



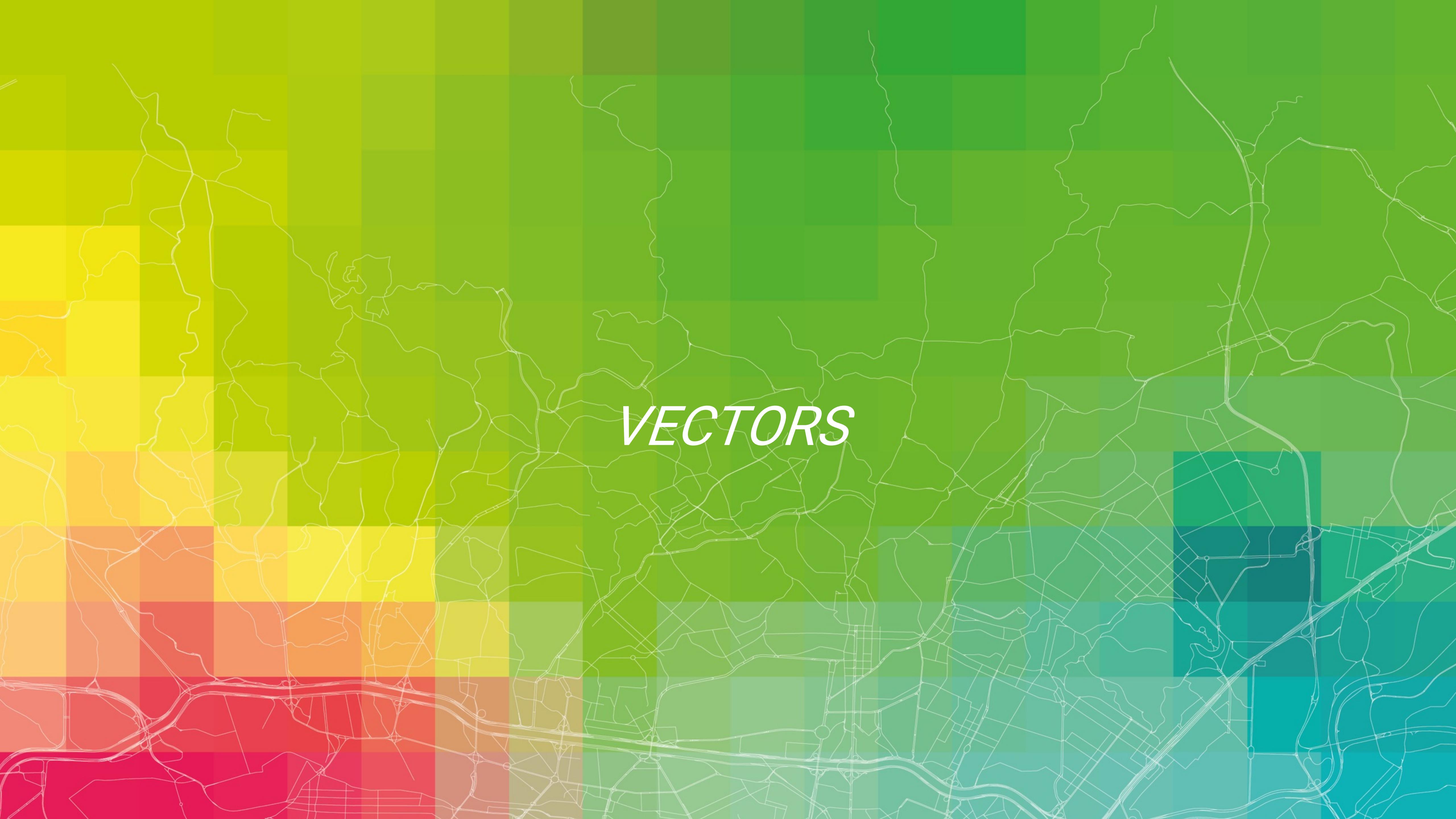
AI IN THE BUILT ENVIRONMENT

Professors:
Dr. Karla Saldana Ochoa

TA:
Mobina Noorani

University of Florida
College of Design Construction and Planning

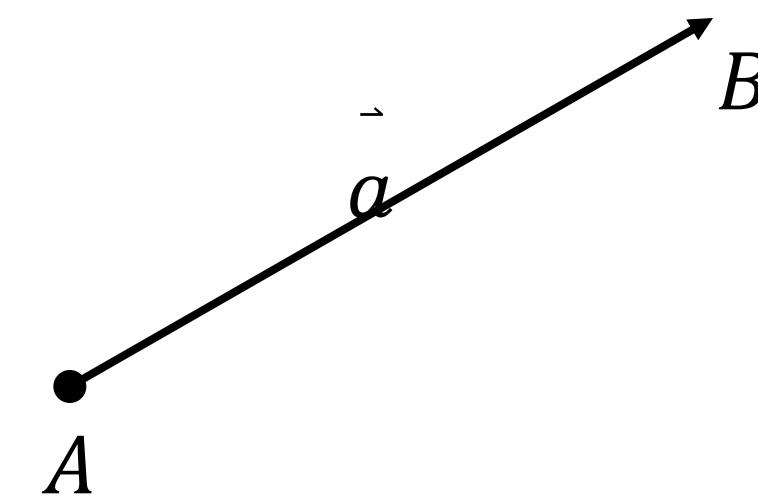




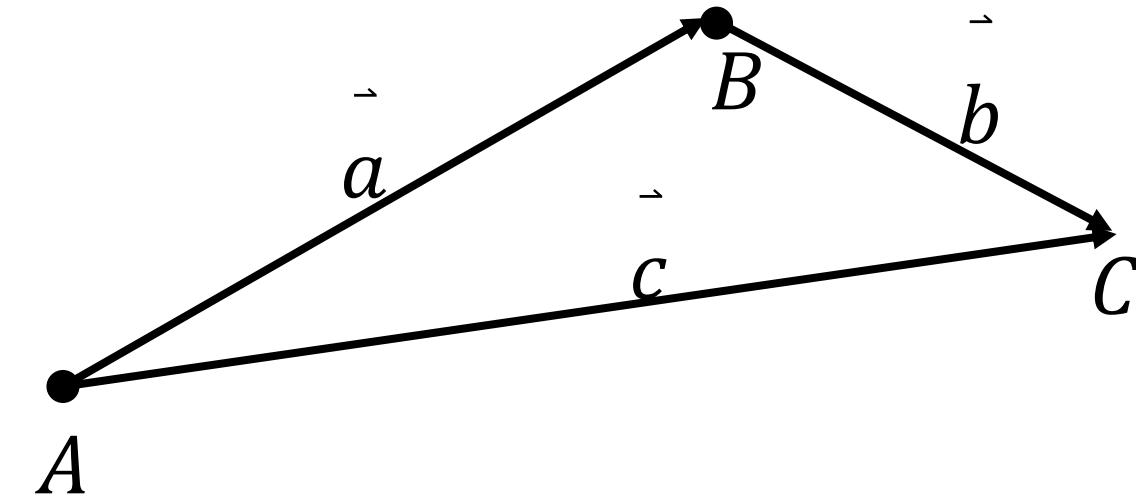
VECTORS

WHAT ARE VECTORS

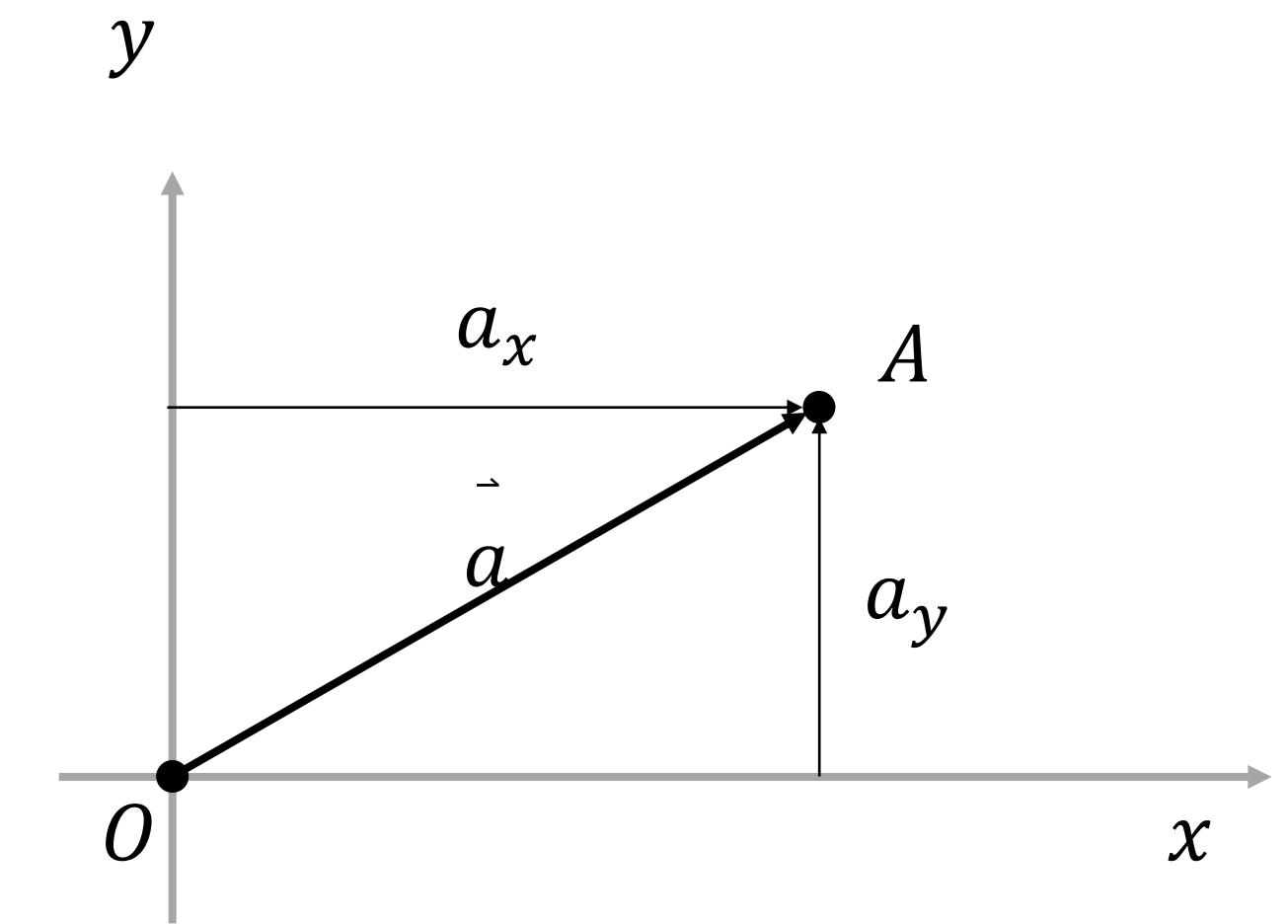
Vectors in Geometry



A vector pointing from point A to B



Addition and subtraction



Represent the coordinate of a point
in Cartesian coordinate system

Vectors in Algebra

$$\vec{a} = (2,3)$$

An example in 2 dimensions

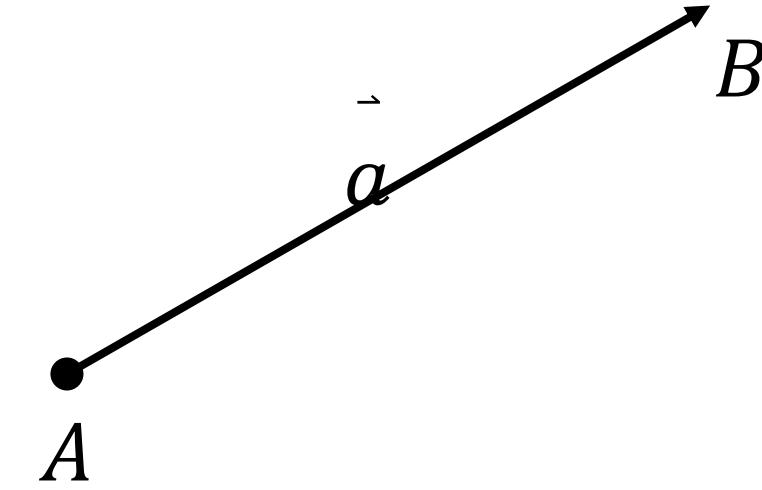
$$\vec{a} = (a_1, a_2, \dots, a_n)$$

Generalize to n-dimensional Euclidean space

Euclidean Distance

Measuring the similarities

$$\|\vec{a}\| = \sqrt{a_1^2 + a_2^2 + \cdots + a_n^2}$$



Magnitude (or length, norm) of a vector

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

FEATURE VECTORS

In the context of machine learning feature vectors are vectors that describe measurable properties of the object

