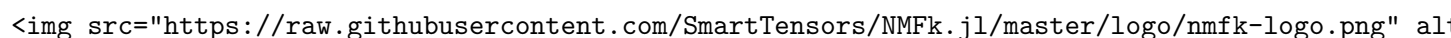


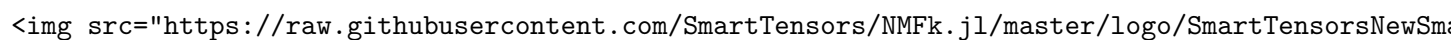
Feature_Extraction_COVID-19

October 22, 2021

1 NMFk: OVID-19 Data Feature Extraction

 ``

NMFk is a code within our award winning [SmartTensors](#) framework for unsupervised, supervised and physics-informed (scientific) machine learning (ML) and artificial intelligence (AI) ([web source](#)).

 ``

NMFk performs Nonnegative Matrix Factorization with k -means clustering

An example problem demonstrating how NMFk can be applied to extract and classify features associated with 2021 COVID-19 public datasets.

This type of analysis is related to the **blind source separation** problem.

Applying NMFk, we can automatically:

- identify the number of the unknown mixed signatures in a dataset
- estimate the shape of the unknown mixed signatures
- estimate how the signatures are mixed at each sensor (measurement location)
- classify measurement locations based on how they observe (are impacted) the extracted features.

If NMFk is not installed, first execute in the Julia REPL:

```
import Pkg
Pkg.add("NMFk")
Pkg.add("Mads")
Pkg.add("XLSX")
Pkg.add("DataFrames")
Pkg.add("CSV")
Pkg.add("Cairo")
Pkg.add("Fontconfig")
Pkg.add("Gadfly")
```

```
[1]: import NMFk
import Mads
import Random
import XLSX
import DataFrames
import CSV
```

```
import Cairo
import Fontconfig
import Gadfly
```

1.1 COVID-19 Data

Let us use the same feature extraction tools on some real data.

Next, we will read in data from an xlsx file.

The dataset contains case and death rates for covid-19 along with relevant demographic data at the county-level.

All of the data within this file is publicly available from various sources.

There are 3,142 counties with 804 demographic features.

```
[2]: ev, eh = XLSX.readtable("Data/CountyData (09-02-2020).xlsx", "Export";
    ↪header=true, stop_in_empty_row=false);
ncounties = length(ev[1])
```

3142

There are 3142 unique counties in the US.

Because the population of counties is so variable across the country, we will want to normalize for population.

We will create a weight that we will use later on. Also we will want to keep track of the individual counties using the FIPS number (unique to each county).

Note that FIPS 46102 is renamed to 46113 due to an outdated name.

Then we will clean up some of the variable names and initialize an array of data, M.

```
[3]: weight = ev[6] ./ maximum(ev[6]);
statecounty = ev[3] .* " " .* ev[4];
fips = parse.(Int64, ev[5]);
fips[indeces(46102, fips)[1]] = 46113;
skipvar = 5;
varnames = NMFk.replace(String.(eh[skipvar+1:end]), "denomin-ational" =>
    ↪"denominational", "busin-esses" => "businesses", "partici-pation" =>
    ↪"participation", "Retire-ment" => "Retirement", "Agri-culture" =>
    ↪"Agriculture", r" +" => " ", "\t" => " ");
nvar = length(varnames);
M = Array{Float32}(undef, ncounties, nvar);
```

```
[4]: for i in 1:nvar
    try
        M[:, i] = NMFk.processdata(ev[i+skipvar]; nanstring="x");
    catch
        #display(ev[i+skipvar][2:end])
    end
end
```

```

        end
    end

    # Look at some of the Variables
    for i in 1:10
        @show varnames[i]
    end

    for i in 110:120
        @show varnames[i]
    end

```

```

varnames[i] = "COLUMN: 78 - Popn count (2015) (per 100,000)"
varnames[i] = "COLUMN: 21 | CATEGORY: '2016 ELECTION' | VARIABLE: '' | UNITS:
'('%)' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 998 | CATEGORY: 'COVID-19 (05-07-2020)' | VARIABLE: 'Case
rate (per million)' | UNITS: 'Rate' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 999 | CATEGORY: 'COVID-19 (05-07-2020)' | VARIABLE:
'Death rate (per million)' | UNITS: 'Rate' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 1000 | CATEGORY: 'COVID-19 (05-07-2020)' | VARIABLE:
'Worst week - cases (weekly cases per million)' | UNITS: 'Rate' | COVERAGE:
'100.0%'"
varnames[i] = "COLUMN: 1001 | CATEGORY: 'COVID-19 (05-07-2020)' | VARIABLE:
'Worst week - deaths (weekly deaths per million)' | UNITS: 'Rate' | COVERAGE:
'78.5%'"
varnames[i] = "COLUMN: 1002 | CATEGORY: 'COVID-19 (06-17-2020)' | VARIABLE:
'Case rate (per million)' | UNITS: 'Rate' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 1003 | CATEGORY: 'COVID-19 (06-17-2020)' | VARIABLE:
'Death rate (per million)' | UNITS: 'Rate' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 1004 | CATEGORY: 'COVID-19 (06-17-2020)' | VARIABLE:
'Worst week - cases (weekly cases per million)' | UNITS: 'Rate' | COVERAGE:
'95.7%'"
varnames[i] = "COLUMN: 1005 | CATEGORY: 'COVID-19 (06-17-2020)' | VARIABLE:
'Worst week - deaths (weekly deaths per million)' | UNITS: 'Rate' | COVERAGE:
'59.9%'"
varnames[i] = "COLUMN: 701 | CATEGORY: 'CDC Social Vulnerabilty Index' |
VARIABLE: 'RPL_THEMES' | UNITS: 'Rate' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 489 | CATEGORY: 'IHME Cardiovascular Mortalityt Rates' |
VARIABLE: 'Mortality Rate, 2014* Hypertensive heart disease' | UNITS: 'Rate' |
COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 358 | CATEGORY: 'Yale Climate Opinion' | VARIABLE:
'consensusOppose' | UNITS: '% ' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 467 | CATEGORY: 'COVID Community Vulnerability Index' |
VARIABLE: 'THEME 1: Socioeconomic Status' | UNITS: 'Index' | COVERAGE:
'100.0%'"
varnames[i] = "COLUMN: 430 | CATEGORY: 'IPCSR Crime Data 2016 (2012-2014)' |
VARIABLE: 'BURGLRY' | UNITS: 'per 100,000' | COVERAGE: '95.0%'"
varnames[i] = "COLUMN: 104 | CATEGORY: 'ESRI COUNTIES DATA (2015)' | VARIABLE:

```

```
'Median age' | UNITS: '(years)'' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 108 | CATEGORY: 'ESRI COUNTIES DATA (2015)' | VARIABLE:
'Average household size' | UNITS: '(count)'' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 656 | CATEGORY: 'CDC Social Vulnerabilty Index' |
VARIABLE: 'MP_AGE65' | UNITS: 'Rate'' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 721 | CATEGORY: 'CDC Social Vulnerabilty Index' |
VARIABLE: 'F_TOTAL' | UNITS: 'Rate'' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 714 | CATEGORY: 'CDC Social Vulnerabilty Index' |
VARIABLE: 'F_THEME3' | UNITS: 'Rate'' | COVERAGE: '100.0%'"
varnames[i] = "COLUMN: 209 | CATEGORY: 'Institute for Health Metrics and
Evaluation (2010/11)' | VARIABLE: 'Male sufficient activity' | UNITS: '(%)'' |
COVERAGE: '99.5%'"
```

```
[5]: Mn, nmin, nmax = NMFk.normalizematrix_col!(M)
Mn_COVID = Mn
Mn_COVID[:,3:18] = Mn_COVID[:,3:18]*10
```

3142×16 Matrix{Float32}:

0.0864532	0.181979	0.0248965	...	0.892706	0.232081	0.403355
0.0731172	0.0759069	0.0175243		0.407982	0.306961	0.117062
0.158552	0.137284	0.0528237		0.614892	0.302963	0.184372
0.159904	0.0	0.0582302		0.774658	0.258569	0.41454
0.0604853	0.0	0.0180404		0.412497	0.245324	0.214699
0.148399	0.335511	0.0516387	...	3.00549	0.942161	1.2607
0.556663	0.348519	0.344195		4.12552	0.422702	1.17126
0.0835663	0.0894943	0.0306091		0.687158	0.327507	0.254274
0.766304	2.24208	0.287566		2.60836	0.265939	0.844305
0.0572218	0.0	0.0165929		0.99334	0.161726	0.301963
0.00285253	0.0	0.00297779		0.0	0.0926556	NaN
0.0	0.0	0.0		0.258366	0.0117354	0.474988
0.0327807	0.0	0.0171101	...	0.0711321	0.0883362	0.125926
0.00847083	0.0	0.00884282		0.220574	0.103117	0.404533
0.0236006	0.0	0.00821234		0.102424	0.0829145	0.16835
0.237792	0.144434	0.0815096		0.0924165	0.28279	0.165607
0.0247039	0.0	0.0128944		0.214423	0.266151	0.393066
0.0533483	0.0	0.0445528	...	1.38915	0.296622	1.11557
0.0	0.0	0.0		0.0	0.065141	NaN

```
[6]: size(Mn)
```

(3142, 804)

1.2 NMFk analysis

Run NMFk on the normalized matrix using a k-range from 2-5.

Then we will cluster the results using the NMFk.clusterresults() function on the resulting W and H matrices.

