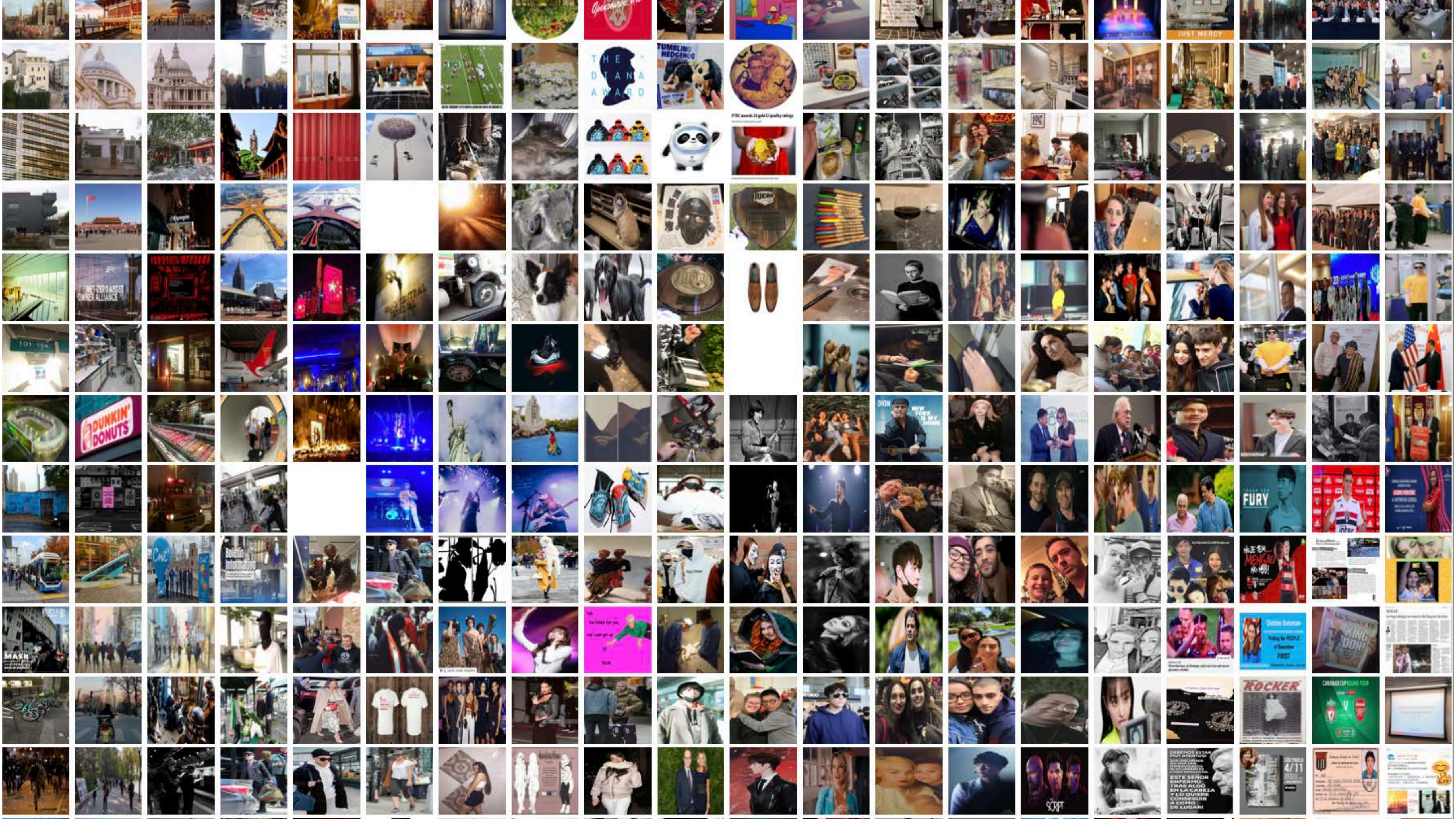


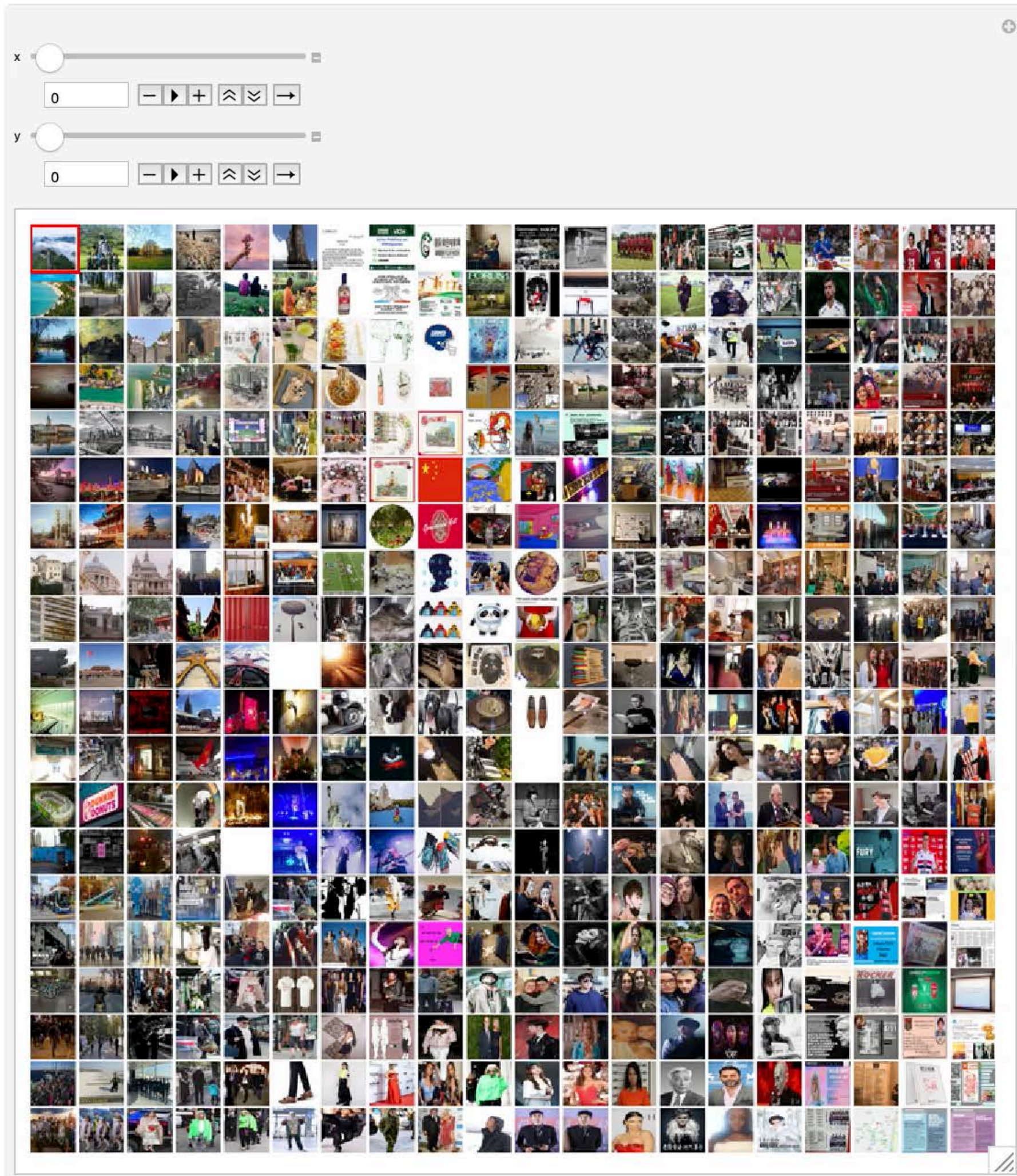
-> "feature extraction"

- common privet
- common jasmine
- laurel
- California laurel
- fruit tree
- pride-of-rochester

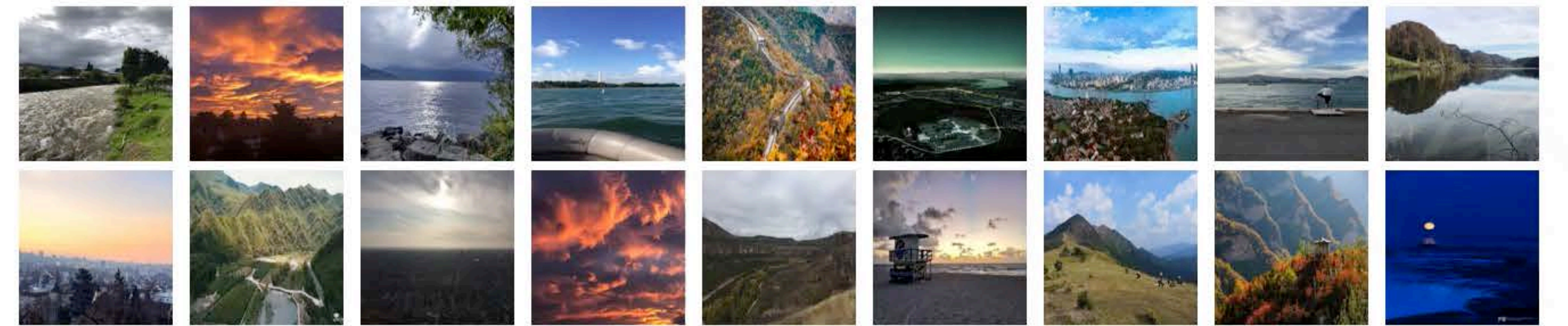
8.22561	-8.62608	28.0713
-3.54004	12.2321	3.18221
-6.41089	1.24627	-2.62163







* cell N = 1 * events= 34



WORKING WITH SOM IN MATHEMATICA

Fitting your questions into the techniques

Functions [»](#)

Creating SOM

some sample data (490MB, 3K images, crawled by keywords, non-geo-taged)

Output: <https://drive.google.com/open?id=1t0F1t4Qygi-HtbRZoVyrD3Fmrnc8psna>

swiss main cities sample data (1GB, 26 cities, 8k images, geo-taged)

Output: <https://drive.google.com/open?id=1F9i0mSq-BOMFodDKVT5Rvcn8vYAzaUIA>

Versions [»](#)

Build Self Organizing Maps

Specifying Working Folder [»](#)

Import Data + Train a SOM [»](#)

OR Import a Saved SOM [»](#)

Visualize SOM [»](#)

Save SOM as File [»](#)

Working With SOM

Overlay two Datasets (for comparison) [»](#)

Highlight SOM by Location/Time/Keywords [»](#)

Select Cells on the SOM [»](#)

Query to SOM [»](#)