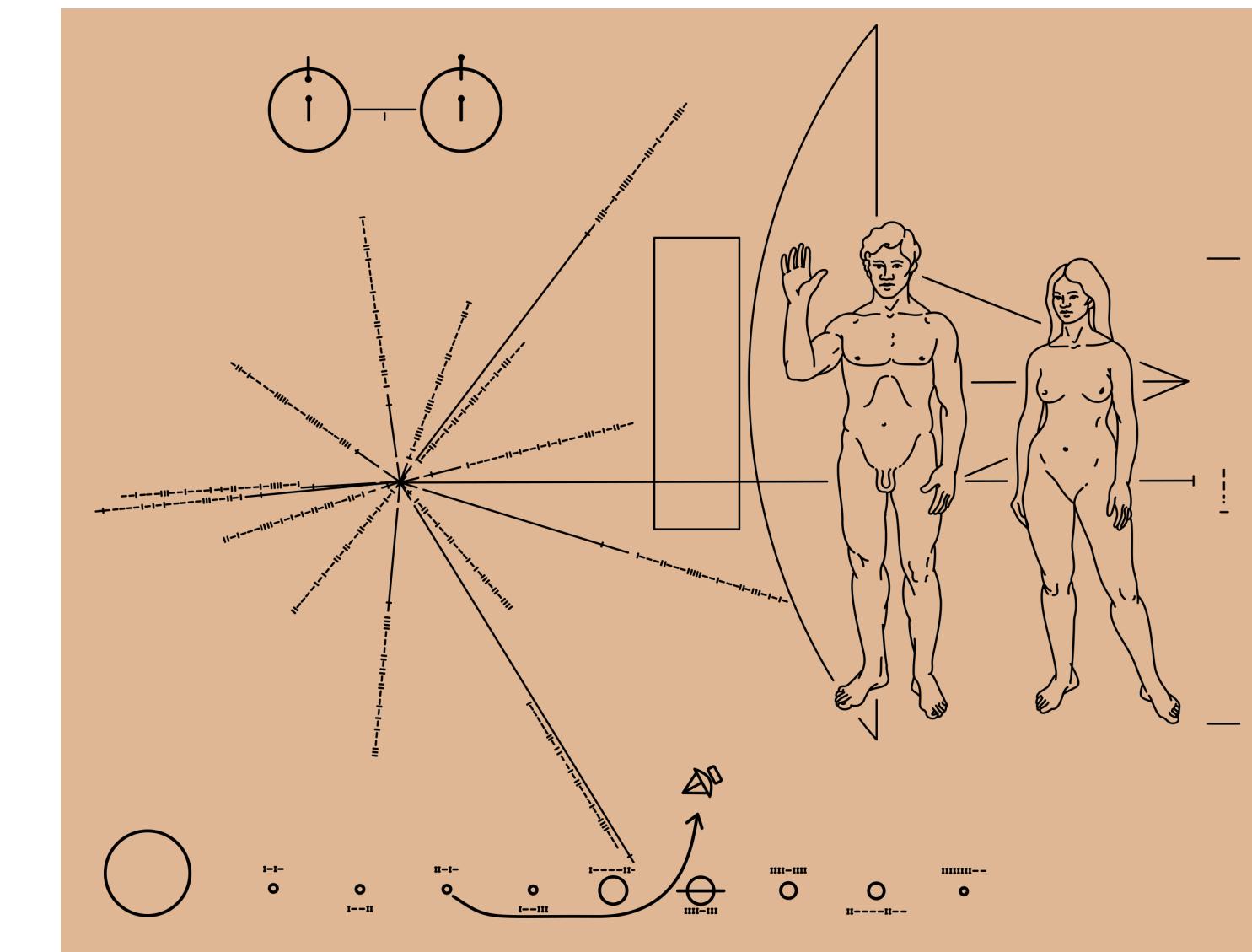
Feature Vector Examples



An apple

(color, size, weight, sweetness)

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



@Pioneer plaque

A person

(age, weight, height)

(25, 70 kg, 182 cm)

Feature Vector + Euclidean Distance



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)

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

Feature Vector + Different Perspective



(color, size, weight, sweetness)

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



(price, do I like it?)

(0.75 Fr, 1 yes)

FEATURE VECTORS FOR DIGITAL OBJECTS

WHY

**Images and texts are already numbers
why do we convert them to some other numbers?**

An Example

Comparing different images



?



?



An Example

```
CompareTwoImage = EuclideanDistance[  
  Flatten@ImageData@ImageResize[#, {32, 32}],  
  Flatten@ImageData@ImageResize[#, {32, 32}]] &  
  
Out[•]= EuclideanDistance[Flatten[ImageData[ImageResize[#, {32, 32}]]],  
  Flatten[ImageData[ImageResize[#, {32, 32}]]]] &
```

In[•]:= CompareTwoImage[, ]

Out[•]= 21.5377

In[•]:= CompareTwoImage[, ]

Out[•]= 16.5109

In[•]:= CompareTwoImage[, ]

Out[•]= 19.0808

Comparing images pixel-by-pixel is not a good idea as it does not reflect the contents

Similarly, we should not do word-by-word comparison for texts

FEATURE EXTRACTION

Computational methods for obtaining feature vectors

Feature Extraction

Feature Engineering



Edge Detection

RGB

Blur transformer

...

Machine Learning

Object Detection

Image Captioning

...

Word Count / Word Frequency

...

Word Embedding

Sentiment Analysis

...

To be, or not to be,--that is the
question:-- Whether 'tis nobler in the
mind to suffer The slings and arrows of
outrageous fortune Or to take arms against
a sea of troubles, And by opposing end them?

Word Frequency

https://en.wikipedia.org/wiki/Bag-of-words_model

Punta Colorada III Shelter / TATÚ Arquitectura
about 9 hours ago



+ 26

the land is in an area of maritime forest near the first stretch of the oceanic beach in uruguay. here it has a diverse number of native species living in an obscure ecosystem. amongst these species are the eucaliptus, coronilla, or aruera among other valuable species that we must preserve to build a narrative about the future architecture project and its immediate landscape. at the same time, the topography of the land presents a pronounced hollow on its back and lateral side, because of two ravines that carry natural water from the mountains to the sea. it was decided that the project would try to keep this ecosystem as intact as possible to reduce the green footprint. it is decided to opt for a stilt-type foundation system made up of concrete piles that will be supported on the ground, leaving the entire construction suspended on the irregular surface of the ground. the shelter is assembled in a longitudinal position that divides the land into two different sides. the first one is pointed to the north, and it is organized in a logical way, as there is an interior-exterior access link. the second one is south facing where there is a new contemplation logic to look at the landscape from a series of specific cut-outs in the shell and cover. the distribution is articulated by the bathroom units that divide the rest areas of the social spaces. the project has been modulated with structural porches that are exposed inside and out of the building, giving rhythm and texture to it. finally, it was decided to increase the internal volume in the social area to acquire greater contact with the exterior and to generate a second bedroom-mezzanine from which to observe the deep horizon of the sea.

<https://www.archdaily.com/981901/punta-colorada-iii-shelter-tatu-arquitectura>

Tribeca Restaurant – Alicante / Noname 29
about 5 hours ago



+ 15

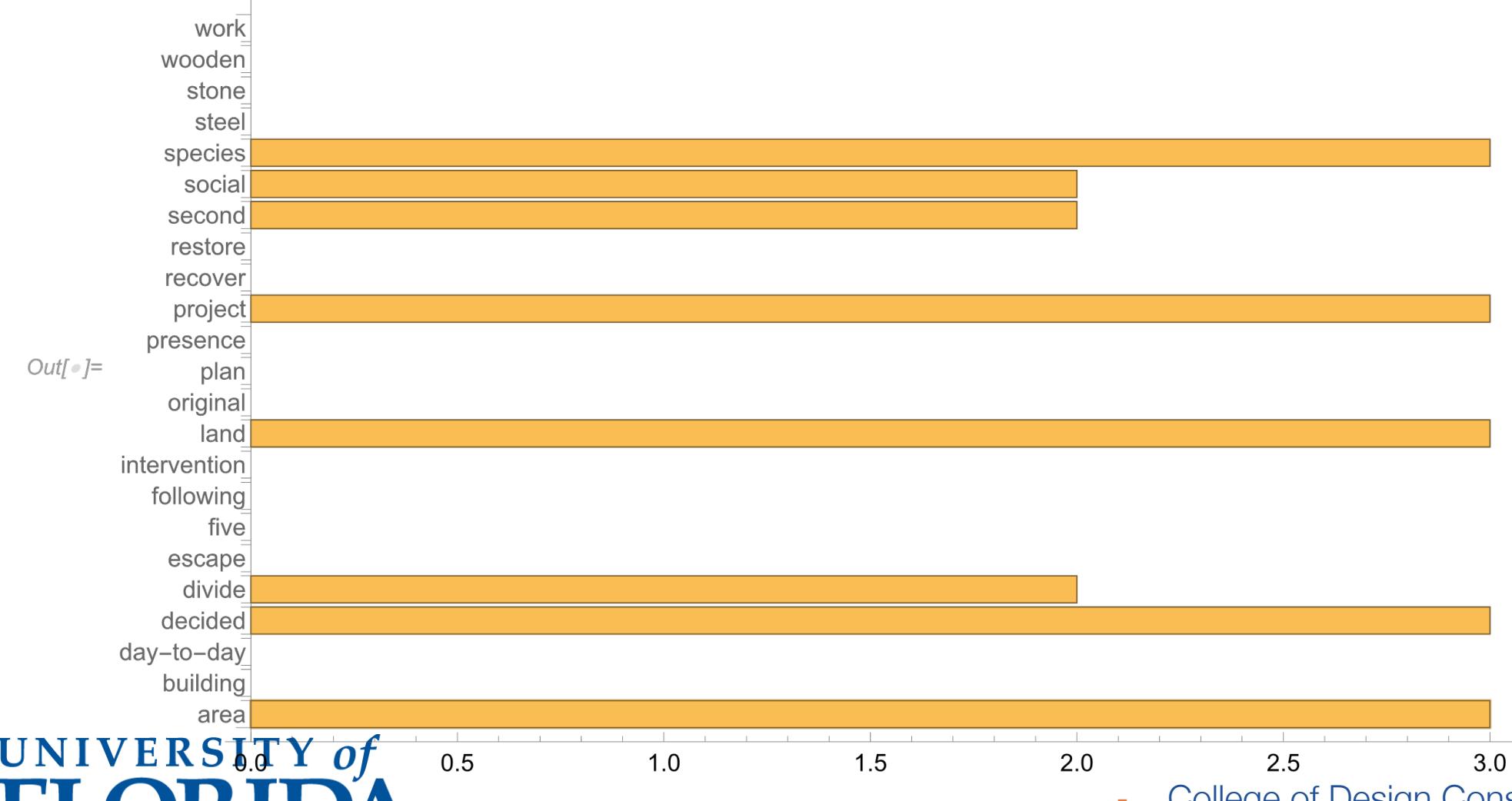
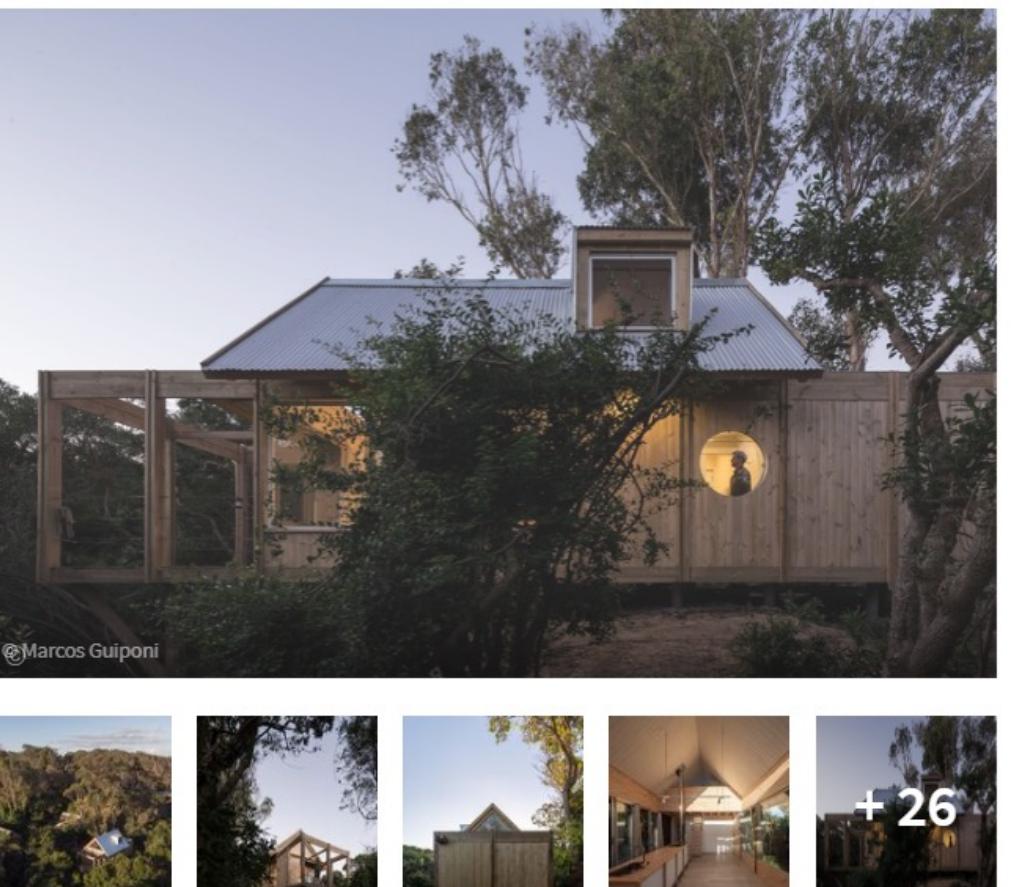
five hundred kilos of calatorao stones, stainless steel 3mx1 .5m plates, solid spanish walnut wood 50 mm thick. thickness is the word that would define the proposal and the "raw" presence of the material, responsible for building its friendly atmosphere. five large blocks of stone, which seem to float, build a fluctuating magma. space, alongside polished steel, escapes between these stones towards infinity, as if, once inside the premises, you could lose yourself beyond its limits, and escape into nothingness. although, you don't even try... these powerful blocks, in addition to articulating the space, take you to the heart, hide the structural elements and contain all the necessary machinery for the restaurant to work. the cavern, which for years was this restaurant, is transformed into a "magic box" which, however, maintains the soul of the place. the intervention on the façade, in a building from the end of the 19th century of which no plans are preserved, is the result of an almost archaeological investigation to discover its origin. the facade of the premises has undergone different interventions throughout history, and the action seeks to re-establish the closest thing to what the original building could have been. the façade has been cleaned of foreign elements, hollows have been restored following the traces of the old wooden landings, the lost massifs have been rebuilt, following the laws of the building, and a lime mortar has been laid that worthily recovers the base of the building. in this way, the façade recovers the original plan and is closer to the massive appearance of the time of its construction, restoring the power of the original image, as well as the slenderness of the openings, so characteristic of the ground floors of historical architecture from alicante. in this proposal, the work is claimed as a factory, improvising and solving in situ with the trades on a continuous day-to-day basis, drawing details, adjusting layouts, and comparing samples. exciting day-to-day with a project that does not have an image final, why a final image? the process is committed, and the construction is humanized so that each stone has its name. the materials have their own life, and identity: each stone, each steel plate, each wooden board... each one of them is precisely measured on-site, and templates are drawn, cut and later find their place on the site. every detail is taken care of in a work without details apparent. a technic ceiling without diffusers, without speakers, without detectors, and a "night owl" lighting made of blown glass, with a presence but then disappears. once seated at the table, all this disappears so that we can focus on the wonderful hambugers.