Additionally, we will use the population weight created previously to weigh each counties influence on the NMFk output by the population of the county.

We set the weight parameter in the NMFk.execute() function to the weight created above using population of the county.

```
[7]: nkrange = 2:5
# W, H, fitquality, robustness, aic, kopt = NMFk.execute(Mn_COVID, nkrange;
↳ weight=weight, resultdir="results-nmfk-COVID",
↳ casefilename="nmfk-nw-$(join(size(Mn), '_'))", load=true);
W, H, fitquality, robustness, aic, kopt = NMFk.load(nkrange;
↳ resultdir="results-nmfk-COVID", casefilename="nmfk-nw-$(join(size(Mn),
↳ '_'))");
```

```
Signals: 2 Fit:      51362.92 Silhouette:    0.8122191 AIC:      -8881786 Signal
order: [2, 1]
```

```
Signals: 3 Fit:      43425.42 Silhouette:    0.2526127 AIC:      -9265359 Signal
order: [2, 3, 1]
```

```
Signals: 4 Fit:      37674.53 Silhouette:    0.4441651 AIC:      -9588743 Signal
order: [4, 3, 2, 1]
```

```
Signals: 5 Fit:      35817.66 Silhouette:    0.6171504 AIC:      -9698714 Signal
order: [5, 4, 2, 1, 3]
```

```
Info: Optimal solution: 5 signals
```

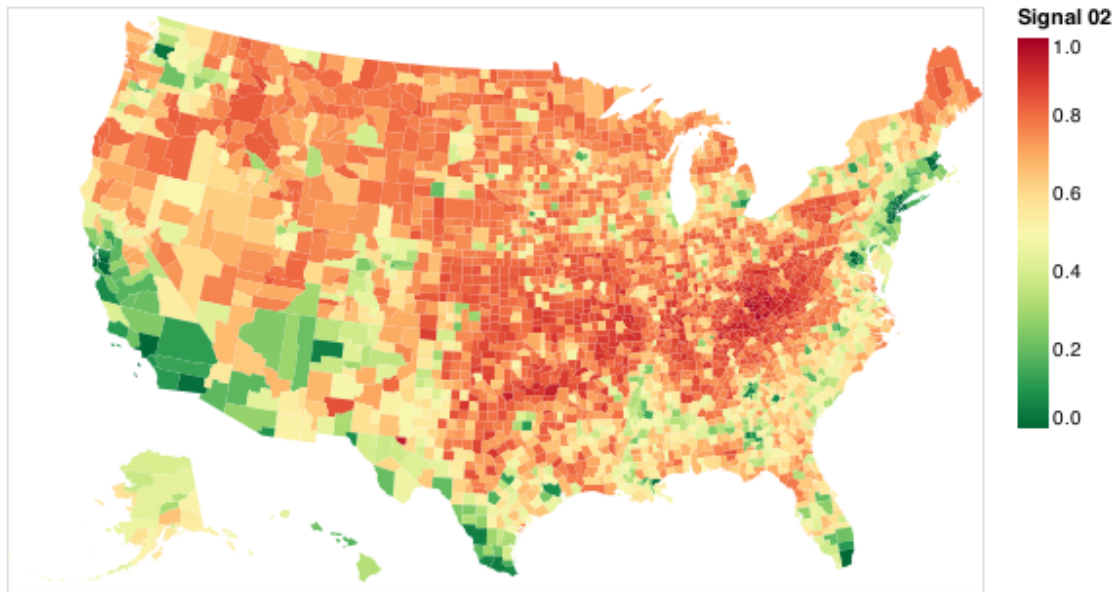
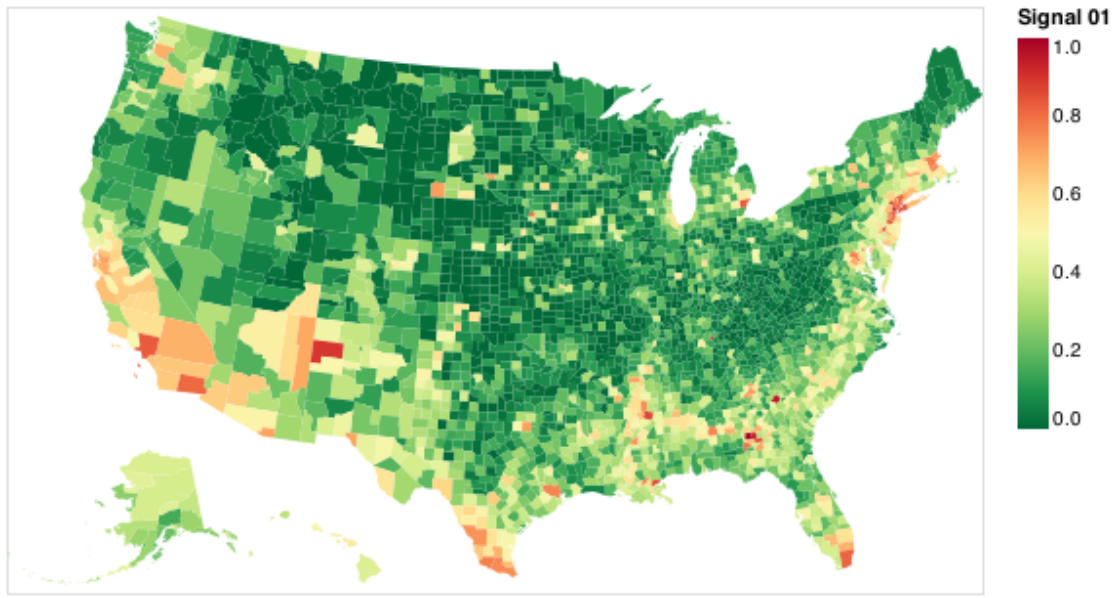
```
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkIO.jl:30
```

NMFk found an optimal number of 5 signals.

We will look at the 2 signal solution for the sake of brevity here.

Shown below are some maps of the signal weight for each county.

```
[8]: Mads.display("maps-nw-covid/signals2-01.png")
Mads.display("maps-nw-covid/signals2-02.png")
```



Great!

Now we can see the spatial representation of the signals created by NMFk.

Now let us look at what features make up the optimal four signals created by NMFk.

First, we will look at the top features in signal 1.

```
[9]: import CSV, DataFrames
df = CSV.read("results-nw-covid/attr-2.csv", DataFrames.DataFrame);
sort!(df, [:S1], rev = true).S1;
@show(df.S1[1:20])
#df.Name[1:10]
[df.Name[s][25:end] for s in 1:1:20]
```

```
df.S1[1:20] = [1.0, 0.9999393749128771, 0.9999373849422112, 0.9999014145257417,
0.9998839710238875, 0.9995353650211203, 0.9995278953322091, 0.9995160140070344,
0.9983448011918812, 0.9966487238031689, 0.994566987290771, 0.9913185782908882,
0.9900514655399231, 0.982357230638405, 0.9810722888107005, 0.9771627316556794,
0.9616750112174638, 0.950042692974512, 0.9245405108171713, 0.917582641495482]
```

```
20-element Vector{String}:

```

```
"'CDC Social Vulnerabilty Index' | VARIABLE: 'EPL_PCI' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'RPL_THEME1' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'EPL_POV' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'EPL_UNEMP' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'RPL_THEMES' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'F_PCI' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'F_UNEMP' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'F_POV' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'SPL_THEME1' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'F_THEME1' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'SPL_THEMES' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'US Polciy Database' | VARIABLE: 'ALCOPEN Alcohol/Liquor Stores Open
↪business_alcohol_exempt attribute flag' | UNITS: 'Classification' | COVERAGE:
↪'100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'F_TOTAL' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'MP_POV' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
"'US Polciy Database' | VARIABLE: 'GUNOPEN Keep Firearms Sellers Open
↪business_firearm_exempt attribute flag' | UNITS: 'Classification' | COVERAGE:
↪'100.0%'"
```

```

'"CDC Social Vulnerabilty Index' | VARIABLE: 'EP_UNEMP' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
'"CDC Social Vulnerabilty Index' | VARIABLE: 'EP_POV' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
'"CDC Social Vulnerabilty Index' | VARIABLE: 'MP_UNEMP' | UNITS: 'Rate' |
↪COVERAGE: '100.0%'"
'"County Health Rankings & Roadmaps (http://www.countyhealthrankings.org/
↪explore-health-rankings)' | VARIABLE: 'Demographics' | UNITS: '% Non-Hispanic
↪White' | COVERAGE: '100.0%'"
'"US Polciy Database' | VARIABLE: 'RACECASE Report cases by race/ethnicity
↪race_cases attribute flag' | UNITS: 'Classification' | COVERAGE: '100.0%'"

```

And let us look at the top 10 counties represented by signal 1.

```

[10]: counties = CSV.read("results-nw-covid/counties-2.csv", DataFrames.DataFrame);
sort!(counties, [:S1], rev = true).S1;
@info(counties.S1[1:10])
counties.Name[1:10]

```

```

Info: [1.0, 0.9947770614151811, 0.9795247280890048, 0.9694927236316476,
0.9674110987902749, 0.9660832746299768, 0.9655588506787406, 0.9609233707310761,
0.9584129703936736, 0.9516967249450189]

```

```

@ Main /Users/vvv/Julia/JuliaWorkshop/notebooks/Feature_Extraction/Feature_Ext
raction_COVID-19.ipynb:3

```

```

10-element Vector{String}:

```

```

"KY Lee"
"KY Leslie"
"KY Owsley"
"KY Breathitt"
"KY Martin"
"KY Letcher"
"KY Powell"
"KY Floyd"
"KY Estill"
"KY Elliott"

```

Signal one is made up of mostly non-hispanic white counties with high unemployment rates.

The counties representing signal one seem to be mostly rural areas.

Now let us look at signal 2.

```

[11]: sort!(df, [:S2], rev = true).S2;
@show(df.S2[1:20])
#df.Name[1:10]
[df.Name[s][25:end] for s in 1:1:20]

```

```

df.S2[1:20] = [1.0, 0.939229276599239, 0.8055552382714836, 0.7245498538608375,
0.6332523701250201, 0.48391347987640054, 0.4390362183588679, 0.4270747704420052,
0.42640161690266964, 0.4058666109270065, 0.3978918887550099,

```


0.39142434830394196, 0.38868460985456504, 0.37413067834139213,
0.3599491793995473, 0.35725203750649337, 0.33838657210869216,
0.33835834801429215, 0.33832435111962644, 0.33832307236082154]

20-element Vector{String}:

```
" 'COVID-19 (08-31-2020)' | VARIABLE: 'Death rate (per million)' | UNITS:↵
↵'Rate' | COVERAGE: '100.0%'"
" 'COVID-19 (08-31-2020)' | VARIABLE: 'Case rate (per million)' | UNITS:↵
↵'Rate' | COVERAGE: '100.0%'"
" 'COVID-19 (07-27-2020)' | VARIABLE: 'Death rate (per million)' | UNITS:↵
↵'Rate' | COVERAGE: '100.0%'"
" 'COVID-19 (07-27-2020)' | VARIABLE: 'Case rate (per million)' | UNITS:↵
↵'Rate' | COVERAGE: '100.0%'"
" 'COVID-19 (06-17-2020)' | VARIABLE: 'Death rate (per million)' | UNITS:↵
↵'Rate' | COVERAGE: '100.0%'"
" 'COVID-19 (07-27-2020)' | VARIABLE: 'Worst week - deaths (weekly deaths per↵
↵million)' | UNITS: 'Rate' | COVERAGE: '70.5%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'EPL_MINRTY' | UNITS: 'Rate' | ↵
↵COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'RPL_THEME3' | UNITS: 'Rate' | ↵
↵COVERAGE: '100.0%'"
"'COVID Community Vulnerability Index' | VARIABLE: 'THEME 3: \nMinority Status↵
↵& Language' | UNITS: 'Index' | COVERAGE: '100.0%'"
" 'COVID-19 (06-17-2020)' | VARIABLE: 'Case rate (per million)' | UNITS:↵
↵'Rate' | COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'SPL_THEME3' | UNITS: 'Rate' | ↵
↵COVERAGE: '100.0%'"
"'COVID-19 (05-07-2020)' | VARIABLE: 'Death rate (per million)' | UNITS:↵
↵'Rate' | COVERAGE: '100.0%'"
" 'COVID-19 (06-17-2020)' | VARIABLE: 'Worst week - deaths (weekly deaths per↵
↵million)' | UNITS: 'Rate' | COVERAGE: '59.9%'"
"'US Polciy Database' | VARIABLE: 'RACEDEAT Report deaths by race/ethnicity↵
↵race_deaths attribute flag' | UNITS: 'Classification' | COVERAGE: '100.0%'"
" 'COVID-19 (08-31-2020)' | VARIABLE: 'Worst week - deaths (weekly deaths per↵
↵million)' | UNITS: 'Rate' | COVERAGE: '79.3%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'EPL_LIMENG' | UNITS: 'Rate' | ↵
↵COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'RPL_THEMES' | UNITS: 'Rate' | ↵
↵COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'EPL_UNEMP' | UNITS: 'Rate' | ↵
↵COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'RPL_THEME1' | UNITS: 'Rate' | ↵
↵COVERAGE: '100.0%'"
"'CDC Social Vulnerabilty Index' | VARIABLE: 'EPL_POV' | UNITS: 'Rate' | ↵
↵COVERAGE: '100.0%'"
```

```
[12]: sort!(counties, [:S2], rev = true).S2;
@info(counties.S2[1:10])
counties.Name[1:10]
```

```
Info: [1.0, 0.948828994907748, 0.9301617149164393, 0.9273224323604071,
0.9257504815323512, 0.9227811908177095, 0.9034471255858552, 0.8989057845711288,
0.8976282640400252, 0.8938270285998805]
```

```
@ Main /Users/vvv/Julia/JuliaWorkshop/notebooks/Feature_Extraction/Feature_Ext
raction_COVID-19.ipynb:2
```

```
10-element Vector{String}:
```

```
"GA Randolph"
"GA Hancock"
"NJ Essex"
"GA Terrell"
"NY Bronx"
"VA Emporia City"
"PA Philadelphia"
"NJ Passaic"
"TN Trousdale"
"NM McKinley"
```

```
[13]: Mnl = log10.(Mn)
Mnl[isinf.(Mnl)] .= -8
Mnln, nlnmin, nlnmax = NMFk.normalizematrix_col!(Mnl)
Mn_COVID = Mnln
Mn_COVID[:,3:18] = Mn_COVID[:,3:18]*10
```

```
3142×16 Matrix{Float32}:
```

```
 7.70753  8.06669  7.10682    8.46708  ...  8.83412  8.18404    8.45076
 7.62669  7.64476  6.93738    7.9943   ...  8.45627  8.31898    7.8538
 8.00019  7.93069  7.46981    8.52674   ...  8.65422  8.31266    8.07299
 8.00429  0.0      7.51683    0.0        ...  8.76568  8.2362     8.46396
 7.53517  0.0      6.95139    0.0        ...  8.46158  8.21082    8.14648
 7.96826  8.3619   7.45886    0.0        ...  9.41991  8.86014    9.00068
 8.60621  8.38025  8.37423    0.0        ...  9.57275  8.47337    8.96517
 7.69115  7.72422  7.2065     0.0        ...  8.70784  8.35025    8.22811
 8.76045  9.2785   8.28749    0.0        ...  9.35152  8.24976    8.80722
 7.5084   0.0      6.91103    0.0        ...  8.88566  8.00976    8.31106

 6.06137  0.0      6.08211  NaN        ...  0.0      7.74097  NaN
 0.0      0.0      0.0      0.0        ...  8.23582  6.74389    8.52965
 7.23958  0.0      6.92584  NaN        ...  7.61341  7.71793    7.88902
 6.58658  0.0      6.60732  NaN        ...  8.1595   7.79259    8.45217
 7.08103  0.0      6.57163  NaN        ...  7.78933  7.68737    8.02913
 8.19577  7.95519  7.67912    8.55123  ...  7.73972  8.2794     8.0212
 7.10307  0.0      6.78933  NaN        ...  8.14586  8.25014    8.43829
 7.47458  0.0      7.38764  NaN        ...  9.0475   8.30245    8.94166
 0.0      0.0      0.0      0.0        ...  0.0      7.57095  NaN
```



```

"COLUMN: 677 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE: 'EPL_POV'
↳| UNITS: 'Rate' | COVERAGE: '100.0%'"
↳
↳
... 0.6645
"COLUMN: 679 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE: 'EPL_PCI'
↳| UNITS: 'Rate' | COVERAGE: '100.0%'"
↳
↳
0.664493
"COLUMN: 682 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE:
↳'RPL_THEME1' | UNITS: 'Rate' | COVERAGE: '100.0%'"
↳
↳
0.664481
"COLUMN: 701 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE:
↳'RPL_THEMES' | UNITS: 'Rate' | COVERAGE: '100.0%'"
↳
↳
0.664419
"COLUMN: 703 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE: 'F_UNEMP'
↳| UNITS: 'Rate' | COVERAGE: '100.0%'"
↳
↳
0.66426
↳
↳
↳
↳
"COLUMN: 803 | CATEGORY: 'US Polciy Database' | VARIABLE: 'CLSCHOOL Date closed
↳K-12 schools school_closure start date' | UNITS: 'Date' | COVERAGE: '98.2%'"
↳
↳
0.0
"COLUMN: 842 | CATEGORY: 'US Polciy Database' | VARIABLE: 'VISITPER Stopped
↳personal visitation in state prisons visit_personal start date' | UNITS:
↳'Date' | COVERAGE: '100.0%'"
↳
0.0
"COLUMN: 780 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳'total_jail_from_bop' | UNITS: 'Total Population' | COVERAGE: '94.4%'"
↳
↳
... 0.0
"COLUMN: 843 | CATEGORY: 'US Polciy Database' | VARIABLE: 'VISITATT Stopped
↳in-person attorney visits in state prisons visit_attorney start date' | UNITS:
↳'Date' | COVERAGE: '29.8%'"
↳
0.0
"COLUMN: 848 | CATEGORY: 'US Polciy Database' | VARIABLE: 'ELECPRCR Suspended
↳elective medical/dental procedures elective_medical end date' | UNITS: 'Date'
↳| COVERAGE: '70.2%'"
↳
0.0