<https://www.archdaily.com/981838/tribeca-restaurant-nil-alicante-noname-29>

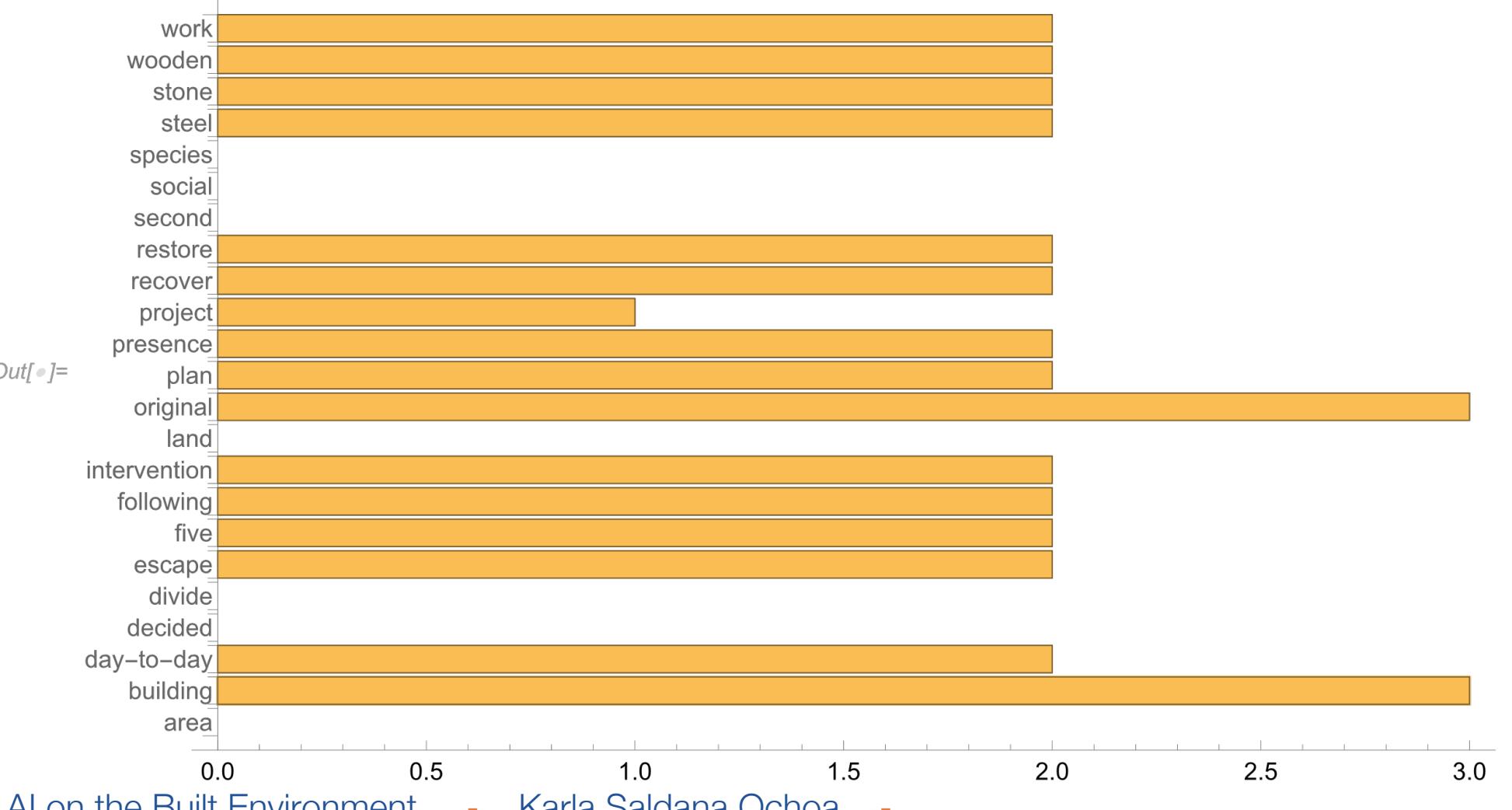
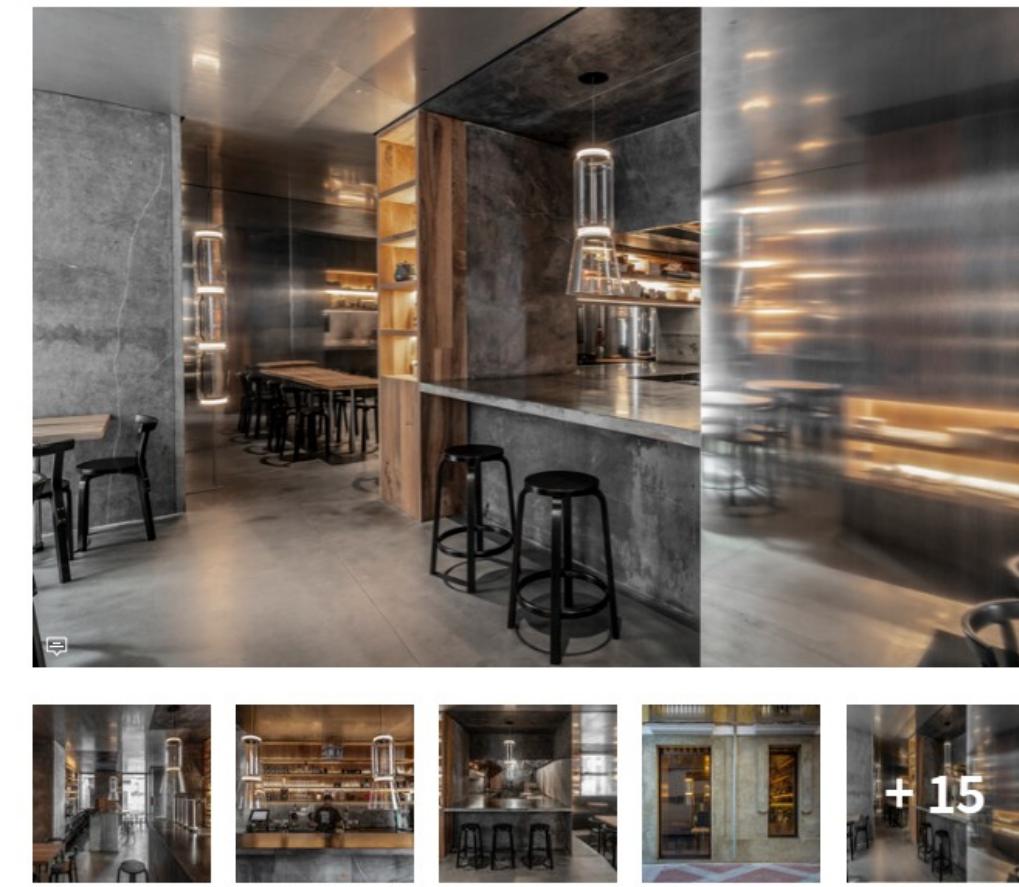
Word Histogram

https://en.wikipedia.org/wiki/Bag-of-words_model

Punta Colorado III Shelter / TATÚ Arquitectura
about 9 hours ago



Tribeca Restaurant – Alicante / Noname 29
about 5 hours ago



Machine Learning (Object Detection)

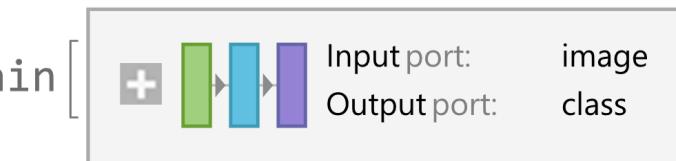
```
In[•]:= model = NetModel["VGG-16 Trained on ImageNet Competition Data"]
```

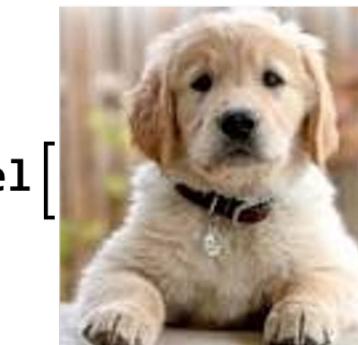
```
Out[•]= NetChain[]
```

```
In[•]:= model[, {"TopProbabilities", 10}]
```

```
Out[•]= {vat → 0.00299698, bathtub → 0.00330974,  
bucket → 0.00428974, washbasin → 0.00527512,  
hamper → 0.00952213, lynx → 0.0144289, Persian cat → 0.0323229,  
tiger cat → 0.0766838, Egyptian cat → 0.213713, tabby cat → 0.562044}
```

```
In[•]:= model = NetModel["VGG-16 Trained on ImageNet Competition Data"]
```

```
Out[•]= NetChain[]
```

```
In[•]:= model[, {"TopProbabilities", 10}]
```

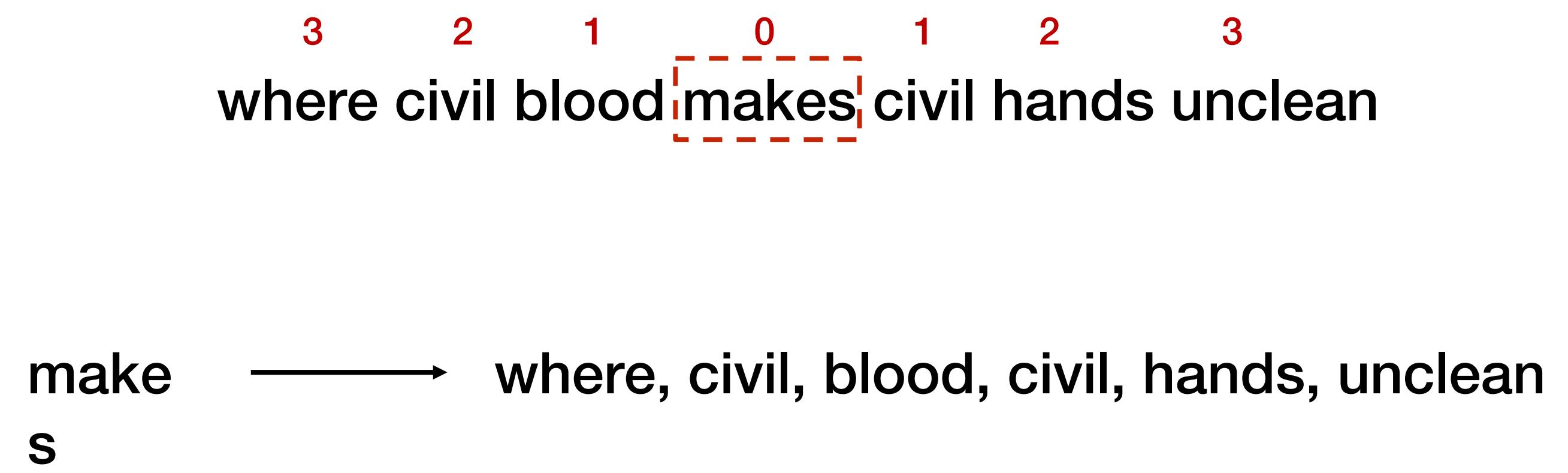
```
Out[•]= {Tibetan terrier → 0.00020129, English cocker spaniel → 0.000205052,  
Great Pyrenees → 0.000418824, Tibetan mastiff → 0.00057785, otter hound → 0.000684315,  
kuvasz → 0.0024348, Sussex spaniel → 0.002732, clumber spaniel → 0.00319501,  
Labrador retriever → 0.0165675, golden retriever → 0.971482}
```