```

```

"COLUMN: 867 | CATEGORY: 'US Polciy Database' | VARIABLE: 'WVDEAREQ Waive
↪requirement to obtain separate DEA registration to dispense outside home state
↪waive_rx_registration start date' | UNITS: 'Date' | COVERAGE: '0.5%'"
↪
0.0
"COLUMN: 829 | CATEGORY: 'US Polciy Database' | VARIABLE: 'MORGFR Froze
↪mortgage payments mortgage_freeze start date' | UNITS: 'Date' | COVERAGE: '2.
↪0%'"
↪
0.0
"COLUMN: 850 | CATEGORY: 'US Polciy Database' | VARIABLE: 'WTPRD Prior to
↪pandemic, no state unemployment waiting period; or date waiting period waived
↪not found unemployment_waiting start date' | UNITS: 'Date' | COVERAGE: '0.
↪0%'"
... 0.0
"COLUMN: 864 | CATEGORY: 'US Polciy Database' | VARIABLE: 'HMDLVOP Home
↪delivery of take-home medication by opioid treatment programs opioid_delivery
↪start date' | UNITS: 'Date' | COVERAGE: '0.2%'"
↪
0.0

224×2 Matrix{Any}:
"COLUMN: 467 | CATEGORY: 'COVID Community Vulnerability Index' | VARIABLE:
↪'THEME 1: Socioeconomic Status' | UNITS: 'Index' | COVERAGE: '100.0%'"
↪
... 1.0
"COLUMN: 473 | CATEGORY: 'COVID Community Vulnerability Index' | VARIABLE:
↪'CCVI SCORE\nHigher = More Vulnerable' | UNITS: 'Index' | COVERAGE: '100.0%'"
↪
0.918963
"COLUMN: 680 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE:
↪'EPL_NOHSDP' | UNITS: 'Rate' | COVERAGE: '100.0%'"
↪
0.918295
"COLUMN: 694 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE:
↪'EPL_MOBILE' | UNITS: 'Rate' | COVERAGE: '100.0%'"
↪
0.817166
"COLUMN: 688 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE:
↪'RPL_THEME2' | UNITS: 'Rate' | COVERAGE: '100.0%'"
↪
0.812817
"COLUMN: 468 | CATEGORY: 'COVID Community Vulnerability Index' | VARIABLE:
↪'THEME 2:\nHousehold Composition & Disability' | UNITS: 'Index' | COVERAGE:
↪'100.0%'"
... 0.771103
"COLUMN: 685 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE:
↪'EPL_DISABL' | UNITS: 'Rate' | COVERAGE: '100.0%'"
↪
0.760656

```

"COLUMN: 861 | CATEGORY: 'US Polciy Database' | VARIABLE: 'LMABRN Made Effort
↳to Limit Abortion Access abortion_limit note text' | UNITS: 'Classification'
↳| COVERAGE: '100.0%'" 0.703488

"COLUMN: 872 | CATEGORY: 'US Polciy Database' | VARIABLE: 'POV18 Percent living
↳under the federal poverty line (2018) poverty quantity percent' | UNITS:
↳'Rate' | COVERAGE: '100.0%'" 0.665191

"COLUMN: 324 | CATEGORY: 'County Health Rankings & Roadmaps ([http://www.
↳countyhealthrankings.org/explore-health-rankings](http://www.countyhealthrankings.org/explore-health-rankings))' | VARIABLE: 'Children
↳eligible for free or reduced price lunch' | UNITS: '% Free or Reduced Lunch'
↳| COVERAGE: '99.4%'" 0.659887

↳

↳

↳

"COLUMN: 756 | CATEGORY: 'Medicare Reimbursements' | VARIABLE: 'Hospice
↳reimbursements per enrollee (2014) Price, age, sex & race-adjusted' | UNITS:
↳'\\$/enrollee' | COVERAGE: '91.6%'" ... 0.010187

"COLUMN: 777 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳'total_jail_from_other_jail' | UNITS: 'Total Population' | COVERAGE: '94.4%'" 0.00795612

↳

"COLUMN: 782 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳'total_jail_from_marshalls' | UNITS: 'Total Population' | COVERAGE: '94.4%'" 0.00772972

↳

"COLUMN: 574 | CATEGORY: 'IHME Respiratory Disease Mortality' | VARIABLE:
↳'Mortality Rate, 2014* Coal workers pneumoconiosis' | UNITS: 'Rate' |
↳COVERAGE: '100.0%'" 0.00760292

"COLUMN: 778 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳'total_jail_from_fed' | UNITS: 'Total Population' | COVERAGE: '94.4%'" 0.00635188

↳

"COLUMN: 757 | CATEGORY: 'Medicare Reimbursements' | VARIABLE: 'Durable medical
↳equipment reimbursements per enrollee (2014) Age, sex & race-adjusted' | UNITS:
↳'\\$/enrollee' | COVERAGE: '99.7%'" ... 0.00496464

"COLUMN: 419 | CATEGORY: 'BGSU Marriage and Divorce (2000 and 2010)' | VARIABLE:
↳'Adjusted Divorce Rate (2000)' | UNITS: 'per 1,000' | COVERAGE: '99.1%'" 0.00486767

↳

```

"COLUMN: 790 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳ 'female_jail_pop_rate' | UNITS: 'Total Population' | COVERAGE: '93.5%'
↳
0.00397553
"COLUMN: 783 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳ 'total_jail_from_other_fed' | UNITS: 'Total Population' | COVERAGE: '94.4%'
↳
0.00336221

107×2 Matrix{Any}:
"COLUMN: 817 | CATEGORY: 'US Polciy Database' | VARIABLE: 'GUNOPEN Keep
↳ Firearms Sellers Open business_firearm_exempt attribute flag' | UNITS:
↳ 'Classification' | COVERAGE: '100.0%' ... 1.0
"COLUMN: 336 | CATEGORY: 'County Health Rankings & Roadmaps (http://www.
↳ countyhealthrankings.org/explore-health-rankings)' | VARIABLE: 'Demographics'
↳ | UNITS: '% Non-Hispanic White' | COVERAGE: '100.0%' 0.894406
"COLUMN: 372 | CATEGORY: 'Yale Climate Opinion' | VARIABLE: 'personalOppose' |
↳ UNITS: '% ' | COVERAGE: '100.0%'
↳
0.892216
"COLUMN: 21 | CATEGORY: '2016 ELECTION' | VARIABLE: ' ' | UNITS: '(%)' |
↳ COVERAGE: '100.0%'
↳
0.877508
"COLUMN: 339 | CATEGORY: 'County Health Rankings & Roadmaps (http://www.
↳ countyhealthrankings.org/explore-health-rankings)' | VARIABLE: 'Demographics'
↳ | UNITS: '% Rural' | COVERAGE: '99.8%' 0.844947
"COLUMN: 203 | CATEGORY: 'USDA-ERS Urban-Rural Influence' | VARIABLE:
↳ 'RUCC_2013' | UNITS: '(#)' | COVERAGE: '99.9%'
↳
... 0.83869
"COLUMN: 370 | CATEGORY: 'Yale Climate Opinion' | VARIABLE: 'harmUSOppose' |
↳ UNITS: '% ' | COVERAGE: '100.0%'
↳
0.832462
"COLUMN: 368 | CATEGORY: 'Yale Climate Opinion' | VARIABLE: 'devharmOppose' |
↳ UNITS: '% ' | COVERAGE: '100.0%'
↳
0.817081
"COLUMN: 362 | CATEGORY: 'Yale Climate Opinion' | VARIABLE: 'worriedOppose' |
↳ UNITS: '% ' | COVERAGE: '100.0%'
↳
0.769432
"COLUMN: 374 | CATEGORY: 'Yale Climate Opinion' | VARIABLE: 'timingOppose' |
↳ UNITS: '% ' | COVERAGE: '100.0%'
↳
0.765579
↳
↳
↳
"COLUMN: 796 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳ 'white_jail_pop_rate' | UNITS: 'Total Population' | COVERAGE: '94.4%'
↳
0.
↳ 00501279

```

```

"COLUMN: 794 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳ 'latinx_jail_pop_rate' | UNITS: 'Total Population' | COVERAGE: '94.4%'"
↳
0.
↳00434213
"COLUMN: 792 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳ 'aapi_jail_pop_rate' | UNITS: 'Total Population' | COVERAGE: '94.1%'"
↳
... 0.
↳00416409
"COLUMN: 415 | CATEGORY: 'BGSU Marriage and Divorce (2000 and 2010)' | VARIABLE:
↳ 'Crude Divorce Rate (2000)' | UNITS: 'per 1,000' | COVERAGE: '99.1%'"
↳
0.00392566
"COLUMN: 797 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳ 'total_jail_adm_rate' | UNITS: 'Total Population' | COVERAGE: '93.5%'"
↳
0.
↳00361789
"COLUMN: 781 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳ 'total_jail_from_ice' | UNITS: 'Total Population' | COVERAGE: '94.4%'"
↳
0.
↳00315572
"COLUMN: 789 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳ 'total_jail_pop_rate' | UNITS: 'Total Population' | COVERAGE: '94.3%'"
↳
0.
↳00263793
"COLUMN: 798 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳ 'total_jail_pretrial_rate' | UNITS: 'Total Population' | COVERAGE: '94.4%'"
↳
... 0.
↳00246455
"COLUMN: 793 | CATEGORY: 'Incarceration Trends' | VARIABLE:
↳ 'black_jail_pop_rate' | UNITS: 'Total Population' | COVERAGE: '94.3%'"
↳
0.
↳00242613

179×2 Matrix{Any}:
"COLUMN: 692 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE:
↳ 'RPL_THEME3' | UNITS: 'Rate' | COVERAGE: '100.0%'"
↳
...
↳ 1.0
"COLUMN: 469 | CATEGORY: 'COVID Community Vulnerability Index' | VARIABLE:
↳ 'THEME 3: \nMinority Status & Language' | UNITS: 'Index' | COVERAGE: '100.
↳0%'"
↳0.963215
"COLUMN: 690 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE:
↳ 'EPL_LIMENG' | UNITS: 'Rate' | COVERAGE: '100.0%'"
↳
0.943092

```


"COLUMN: 691 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE: ┐
↪ 'SPL_THEME3' | UNITS: 'Rate' | COVERAGE: '100.0%' " ┐
↪ ┐
↪ 0.935204 ┐
"COLUMN: 689 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE: ┐
↪ 'EPL_MINRTY' | UNITS: 'Rate' | COVERAGE: '100.0%' " ┐
↪ ┐
↪ 0.890508 ┐
"COLUMN: 693 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE: ┐
↪ 'EPL_MUNIT' | UNITS: 'Rate' | COVERAGE: '100.0%' " ┐
↪ ┐
↪ 0.794264 ┐
"COLUMN: 256 | CATEGORY: 'County Health Rankings & Roadmaps (<http://www.countyhealthrankings.org/explore-health-rankings>)' | VARIABLE: 'Access to ┐
↪ exercise opportunities' | UNITS: '% With Access' | COVERAGE: '99.8%' " ┐
↪ 0.668412 ┐
"COLUMN: 353 | CATEGORY: 'Yale Climate Opinion' | VARIABLE: 'happening' | UNITS: ┐
↪ '%' | COVERAGE: '100.0%' " ┐
↪ ┐
↪ 0.66375 ┐
"COLUMN: 363 | CATEGORY: 'Yale Climate Opinion' | VARIABLE: 'harmplants' | ┐
↪ UNITS: '%' | COVERAGE: '100.0%' " ┐
↪ ┐
↪ 0. ┐
↪ 661831 ┐
"COLUMN: 391 | CATEGORY: 'Yale Climate Opinion' | VARIABLE: 'teachGW' | UNITS: ┐
↪ '%' | COVERAGE: '100.0%' " ┐
↪ ┐
↪ 0.65792 ┐
↪ ┐
↪ ┐
↪ ┐
"COLUMN: 784 | CATEGORY: 'Incarceration Trends' | VARIABLE: ┐
↪ 'jail_rated_capacity' | UNITS: 'Total Population' | COVERAGE: '94.4%' " ┐
↪ ┐
↪ ... 0.00854785 ┐
"COLUMN: 334 | CATEGORY: 'County Health Rankings & Roadmaps (<http://www.countyhealthrankings.org/explore-health-rankings>)' | VARIABLE: 'Demographics' ┐
↪ | UNITS: '% Native Hawaiian/Other Pacific Islander' | COVERAGE: '100.0%' " ┐
↪ 0.00827666 ┐
"COLUMN: 775 | CATEGORY: 'Incarceration Trends' | VARIABLE: ┐
↪ 'total_jail_pretrial' | UNITS: 'Total Population' | COVERAGE: '94.4%' " ┐
↪ ┐
↪ 0.00723625 ┐
"COLUMN: 766 | CATEGORY: 'Incarceration Trends' | VARIABLE: ┐
↪ 'female_juvenile_jail_pop' | UNITS: 'Total Population' | COVERAGE: '93.3%' " ┐
↪ ┐
↪ 0.00714284 ┐

"COLUMN: 86 | CATEGORY: 'ESRI COUNTIES DATA (2015)' | VARIABLE: 'Popn: Hawaii/
 ↳PI' | UNITS: '(count)'' | COVERAGE: '100.0%'" 0. ↳

↳00606104

"COLUMN: 735 | CATEGORY: 'Medicare County Rates' | VARIABLE: 'Average annual
 ↳percent of diabetic Medicare enrollees age 65-75 having blood lipids (LDL-C) ↳
 ↳test (2015) Overall' | UNITS: 'Rate'' | COVERAGE: '97.9%'" ... 0. ↳

↳00384082

"COLUMN: 734 | CATEGORY: 'Medicare County Rates' | VARIABLE: 'Average annual
 ↳percent of diabetic Medicare enrollees age 65-75 having eye examination (2015) ↳
 ↳Overall' | UNITS: 'Rate'' | COVERAGE: '97.6%'" 0. ↳

↳00376193

"COLUMN: 774 | CATEGORY: 'Incarceration Trends' | VARIABLE: ↳
 ↳'other_race_jail_pop' | UNITS: 'Total Population'' | COVERAGE: '94.3%'" ↳

↳

↳ 0.00285079 ↳

"COLUMN: 779 | CATEGORY: 'Incarceration Trends' | VARIABLE: ↳
 ↳'total_jail_from_bia' | UNITS: 'Total Population'' | COVERAGE: '94.4%'" ↳

↳

↳ 0.0020975 ↳

32x2 Matrix{Any}:

"COLUMN: 1011 | CATEGORY: 'COVID-19 (08-31-2020)' | VARIABLE: 'Death rate (per
 ↳million)' | UNITS: 'Rate'' | COVERAGE: '100.0%'" ↳

↳ ... 1.0

"COLUMN: 1007 | CATEGORY: 'COVID-19 (07-27-2020)' | VARIABLE: 'Death rate (per
 ↳million)' | UNITS: 'Rate'' | COVERAGE: '100.0%'" ↳

↳ 0.889586

"COLUMN: 1003 | CATEGORY: 'COVID-19 (06-17-2020)' | VARIABLE: 'Death rate (per
 ↳million)' | UNITS: 'Rate'' | COVERAGE: '100.0%'" ↳

↳ 0.699747

"COLUMN: 1010 | CATEGORY: 'COVID-19 (08-31-2020)' | VARIABLE: 'Case rate (per
 ↳million)' | UNITS: 'Rate'' | COVERAGE: '100.0%'" ↳

↳ 0.58381

"COLUMN: 1006 | CATEGORY: 'COVID-19 (07-27-2020)' | VARIABLE: 'Case rate (per
 ↳million)' | UNITS: 'Rate'' | COVERAGE: '100.0%'" ↳

↳ 0.535139

"COLUMN: 1009 | CATEGORY: 'COVID-19 (07-27-2020)' | VARIABLE: 'Worst week -
 ↳deaths (weekly deaths per million)' | UNITS: 'Rate'' | COVERAGE: '70.5%'" ↳

↳ ... 0.531842

"COLUMN: 999 | CATEGORY: 'COVID-19 (05-07-2020)' | VARIABLE: 'Death rate (per
 ↳million)' | UNITS: 'Rate'' | COVERAGE: '100.0%'" ↳

↳ 0.432526

"COLUMN: 1005 | CATEGORY: 'COVID-19 (06-17-2020)' | VARIABLE: 'Worst week -
 ↳deaths (weekly deaths per million)' | UNITS: 'Rate'' | COVERAGE: '59.9%'" ↳

↳ 0.429182

"COLUMN: 1002 | CATEGORY: 'COVID-19 (06-17-2020)' | VARIABLE: 'Case rate (per
 ↪million)' | UNITS: 'Rate' | COVERAGE: '100.0%'" 0.403254

"COLUMN: 1013 | CATEGORY: 'COVID-19 (08-31-2020)' | VARIABLE: 'Worst week -
 ↪deaths (weekly deaths per million)' | UNITS: 'Rate' | COVERAGE: '79.3%'" 0.345981

↪

↪

"COLUMN: 846 | CATEGORY: 'US Polciy Database' | VARIABLE: 'NOPAYALL Waived all
 ↪copays during pandemic for incarcerated individuals waive_allcopay attribute
 ↪flag' | UNITS: 'Classification' | COVERAGE: '100.0%'" 0.0371921

"COLUMN: 710 | CATEGORY: 'CDC Social Vulnerabilty Index' | VARIABLE:
 ↪'F_SNGPNT' | UNITS: 'Rate' | COVERAGE: '100.0%'" 0.0294057

"COLUMN: 462 | CATEGORY: 'Religion Rates (2010) ([http://www.usreligioncensus.
 ↪org/](http://www.usreligioncensus.org/))' | VARIABLE: 'Black Protestant' | UNITS: 'per 1,000' | COVERAGE: '47.
 ↪8%'" ... 0.0257933

"COLUMN: 308 | CATEGORY: 'County Health Rankings & Roadmaps ([http://www.
 ↪countyhealthrankings.org/explore-health-rankings](http://www.countyhealthrankings.org/explore-health-rankings))' | VARIABLE: 'HIV
 ↪prevalence' | UNITS: 'HIV Prevalence Rate' | COVERAGE: '77.1%'" 0.
 ↪0228768

"COLUMN: 81 | CATEGORY: 'ESRI COUNTIES DATA (2015)' | VARIABLE: 'Popn density
 ↪(2010)' | UNITS: 'ppl/mi2' | COVERAGE: '100.0%'" 0.00239256