Machine Learning (Word2Vec)

https://en.wikipedia.org/wiki/Bag-of-words_model

PROLOGUE

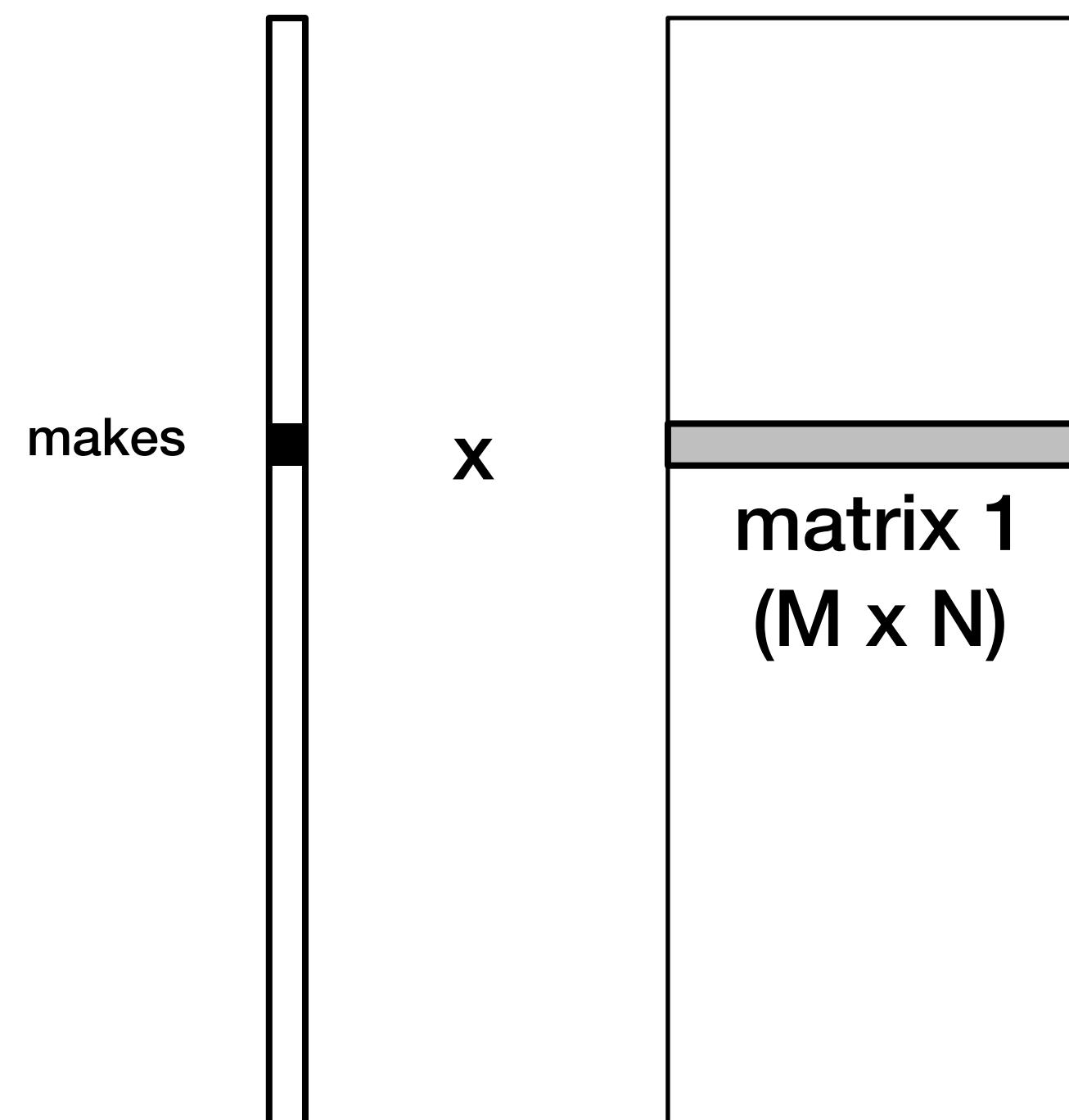
*Two households, both alike in dignity,
In fair Verona, where we lay our scene,
From ancient grudge break to new mutiny,
Where civil blood makes civil hands unclean.
From forth the fatal loins of these two foes
A pair of star-cross'd lovers take their life;
Whose misadventured piteous overthrows
Do with their death bury their parents' strife.
The fearful passage of their death-mark'd love,
And the continuance of their parents' rage,
Which, but their children's end, nought could remove,
Is now the two hours' traffic of our stage;
The which if you with patient ears attend,
What here shall miss, our toil shall strive to mend.*



Machine Learning (Word2Vec)

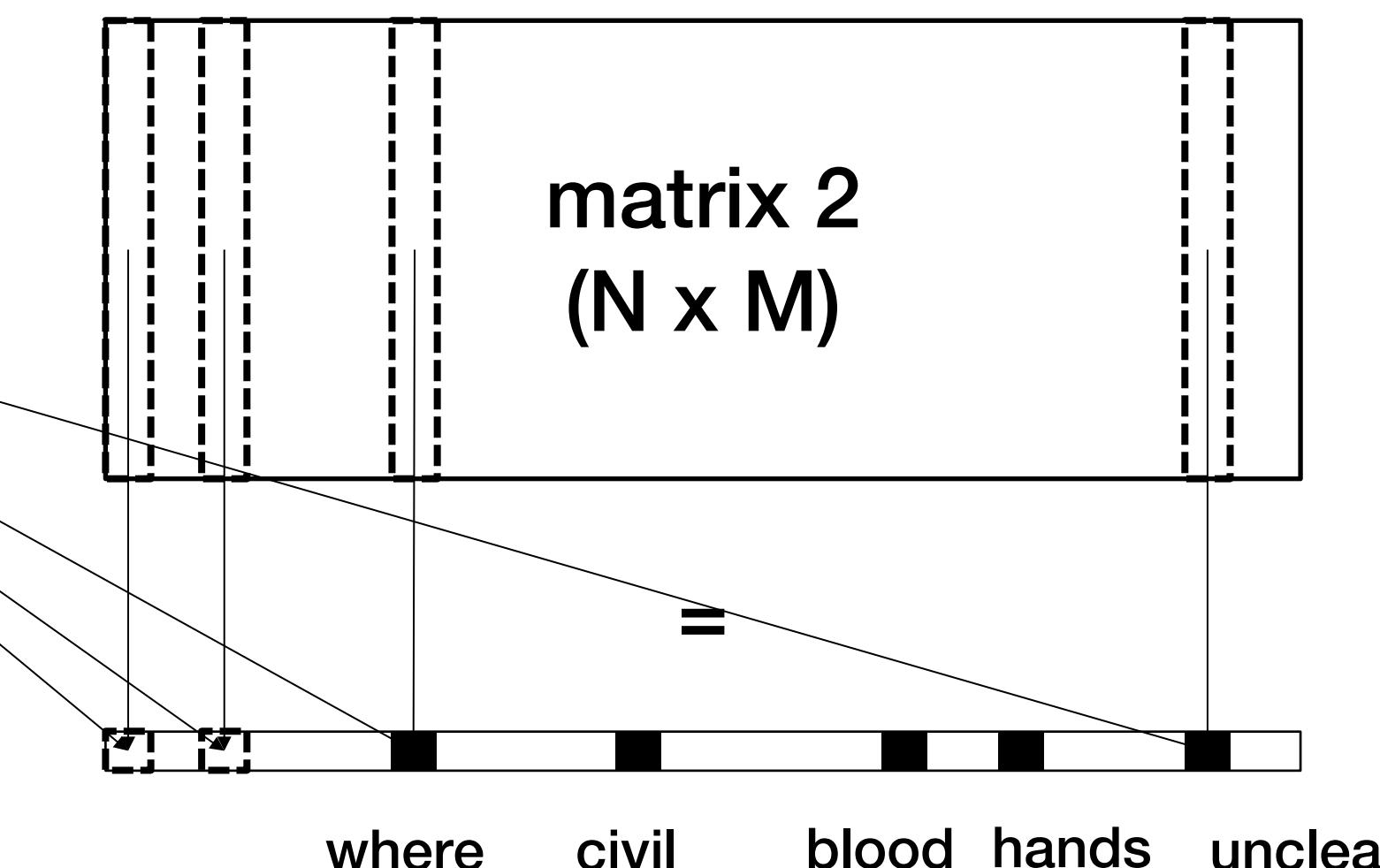
<https://www.youtube.com/watch?v=ERibwqs9p38>

M-dimensional
“one-hot” vector



N-dimensional
embedding vector

=



The “embedding layer”

M-dimensional vector

Machine Learning (Word2Vec)

<https://www.youtube.com/watch?v=ERibwqs9p38>

The similarity of words are determined by their meanings (i.e., their neighboring words)

```
In[•]:= model = NetModel["GloVe 100-Dimensional Word Vectors Trained on Tweets"]
```

```
Out[•]= EmbeddingLayer
```



```
In[•]:= EuclideanDistance[model["son"], model["daughter"]]
```

```
Out[•]= 0.14814
```

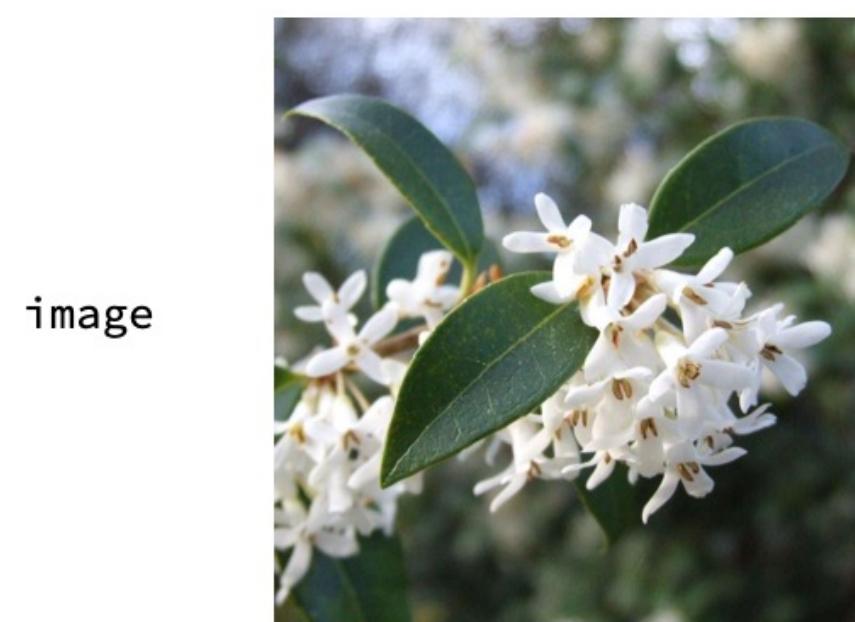
```
In[•]:= EuclideanDistance[model["car"], model["cat"]]
```

```
Out[•]= 0.72364
```

FEATURE EXTRACTION

Demonstration with the previous collected data

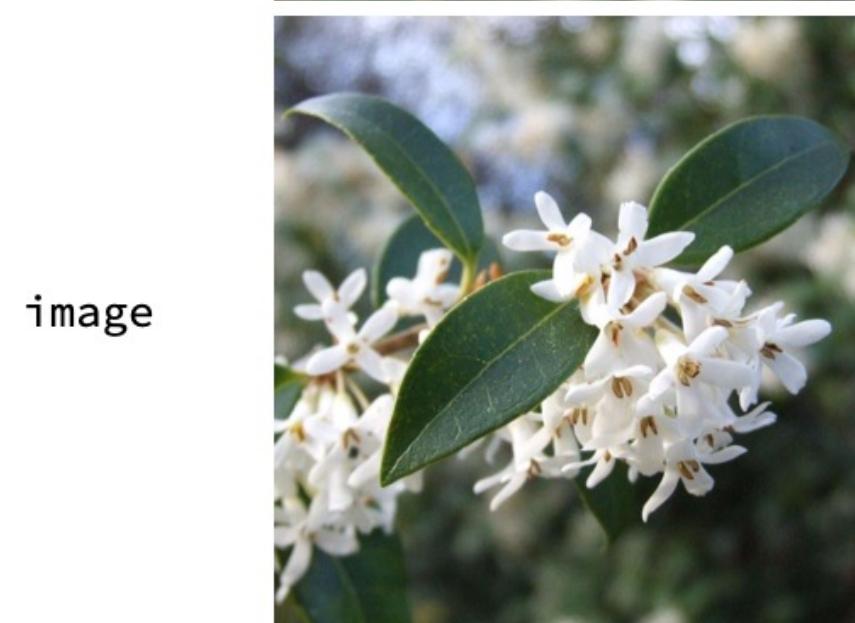
CODE on IMAGES



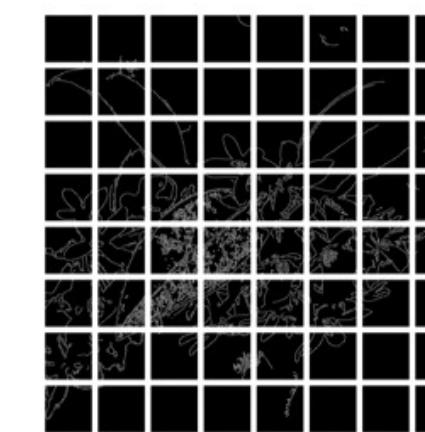
-> "colors"