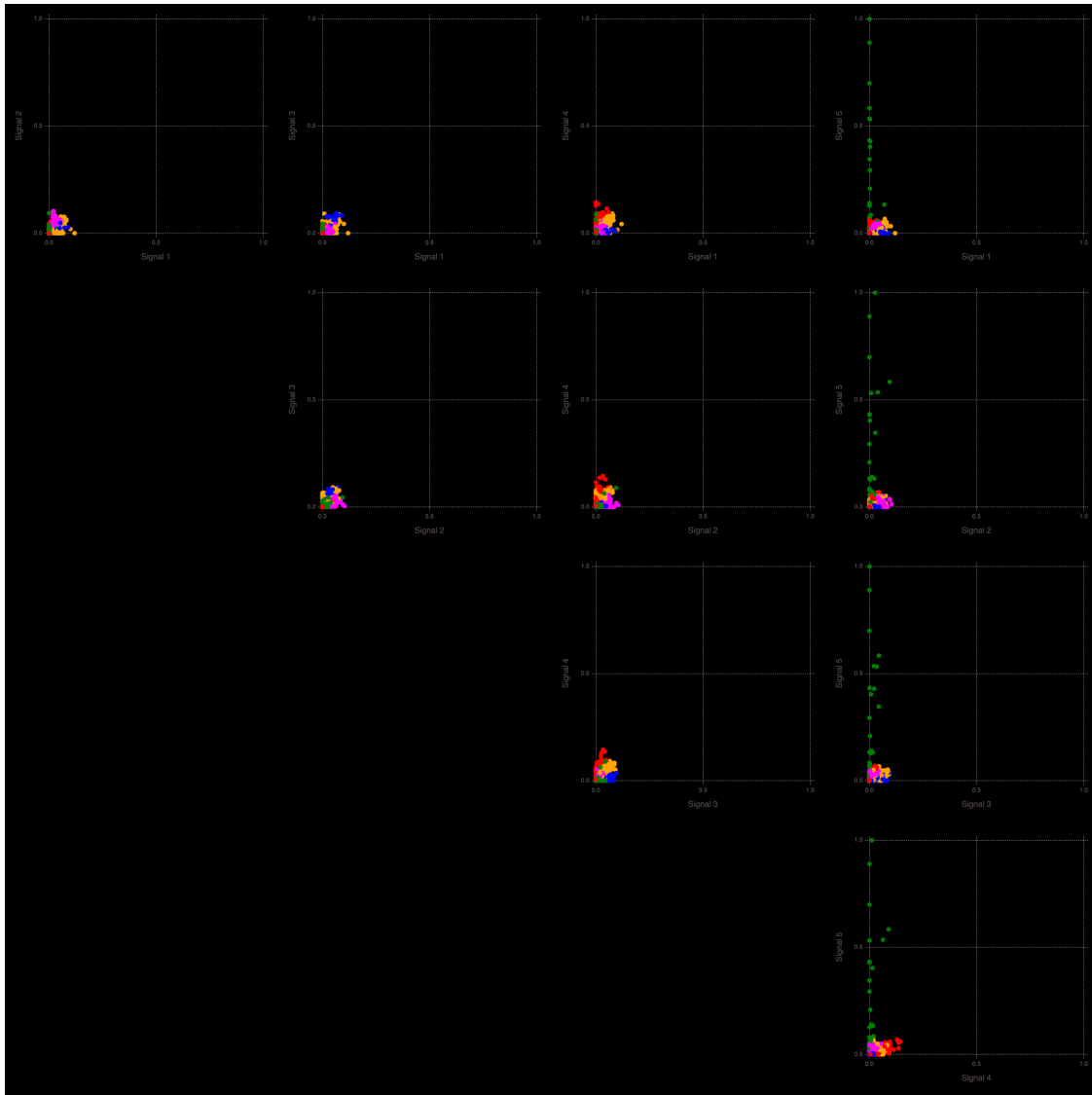
"COLUMN: 79 | CATEGORY: 'ESRI COUNTIES DATA (2015)' | VARIABLE: 'Popn density
 ↪(2015)' | UNITS: 'ppl/mi2' | COVERAGE: '100.0%'" 0.002361

"COLUMN: 776 | CATEGORY: 'Incarceration Trends' | VARIABLE:
 ↪'total_jail_from_prison' | UNITS: 'Total Population' | COVERAGE: '94.4%'" 0.
 ↪00172575

"COLUMN: 785 | CATEGORY: 'Incarceration Trends' | VARIABLE: 'private_jail_flag'
 ↪| UNITS: 'Total Population' | COVERAGE: '97.6%'" ... 0.00154816

"COLUMN: 437 | CATEGORY: 'Cities' | VARIABLE: 'LargetCity-County popn ratio' |
 ↪UNITS: 'ppl/mi2' | COVERAGE: '96.9%'" 0.000480029

↪



Info: Robust k-means analysis results are saved in file results-naff-COVID/Wmatrix-5-5_3142-1000.jld!

@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkCluster.jl:100

Info: Signal A -> A Count: 262

@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:316

Info: Signal B -> B Count: 224

@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:316

Info: Signal D -> C Count: 107

@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:316

Info: Signal C -> D Count: 179

@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:316

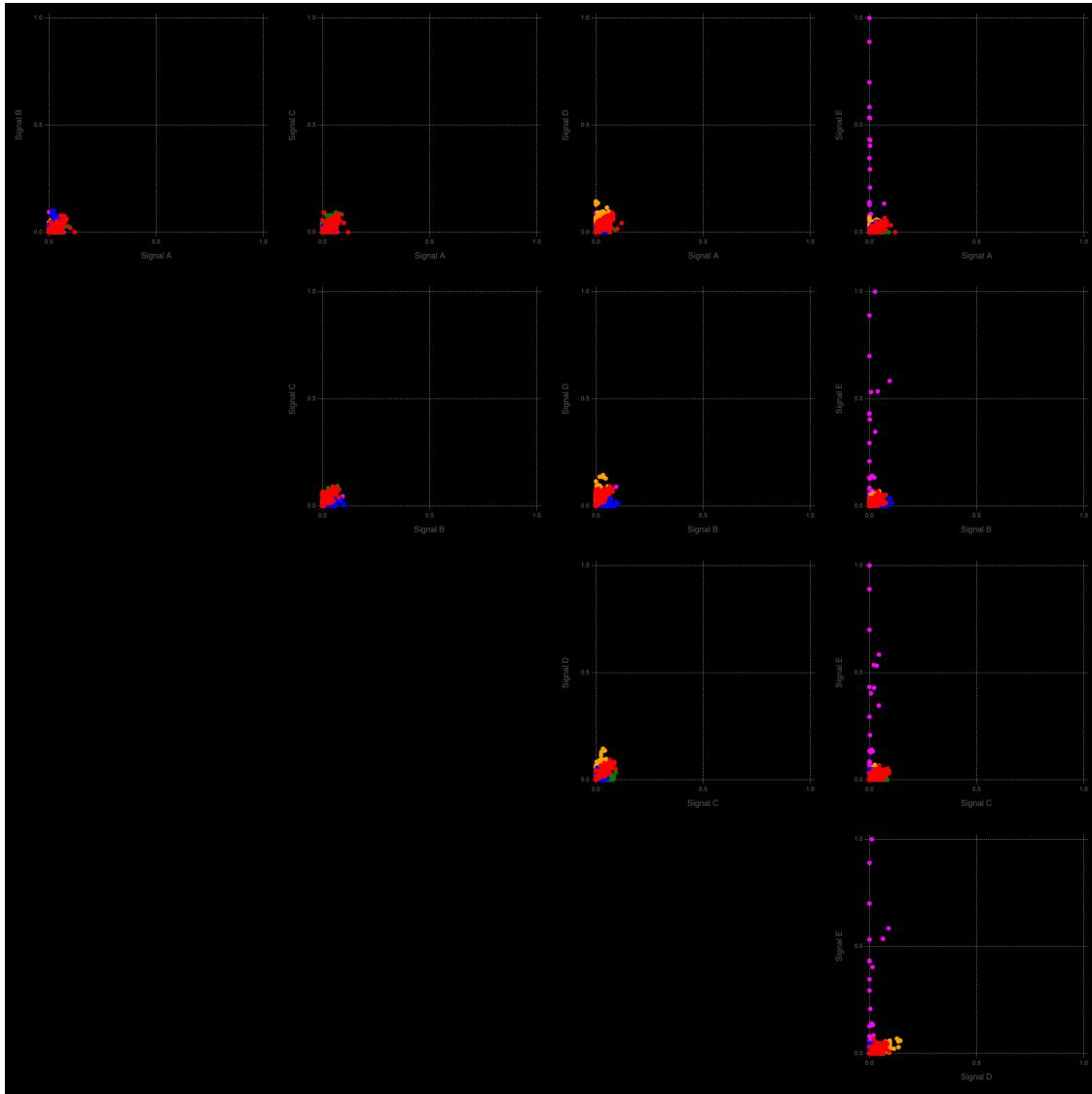
Info: Signal E -> E Count: 32

@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:316

```

Info: Signal A (S1) (k-means clustering)
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:333
Info: Signal B (S2) (k-means clustering)
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:333
Info: Signal C (S3) (k-means clustering)
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:333
Info: Signal D (S4) (k-means clustering)
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:333
Info: Signal E (S5) (k-means clustering)
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:333

```



900×2 Matrix{Any}:

"IL Mcdonough"	1.0
"PA Westmoreland"	0.997728
"IL Dekalb"	0.997211
"NY Wayne"	0.985295
"IL Sangamon"	0.962425
"VT Bennington"	0.962236
"IL Monroe"	0.958234
"NY Tioga"	0.956166
"NY Genese"	0.951405
"NY Delaware"	0.946746

"CO Mesa"	0.434413
"AL Shelby"	0.433669
"ID Ada"	0.433634
"NY Kings"	0.424583
"MT Gallatin"	0.419622
"CA Modoc"	0.416435
"SC Lexington"	0.415273
"MT Lake"	0.408726
"NM San Juan"	0.3706

680×2 Matrix{Any}:

"MS Quitman"	1.0
"AL Perry"	0.99734
"MS Issaquena"	0.959835
"MS Jeff Davis"	0.951861
"AR Phillips"	0.947458
"MS Tallahatchie"	0.942861
"LA East Carroll"	0.928949
"AL Wilcox"	0.92588
"MS Sunflower"	0.916522
"AL Greene"	0.913687

"NE Dawson"	0.295635
"NE Dakota"	0.295626
"TX Brewster"	0.28631
"WA Douglas"	0.278466
"TX Midland"	0.277688
"TX Brazoria"	0.275867
"MS Madison"	0.272992
"TX Montgomery"	0.239962
"IA Buena Vista"	0.207088

719×2 Matrix{Any}:

"KS Ness"	1.0
"KS Wallace"	0.993743
"KS Hodgeman"	0.988604
"TX King"	0.974095
"KS Lane"	0.966711

"KS Scott"	0.959985
"KS Greeley"	0.958219
"KS Comanche"	0.92792
"TX Roberts"	0.920863
"KS Cheyenne"	0.92073

"AZ Yavapai"	0.351494
"FL Okaloosa"	0.34978
"ND Cass"	0.343864
"WA Klickitat"	0.338691
"NM Lincoln"	0.332411
"ID Canyon"	0.331136
"WA Kittitas"	0.323648
"IN Hamilton"	0.321755
"IA Woodbury"	0.312126

276×2 Matrix{Any}:

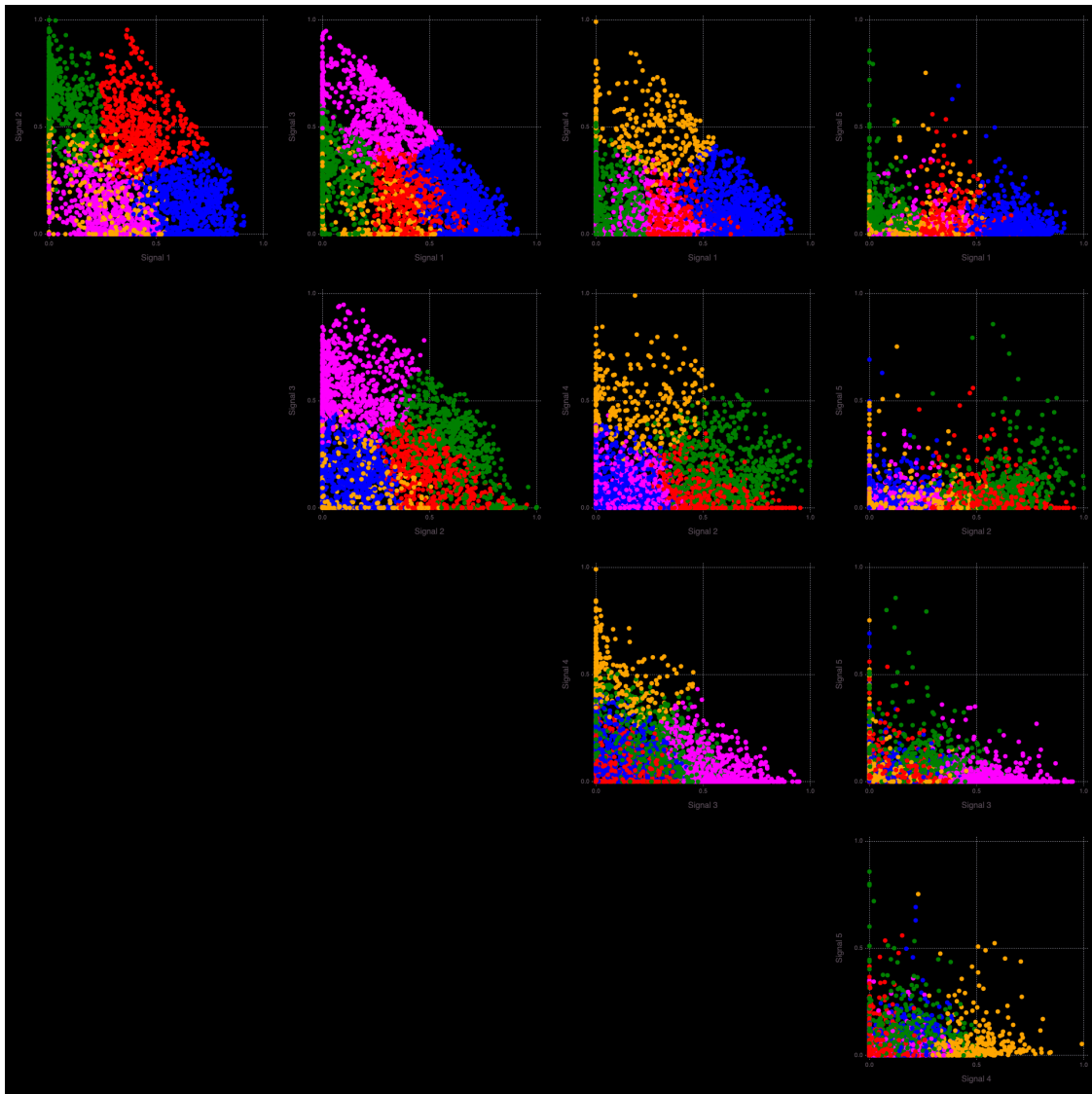
"CA Los Angeles"	1.0
"CA Alameda"	0.853052
"CA San Francisco"	0.847148
"DC DC"	0.816289
"CA Santa Clara"	0.810366
"TX Harris"	0.808336
"FL Miami-Dade"	0.804729
"CA Monterey"	0.780262
"CA San Mateo"	0.770861
"TX Dallas"	0.75118

"OH Lucas"	0.292148
"KS Shawnee"	0.284051
"LA Jefferson"	0.281467
"SC Greenville"	0.281217
"FL Seminole"	0.280955
"NV Carson City"	0.262516
"OK Cleveland"	0.241853
"IA Marshall"	0.232696
"NY Bronx"	0.229437

567×2 Matrix{Any}:

"VA Emporia City"	0.652567
"VA Galax City"	0.624952
"LA St. John The Baptist"	0.557114
"VA Northampton"	0.535653
"LA Bienville"	0.483731
"LA East Feliciana"	0.427056
"LA Iberville"	0.398824
"LA St. James"	0.394441
"AL Tallapoosa"	0.391133
"VA Greensville"	0.385561

"WV Lincoln"	0.0
"WV McDowell"	0.0
"WV Pocahontas"	0.0
"WV Raleigh"	0.0
"WV Ritchie"	0.0
"WV Summers"	0.0
"WV Webster"	0.0
"WV Wetzel"	0.0
"WV Wirt"	0.0