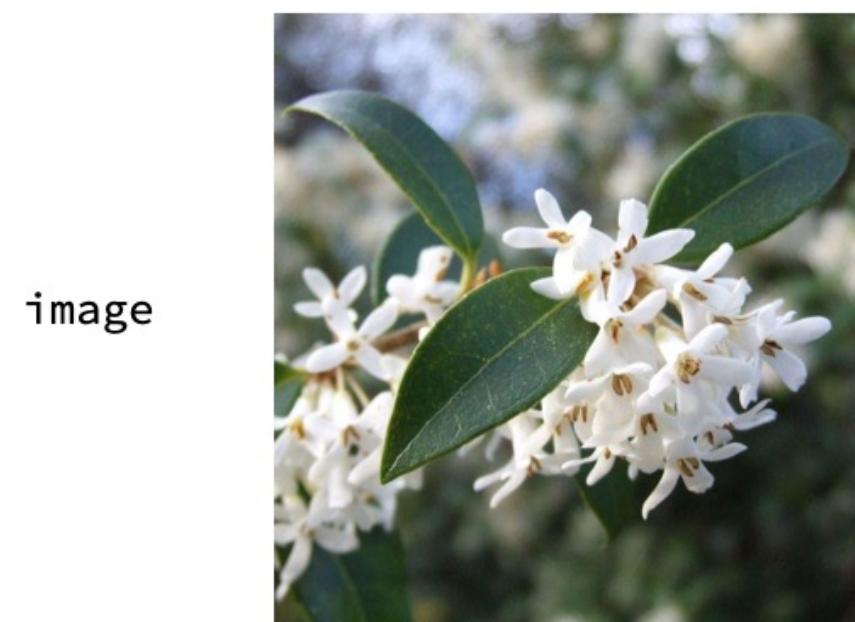
1600	0	1600	0	1600
0	1600	0	1600	0
1600	0	1516	84	1536
64	1600	0	1562	38
1477	123	1494	106	1558
42	1600	0	1600	0
1600	0	1600	0	1512



-> "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



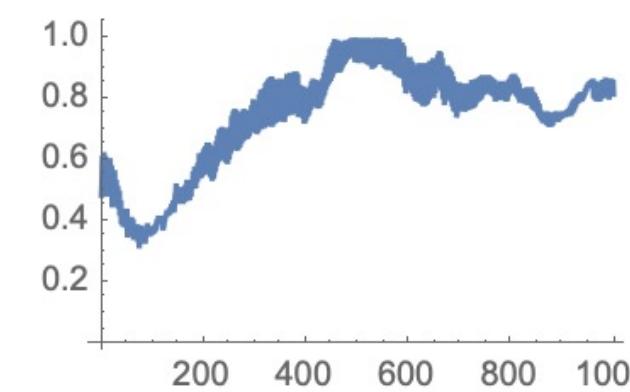
-> "feature extraction"

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

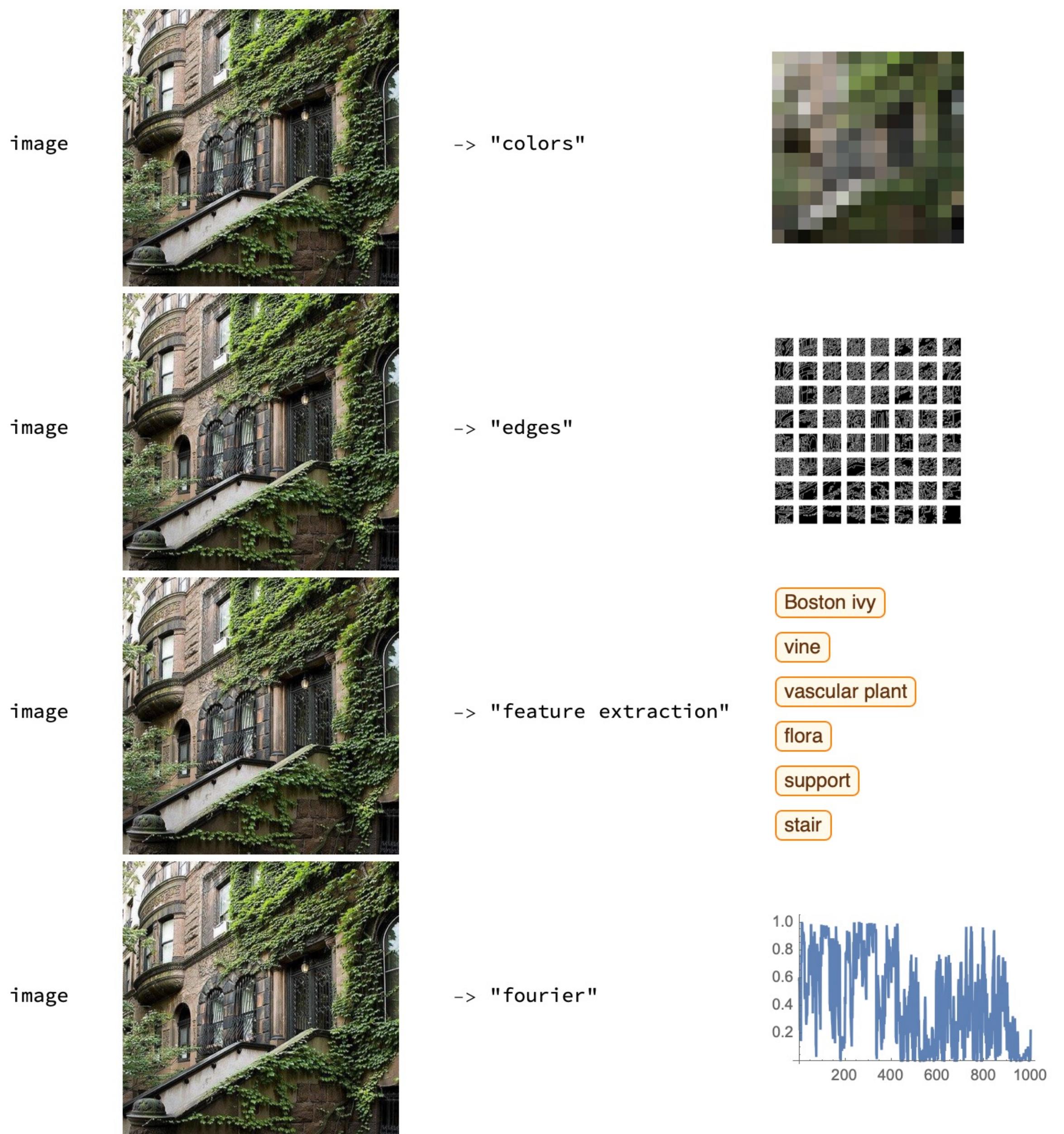
8.22561	-8.62608	28.0713
-3.54004	12.2321	3.18221
-6.41089	1.24627	-2.62163



-> "fourier"



311.196 + 0. i	-2.8447 + 8.53134 i
-2.8447 - 8.53134 i	-18.8027 + 15.8672 i
0.0507741 - 1.67722 i	-0.855818 - 0.620666 i
11.2859 + 32.356 i	2.20177 + 1.97652 i
1.98793 + 0.293197 i	-2.49415 + 16.4691 i
1.08693 - 0.0374585 i	-0.728638 - 0.404993 i
-7.28062 + 7.17637 i	0.616701 + 0.874254 i



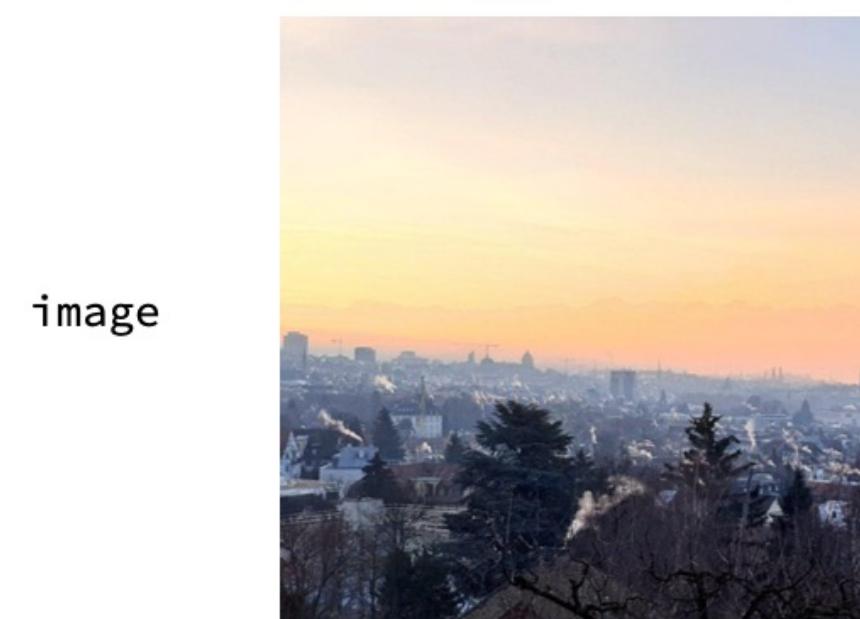
0.745098	0.741176	0.662745	0.694118	0.666667
0.635294	0.705882	0.658824	0.627451	0.494118
0.490196	0.423529	0.368627	0.427451	0.278431
0.447059	0.517647	0.313725	0.34902	0.423529
0.196078	0.203922	0.235294	0.133333	0.301961
0.305882	0.196078	0.254902	0.282353	0.172549

1146	454	1138
462	1057	543
1107	493	1064
536	991	609
1156	444	1204

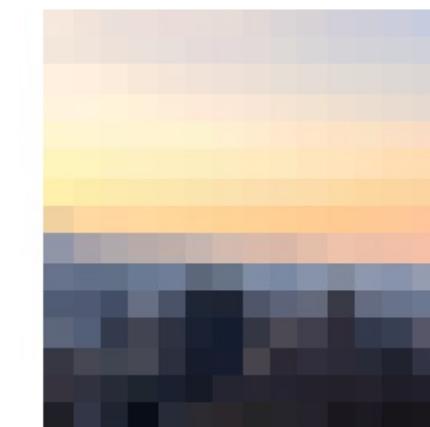
- Boston ivy
- vine
- vascular plant
- flora
- support
- stair

11.9924	5.44124	-2.30834
0.115535	2.4649	4.43479
5.21442	4.58633	-3.29425

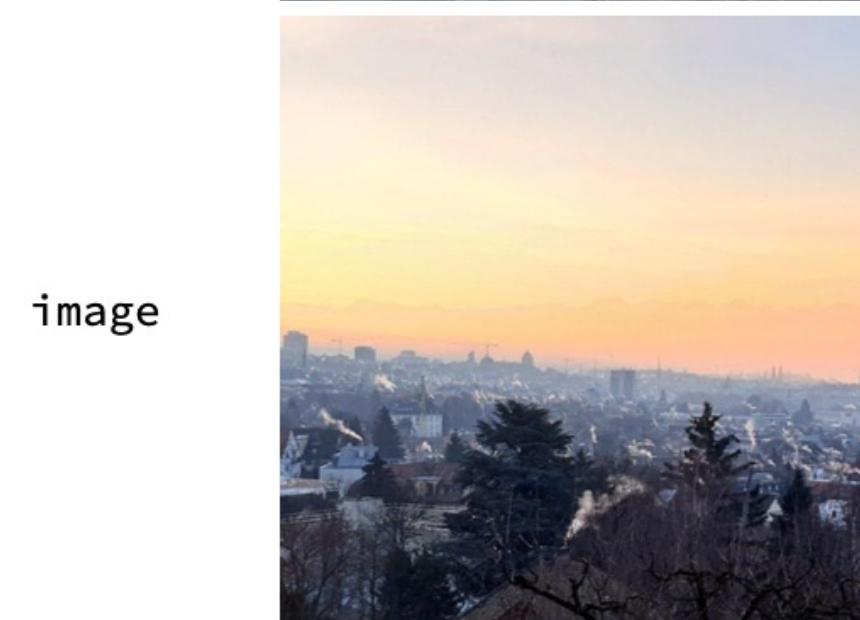
$232.95 + 0. i \quad 6.82914 + 15.0475 i$



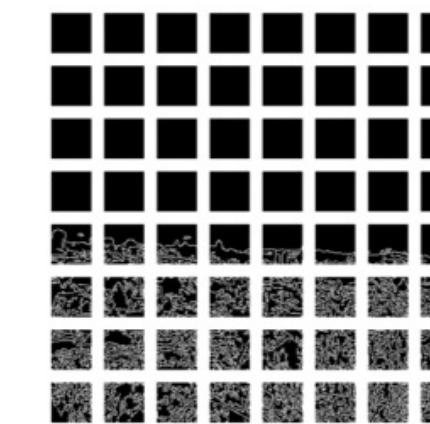
-> "colors"



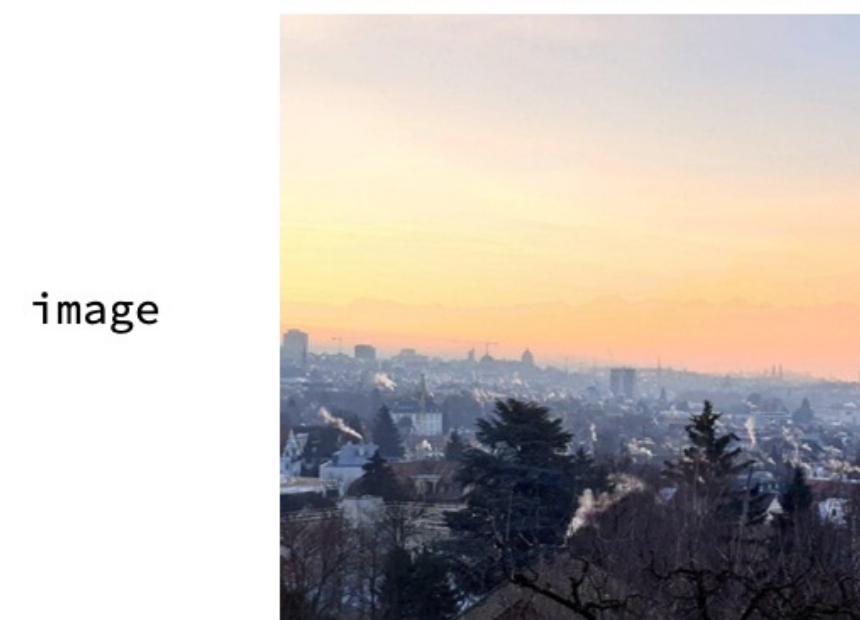
0.956863 0.901961 0.858824 0.92549 0.878431
0.854902 0.913725 0.870588 0.85098 0.905882
0.862745 0.85098 0.894118 0.85098 0.843137
0.866667 0.839216 0.839216 0.835294 0.823529
0.843137 0.811765 0.807843 0.85098 0.796078
0.803922 0.862745 0.776471 0.8 0.866667



-> "edges"



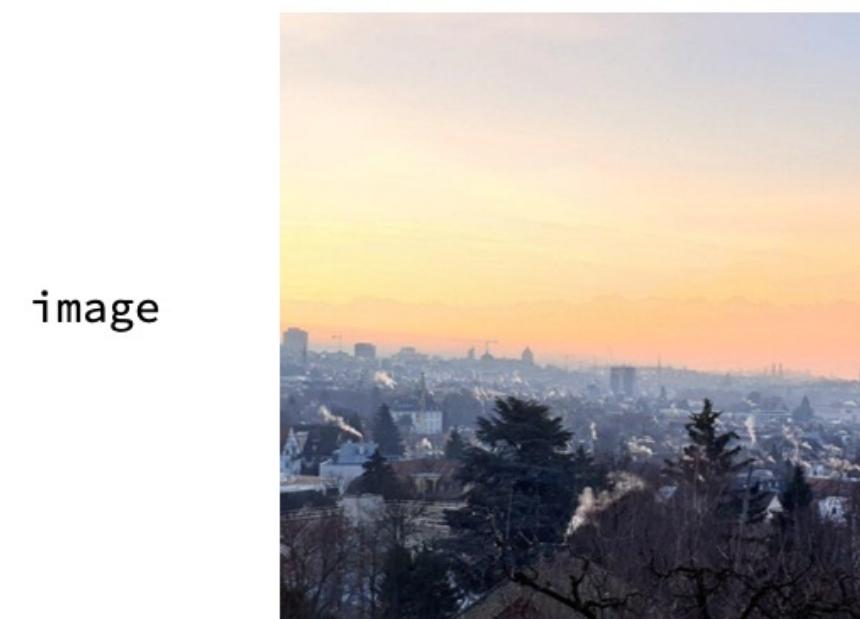
1600 0 1600
0 1600 0
1600 0 1600
0 1600 0
1600 0 1600



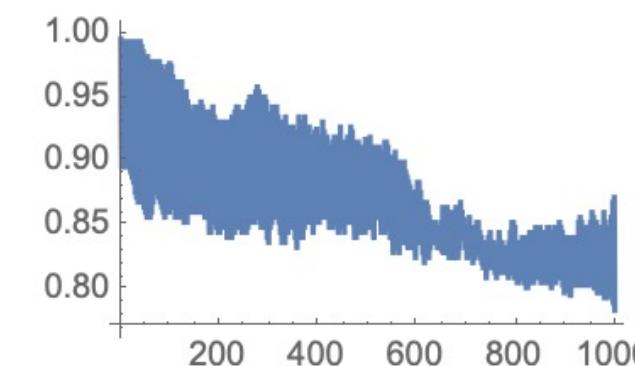
-> "feature extraction"

atmospheric phenomenon
physical phenomenon
natural phenomenon
cloud
mount
atmosphere

7.15525 4.59606 -1.56497
-1.7739 -0.335489 13.6057
6.20777 -4.12575 -0.151123



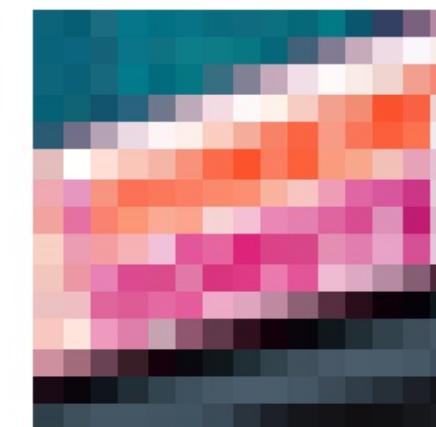
-> "fourier"



431.125 + 0. i 13.5396 + 6.74412 i



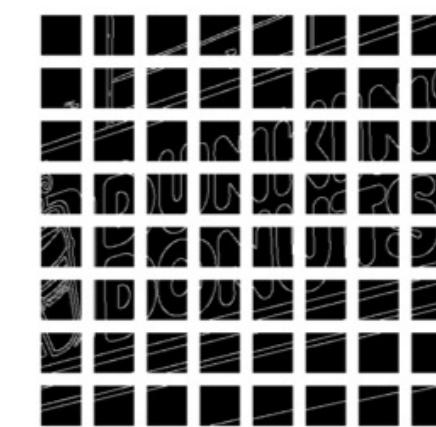
-> "colors"



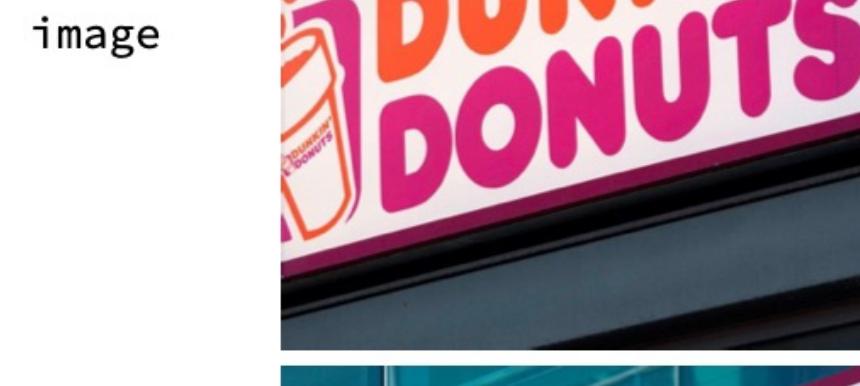
0.0352941	0.384314	0.47451	0.0784314	0.403922
0.490196	0.0431373	0.462745	0.537255	0.027451
0.462745	0.52549	0.0196078	0.439216	0.501961
0.	0.403922	0.470588	0.0392157	0.4
0.466667	0.172549	0.423529	0.505882	0.447059
0.443137	0.552941	0.745098	0.643137	0.72549



-> "edges"



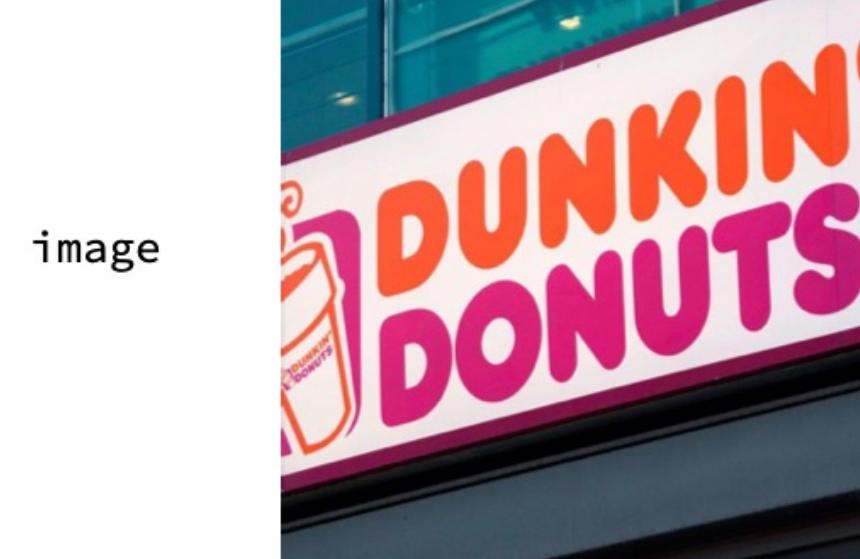
1600	0	1515
85	1600	0
1557	43	1503
97	1511	89
1500	100	1525



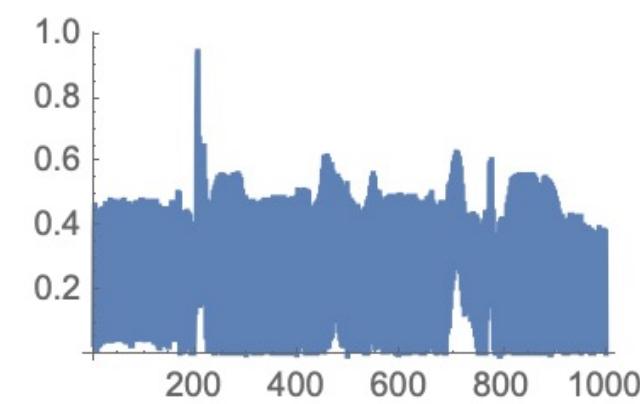
-> "feature extraction"

- casino
- grocery store
- supermarket
- self-propelled vehicle
- motor vehicle
- automobile

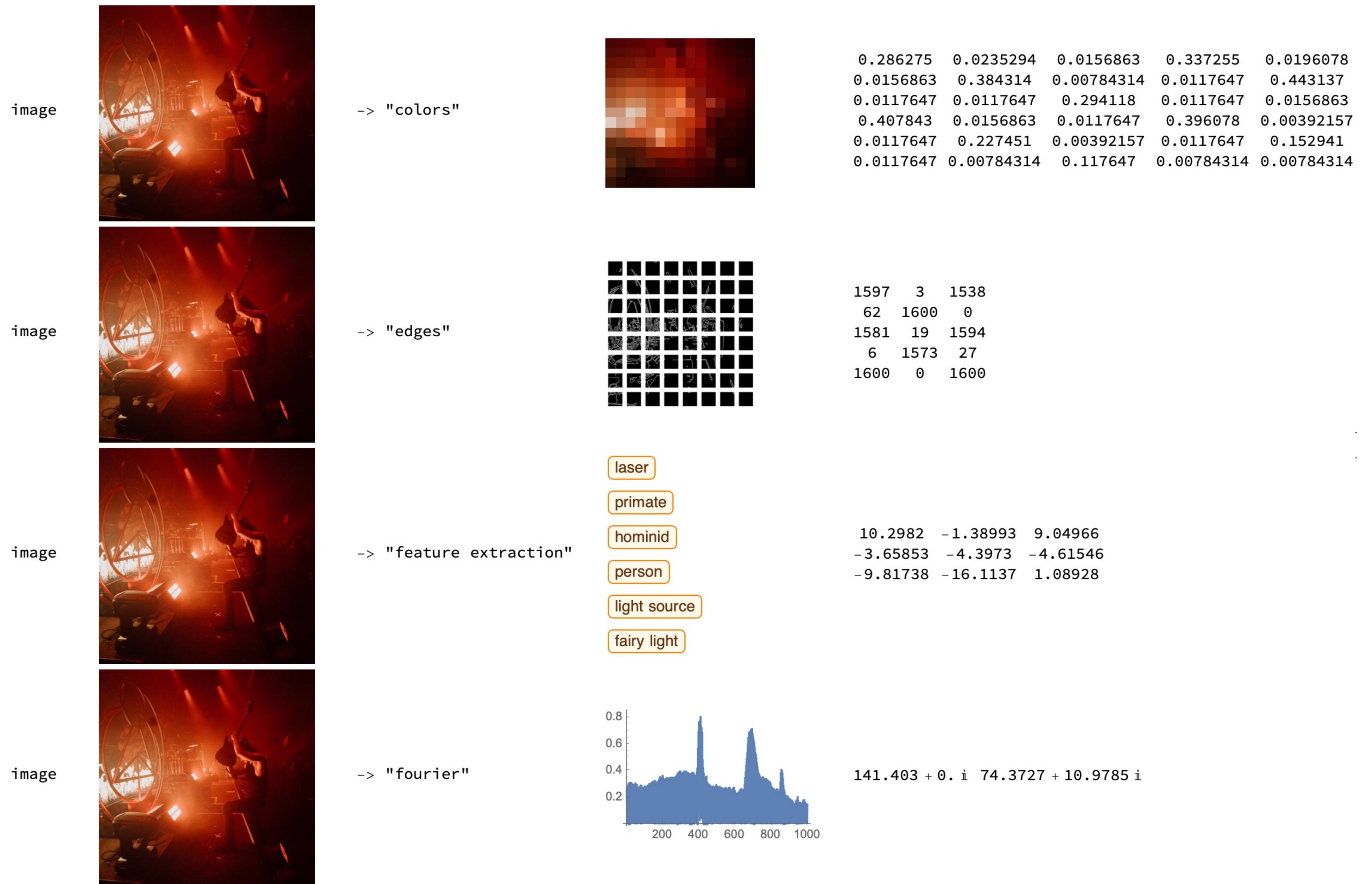
1.48464	8.58569	-0.247135
9.6562	1.21292	-4.77248
-4.94734	4.30959	12.4666