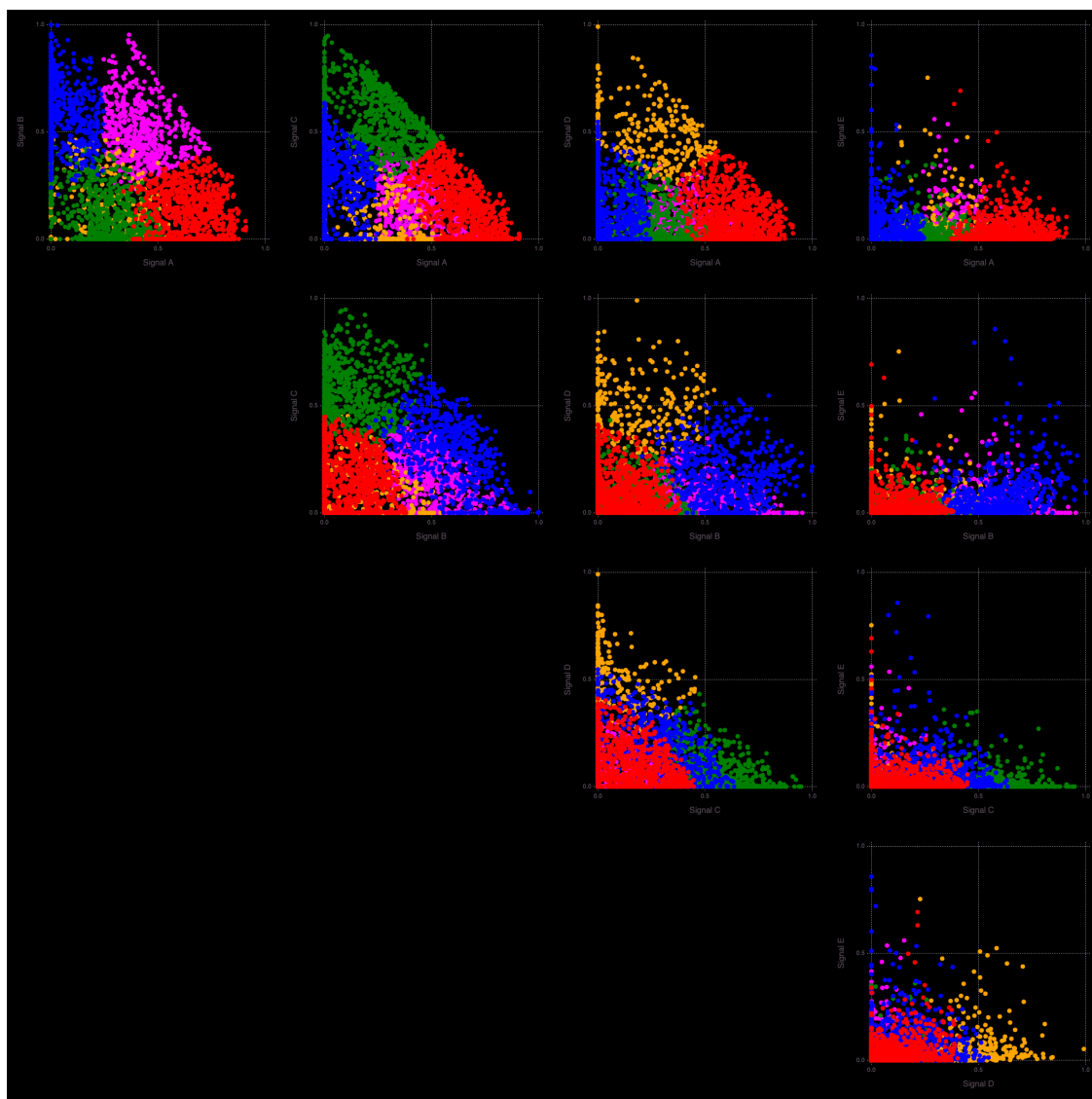


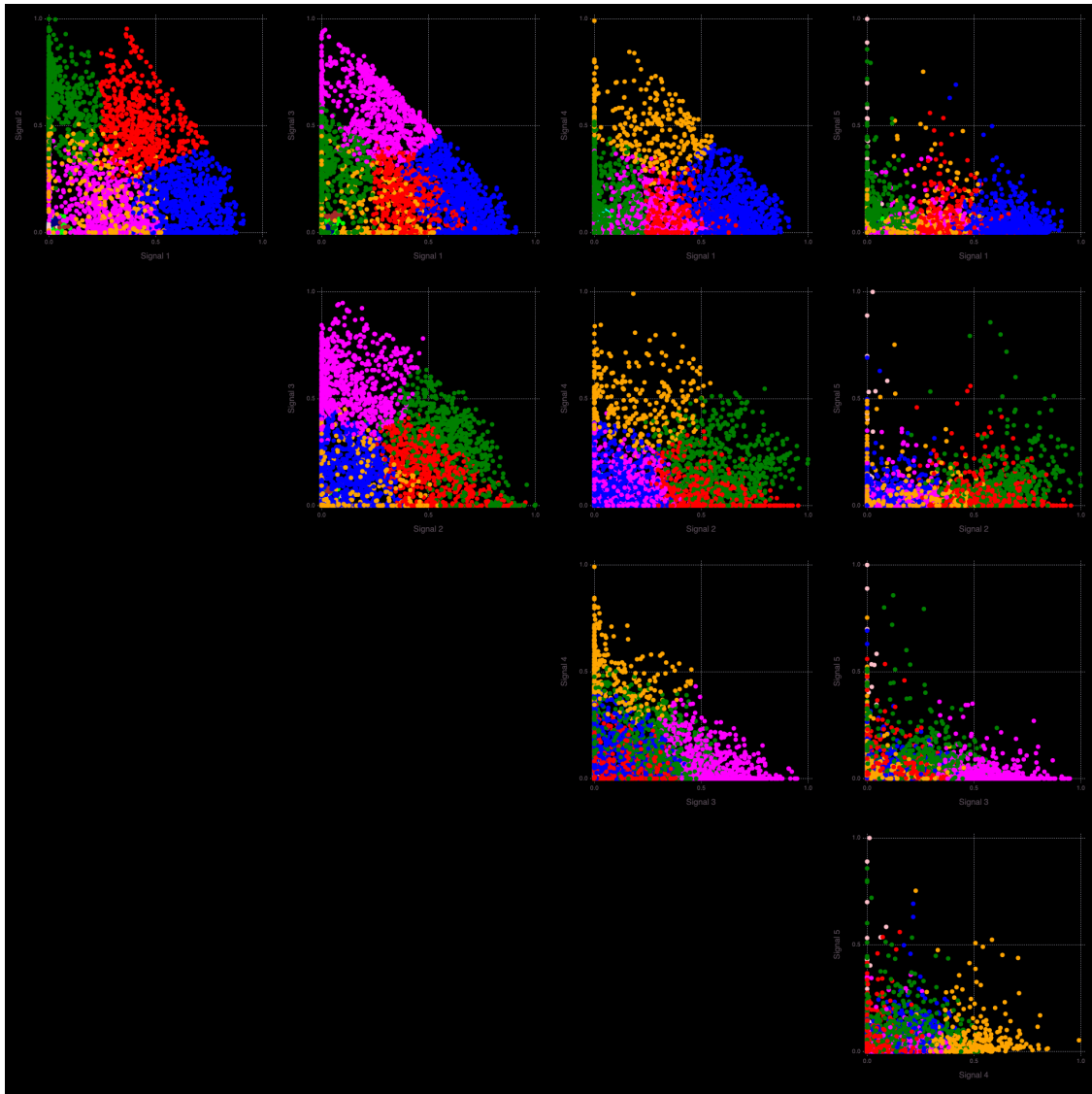
Info: Counties (signals=5)
 @ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:391
 Info: Signal A (S1) Count: 900

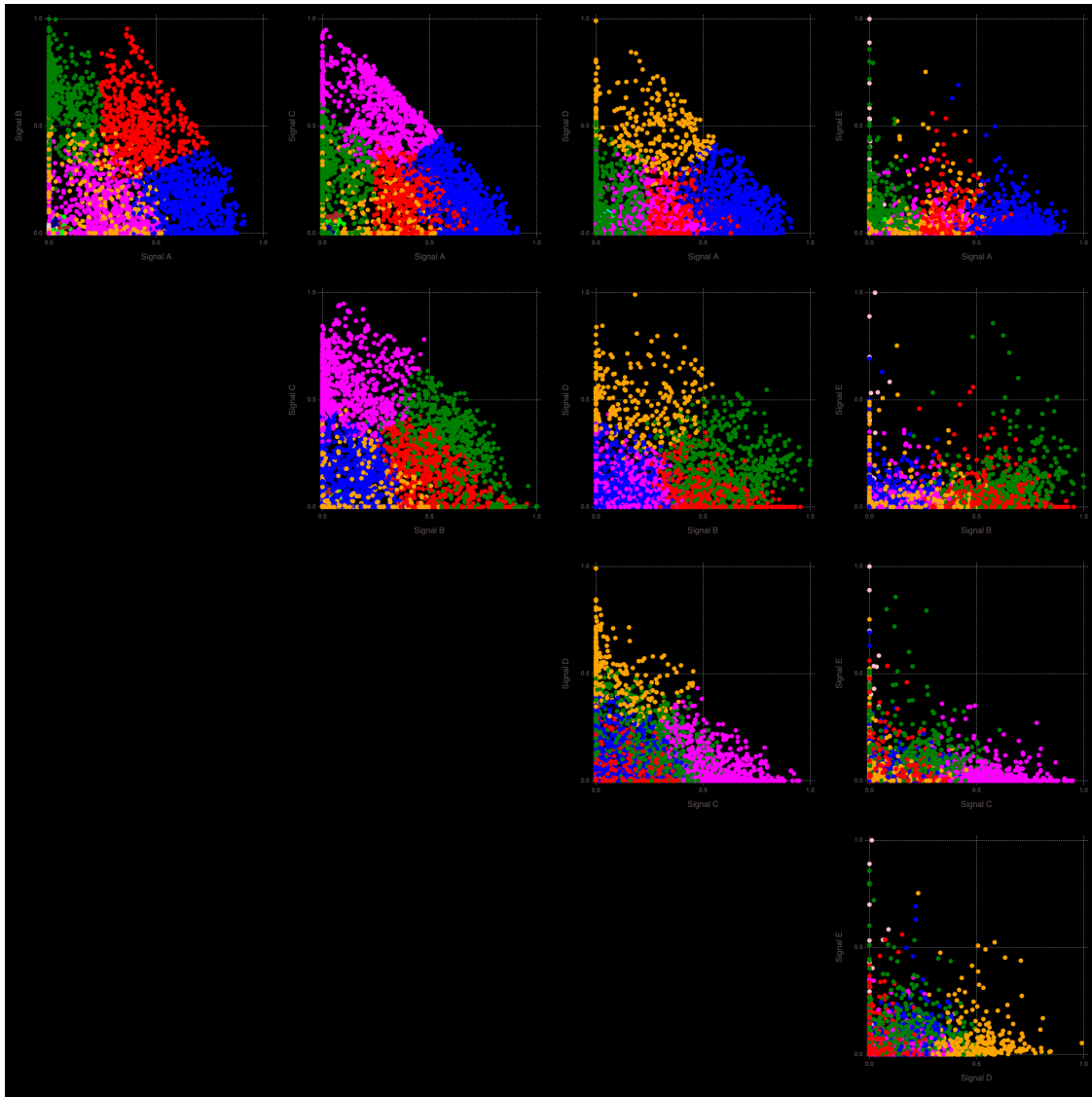

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@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:404
Info: Signal B (S3) Count: 719
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:404
Info: Signal C (S2) Count: 680
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:404
Info: Signal D (S5) Count: 567
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:404
Info: Signal E (S4) Count: 276
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:404
Info: Signal A -> A Count: 900
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:414
Info: Signal C -> B Count: 680
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:414
Info: Signal B -> C Count: 719
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:414
Info: Signal E -> D Count: 276
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:414
Info: Signal D -> E Count: 567
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:414
Info: Signal A (remapped k-means clustering)
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:429
Info: Signal B (remapped k-means clustering)
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:429
Info: Signal C (remapped k-means clustering)
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:429
Info: Signal D (remapped k-means clustering)
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:429
Info: Signal E (remapped k-means clustering)
@ NMFk /Users/vvv/.julia/dev/NMFk/src/NMFkPostprocess.jl:429

```







```
([[1, 2, 3, 4, 5]], [['E', 'A', 'B', 'E', 'E', 'B', 'E', 'E', 'E', 'E' ... 'C', ↵
↵ 'C', 'C', 'C', 'C', 'C', 'D', 'C', 'C', 'C']], [['D', 'C', 'E', 'E', 'E', 'E', ↵
↵ 'E', 'E', 'E', 'E' ... 'B', 'B', 'A', 'B', 'B', 'A', 'A', 'A', 'A']])
```