-> "fourier"



$$357.98 + 0. \text{i} \quad 21.9133 - 10.4063 \text{i}$$



image



-> "colors"

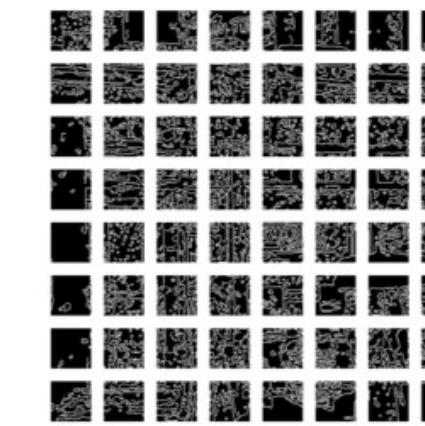


0.513725 0.556863 0.470588 0.52549 0.560784
0.478431 0.784314 0.776471 0.662745 0.65098
0.627451 0.513725 0.639216 0.619608 0.533333
0.721569 0.709804 0.643137 0.568627 0.552941
0.501961 0.533333 0.509804 0.443137 0.682353
0.67451 0.619608 0.54902 0.537255 0.482353

image



-> "edges"



1281 319 1216
384 1570 30
1187 413 1254
346 1310 290
1343 257 1562

image



-> "feature extraction"

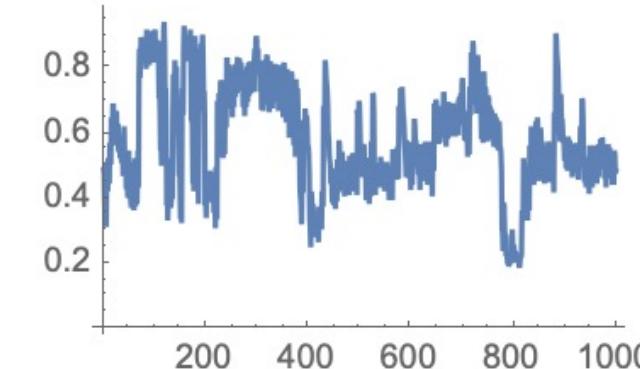
sprinkler
crucifix
lock
padlock
cockpit
abacus

10.2982 -1.38993 9.04966
-3.65853 -4.3973 -4.61546
-9.81738 -16.1137 1.08928

image



-> "fourier"

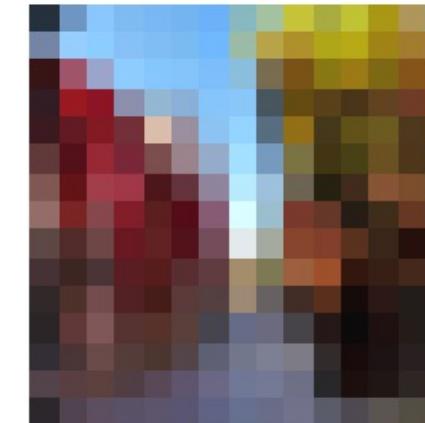


381.644 + 0. i 5.46611 + 14.145 i

image



-> "colors"

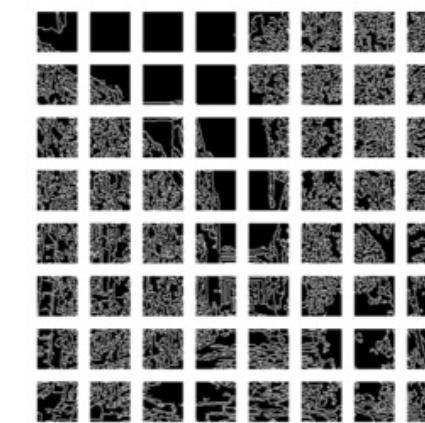


0.298039 0.392157 0.494118 0.541176 0.792157
1. 0.498039 0.737255 0.94902 0.454902
0.713725 0.956863 0.45098 0.709804 0.917647
0.666667 0.74902 0.560784 0.737255 0.713725
0.231373 0.713725 0.717647 0.172549 0.690196
0.592157 0.141176 0.592157 0.572549 0.486275

image



-> "edges"



1477 123 1600
0 1600 0
1600 0 1596
4 1275 325
1155 445 1080

image



-> "feature extraction"

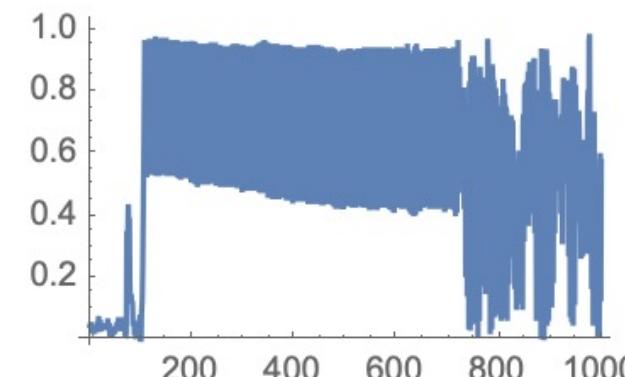
Boston ivy
tree
flowering tree
maple tree
boxelder
California box elder

8.05123 -1.32554 -1.67072
-4.65785 3.92969 2.48092
1.45389 -6.90618 2.5591

image



-> "fourier"



258.052 + 0. i 15.2118 + 2.63635 i

FEATURE EXTRACTION on TEXT

text	To be, or not to be,--that is the question:-- Whether 'tis nobler in the mind to suffer The slings and arrows of outrageous fortune Or to take arms against a sea of troubles, And by opposing end them?	-> "Sentiment Analysis"	Qualifying text by positive, neutral or negative	0.232578	0.908024	0.0687178
				0.68047	-0.039263	0.30186
				0.032246	-0.41376	0.13228
				0.17118	0.22419	-0.10046
				0.67846	0.057204	-0.34448
				0.55963	0.10032	0.18677
				-2.0932	0.22171	-0.39868
				3.8826	0.47466	-0.95658
				-0.32752	0.12751	0.088359
				-0.094375	0.018324	0.21048
				0.082279	-0.09434	-0.073297
						-0.064699
						-0.26044

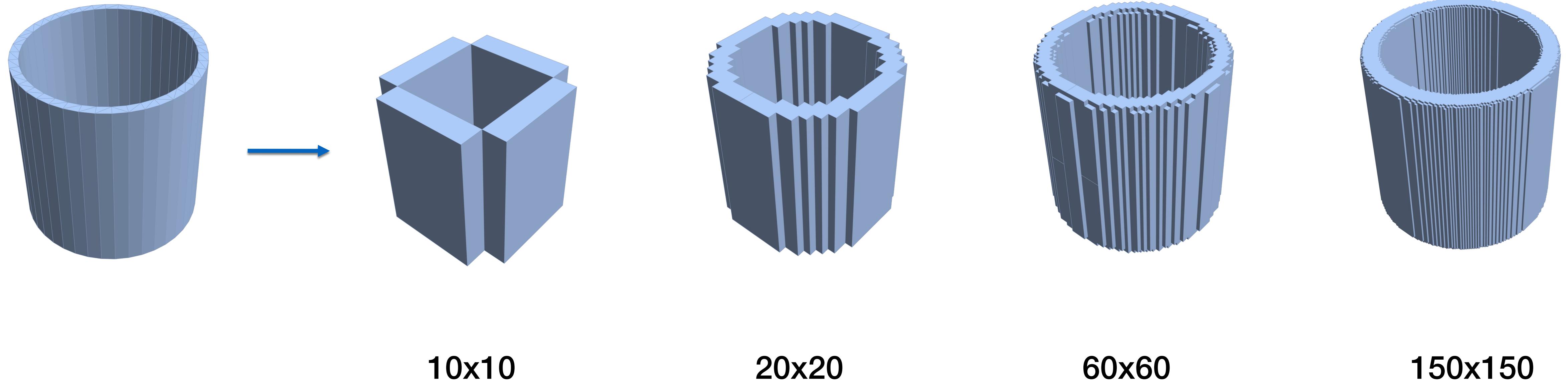
text	say we end The heartache, and the thousand natural shocks That flesh is heir to,--'tis a consummation Devoutly to be wish'd. To die,--to sleep;-- To sleep: perchance to dream:--ay, there's the rub; For in that sleep of death what dreams may come, Whe	-> "Sentiment Analysis"	Qualifying text by positive, neutral or negative	0.232578	0.908024	0.0687178		
text	say we end The heartache, and the thousand natural shocks That flesh is heir to,--'tis a consummation Devoutly to be wish'd. To die,--to sleep;-- To sleep: perchance to dream:--ay, there's the rub; For in that sleep of death what dreams may come, Whe	-> "Word2Vec"	Qualifying text by it's content with word-embeddings	0.68047 0.032246 0.171118 0.67846 0.55963 -2.0932 3.8826 -0.32752 -0.094375 0.082279	-0.039263 -0.41376 0.22419 0.057204 0.10032 0.22171 0.47466 0.12751 0.018324 -0.09434	0.30186 0.13228 -0.10046 -0.34448 0.18677 -0.39868 -0.95658 0.088359 0.21048 -0.073297	-0.17792 -0.29847 -0.43653 -0.42785 -0.26854 0.20912 -0.37788 0.16351 -0.03088 -0.064699	0.42962 -0.085253 0.33418 -0.43275 0.037334 -0.55725 0.20869 -0.21634 -0.19722 -0.26044

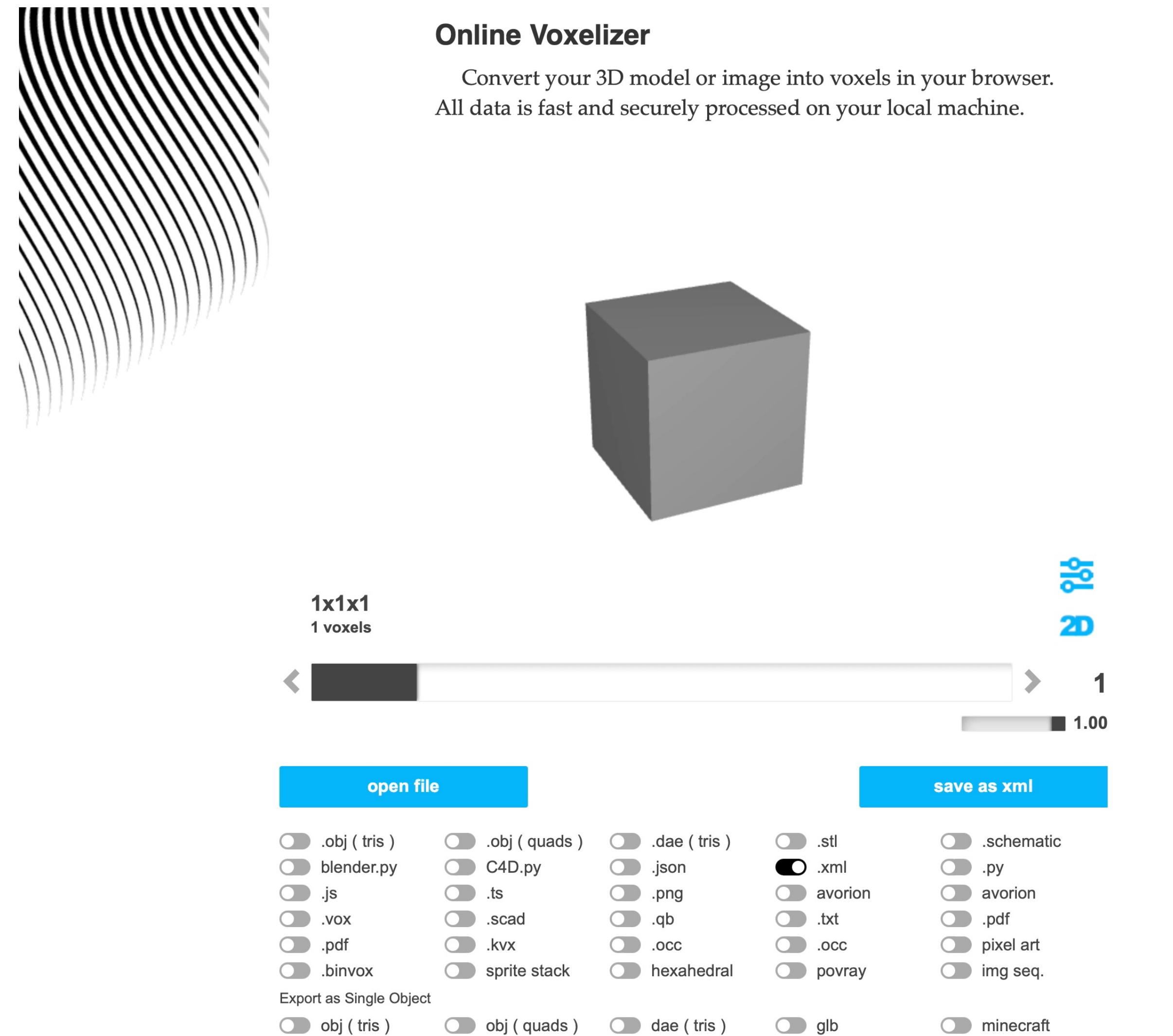
text	so long life; For who would bear the whips and scorns of time, The oppressor's wrong, the proud man's contumely, The pangs of despis'd love, the law's delay, The insolence of office, and the spurns That patient merit of the unworthy takes, When he himself might his quietus make With a bare bodki	-> "Sentiment Analysis"	Qualifying text by positive, neutral or negative	0.232578	0.908024	0.0687178		
text	so long life; For who would bear the whips and scorns of time, The oppressor's wrong, the proud man's contumely, The pangs of despis'd love, the law's delay, The insolence of office, and the spurns That patient merit of the unworthy takes, When he himself might his quietus make With a bare bodki	-> "Word2Vec"	Qualifying text by it's content with word-embeddings	0.68047 0.032246 0.17118 0.67846 0.55963 -2.0932 3.8826 -0.32752 -0.094375 0.082279	-0.039263 -0.41376 0.22419 0.057204 0.10032 0.22171 0.47466 0.12751 0.018324 -0.09434	0.30186 0.13228 -0.10046 -0.34448 0.18677 -0.39868 -0.95658 0.088359 0.21048 -0.073297	-0.17792 -0.29847 -0.43653 -0.42785 -0.26854 0.20912 -0.37788 0.16351 -0.03088 -0.064699	0.42962 -0.085253 0.33418 -0.43275 0.037334 -0.55725 0.20869 -0.21634 -0.19722 -0.26044

text	who would these fardels bear, To grunt and sweat under a weary life, But that the dread of something after death,-- The undiscover'd country, from whose bourn No traveller returns,--puzzles the wil	-> "Sentiment Analysis"	Qualifying text by positive, neutral or negative	0.232578	0.908024	0.0687178
				0.68047	-0.039263	0.30186
				0.032246	-0.41376	0.13228
				0.17118	0.22419	-0.10046
				0.67846	0.057204	-0.34448
				0.55963	0.10032	0.18677
				-2.0932	0.22171	-0.39868
				3.8826	0.47466	-0.95658
				-0.32752	0.12751	0.088359
				-0.094375	0.018324	0.21048
				0.082279	-0.09434	-0.073297
					-0.064699	-0.26044

CODE on 3D OBJECTS

A voxel is a unit of graphic information that defines a point in three-dimensional space





Online Voxelizer

Convert your 3D model or image into voxels in your browser.
All data is fast and securely processed on your local machine.

1x1x1
1 voxels

2D

1
1.00

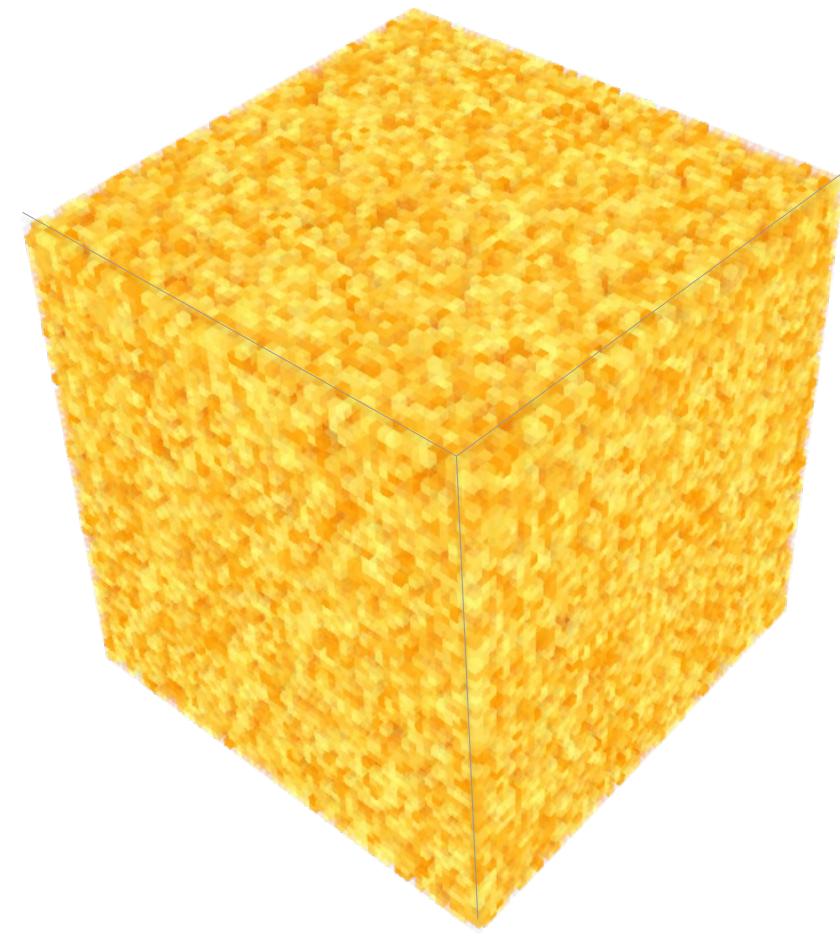
open file **save as xml**

- .obj (tris) .obj (quads) .dae (tris) .stl .schematic
- blender.py C4D.py .json .xml .py
- .js .ts .png avorion avorion
- .vox .scad .qb .txt .pdf
- .pdf .kvx .occ .occ pixel art
- .binvox sprite stack hexahedral povray img seq.

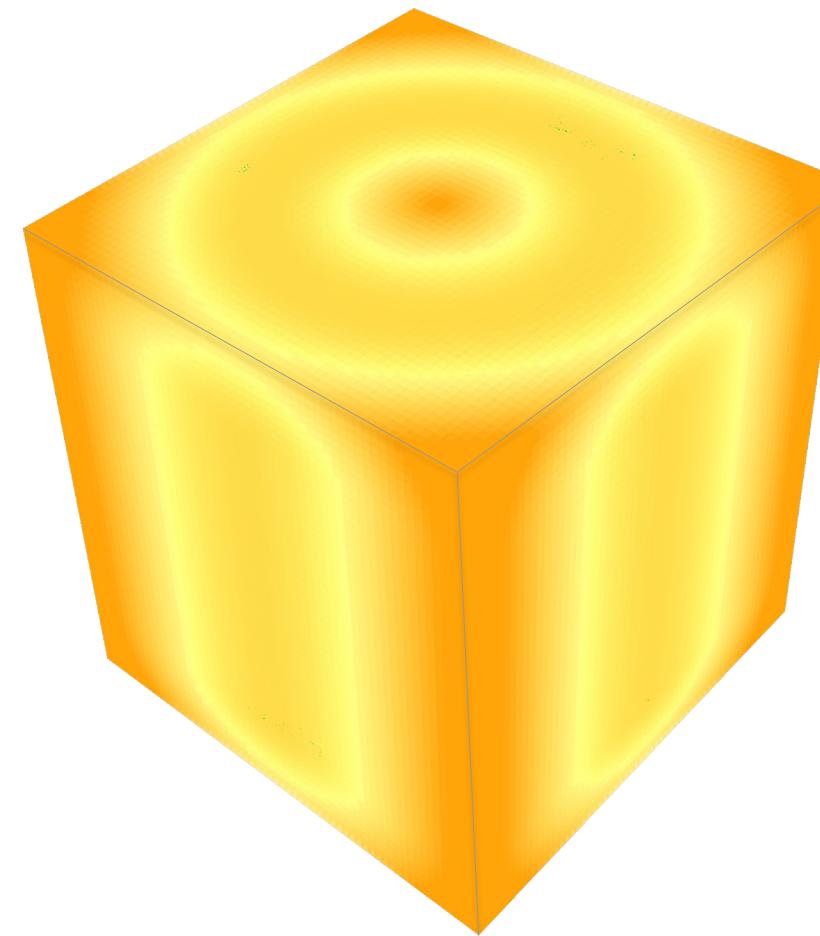
Export as Single Object

- obj (tris) obj (quads) dae (tris) glb minecraft

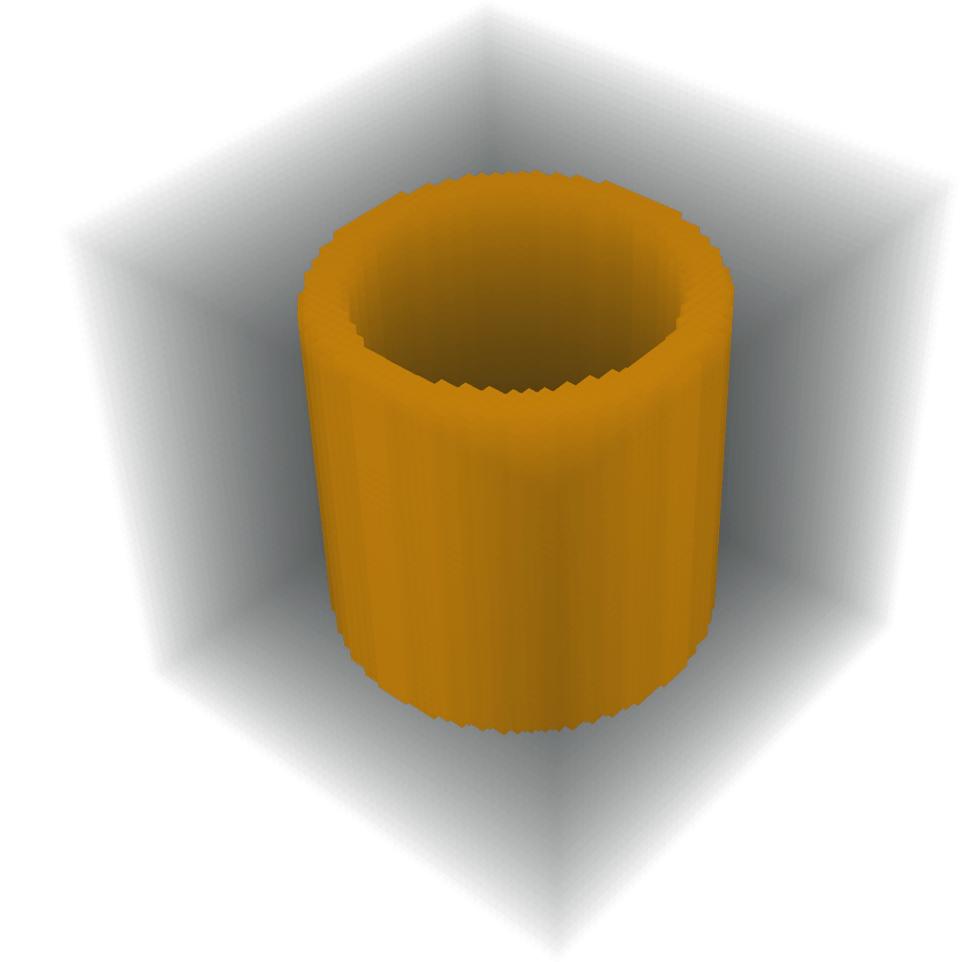
Currently you can fond several online platforms to transform 3D models from mesh to voxels



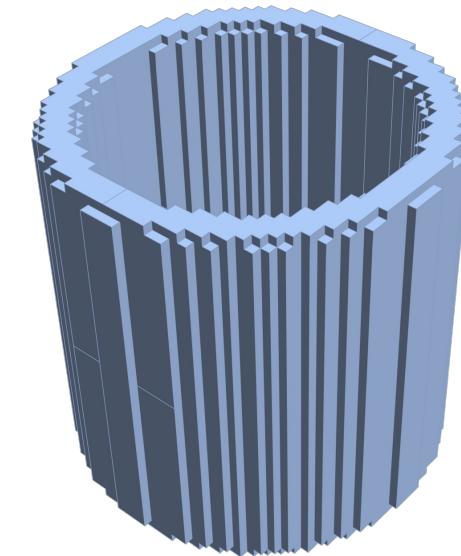
3D space voxel
60x60x60



Distances from
an object to
every 3D point in
a 60x60x60 3D
space



Selecting only
shortest
distances to the
object



The final voxel

3D object

Numerical vector

	$\rightarrow \{-154.283, -74.851, -78.3065, -13.9489, -108.249, 49.9639, 135.499\}$
	$\rightarrow \{1218.48, -4545.57, 2019.53, 5668.56, 441.047, 891.547, -4108.11\}$
	$\rightarrow \{-136.967, -97.8868, -10.4024, -45.0804, -121.087, 25.0047, -137.749\}$
	$\rightarrow \{562.349, -1510.23, 1288.7, 2649.55, 376.452, 99.3022, -832.582\}$
	$\rightarrow \{30.9925, 17.1258, 621.028, 98.4733, -205.557, -210.251, 96.3287\}$
	$\rightarrow \{-99.2109, -52.4264, 63.3743, -16.1669, -43.6128, 8.52891, -43.4448\}$

Consider it as an image, therefore you can extract features as with Fourier