Sample Cost and Usage Analysis

This notebook provides:

- A correlation analysis of various services,
  - the assumption being that the usage (and hence the cost) of related services will grow proportionally (direct or inverse)
- A time-series prediction of the costs incurred by a specific service
  - cost projections for the service for the next few days (or other periodic cycles based on input data)
  - the further away we get from the last available data (actuals) the less accurate the prediction, this is seen in the seasonality components.

Setup and Imports

In [1]:
```
# Importing libraries
import os
import glob
import time

from IPython.display import display, HTML

import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import plotly.express as px
import plotly.graph_objs as go
import plotly.io as pio
import seaborn as sn
from prophet import Prophet
from scipy.stats import pearsonr

pio.renderers.default = "iframe"
pd.set_option("display.max_columns", None)
```

Check the directory for the files

In [2]:
```
# !dir .\may08\daily /b
```

define the list of files that will be processed in this notebook

In [3]:
```
# list of files
# KIAL-PROD-Hourly.csv
# KMBL-811-PROD-Hourly.csv
# KMBL-Logs-Hourly.csv
# KMBL-MB2-Hourly.csv
# KMBL-OU-Hourly.csv
# kmbl-prod-data-analytics-platform-Hourly.csv
# KMBL-PROD-Hourly.csv

# filepath = "./may07/hourly/"
filepath = "./may08/daily/"
# print(os.listdir(filepath))
all_files = os.listdir(filepath)
# filelist = glob.glob('./'+filepath+'/*.csv')
csv_files = [item for item in all_files if item.endswith('.csv')]
print(all_files)
filelist = csv_files
filelist
```

```
['.ipynb_checkpoints', 'KIAL-PROD-Daily.csv', 'KMBL-811-PROD-Daily.csv', 'KMBL-Logs-Daily.csv', 'KMBL-MB2-PROD-Daily.csv', 'KMBL-OU-Daily.csv', 'KMBL-PROD-Daily.csv', 'output']
```

Out[3]:
```
['KIAL-PROD-Daily.csv',
 'KMBL-811-PROD-Daily.csv',
 'KMBL-Logs-Daily.csv',
 'KMBL-MB2-PROD-Daily.csv',
 'KMBL-OU-Daily.csv',
 'KMBL-PROD-Daily.csv']
```

Helper functions

In [4]:
```
class color:
   PURPLE = '\033[95m'
   CYAN = '\033[96m'
   DARKCYAN = '\033[36m'
   BLUE = '\033[94m'
   GREEN = '\033[92m'
   YELLOW = '\033[93m'
   RED = '\033[91m'
   BOLD = '\033[1m'
   UNDERLINE = '\033[4m'
   END = '\033[0m'
```

In [5]:
```
# collapse all cleanup in a single method
def prep_data(df):
    r = df.fillna(0)[1:]
    r.rename(columns={"Service": "date-time"}, inplace=True)
    r["date-time"] = pd.to_datetime(r["date-time"])
    r.index = r["date-time"]
    # print(type(r))
    return r
```

In [6]:
```
# calculate volatility (basically Coefficient of Variation as percentage)
# std = pd.DataFrame(cur_summary.loc['std'])
# mean = pd.DataFrame(cur_summary.loc['mean'])
# assumes the two dataframes have identical indices and shapes, returns a dataframe
def compute_volatility(std, mean):
    v = std.join(mean)
    v["volatility"] = (v["std"] / v["mean"]) * 100
    v.sort_values(by="volatility", inplace=True, ascending=False)
    return v
```

In [7]:
```
def drop_totals_and_reindex(df):
    df.drop(["Total costs($)"], axis=1)
    df = df.reindex(
        columns=[
            "date-time",
            "EC2-Instances($)",
            "S3($)",
            "Relational Database Service($)",
            "EC2-Other($)",
            "Glue($)",
            "DocumentDB (with MongoDB compatibility)($)",
            "Elastic MapReduce($)",
            "CloudWatch($)",
            "VPC($)",
            "OpenSearch Service($)",
            "Redshift($)",
            "Managed Streaming for Apache Kafka($)",
            "SageMaker($)",
            "ElastiCache($)",
            "DMS($)",
            "Elastic Load Balancing($)",
            "QuickSight($)",
            "Elastic File System($)",
            "SNS($)",
            "Lambda($)",
            "Elastic Container Service for Kubernetes($)",
            "Rekognition($)",
            "Hardened Red Hat Enterprise 7 (RHEL 7)($)",
            "Step Functions($)",
            "Glacier($)",
            "DynamoDB($)",
            "Backup($)",
            "AppFlow($)",
            "Route 53($)",
            "SQS($)",
```

```
            "EC2 Container Registry (ECR)($)",
            "Key Management Service($)",
            "API Gateway($)",
            "CloudFront($)",
            "Athena($)",
            "Secrets Manager($)",
            "CloudWatch Events($)",
            "Cognito($)",
            "X-Ray($)",
            "Cost Explorer($)",
            "Service Catalog($)",
            "Systems Manager($)",
            "SES($)",
            "Simple Workflow Service($)",
            "Direct Connect($)",
            "CloudTrail($)",
            "CodeArtifact($)",
            "Elastic Container Service($)",
            "Migration Hub Refactor Spaces($)",
            "Location Service($)",
        ]
    )
    return df
```

In [8]:
```
# Import the csv and convert to dataframe.
# Fill all na to 0, ignore the summation row
percentiles = [i / 10 for i in range(10)][1:]


def process_data():
    d = {}
    for filename in filelist:
        cur_data_raw = pd.read_csv(filepath + filename)
        cur_data = prep_data(cur_data_raw)
        # print(type(cur_data))
        cur_summary = cur_data.describe(percentiles=percentiles)
        # print(type(cur_summary))
        volatility = compute_volatility(
            pd.DataFrame(cur_summary.loc["std"]),
            pd.DataFrame(cur_summary.loc["mean"]),
        )
        cur_data_simple = drop_totals_and_reindex(cur_data)
        # correlation - higher is more correlated
        cur_rho = cur_data_simple.corr(method="pearson", min_periods=3)
        # p-value - lower is surer
        curr_pval = cur_data_simple.corr(
            method=lambda x, y: pearsonr(x, y)[1]
        ) - np.eye(*cur_rho.shape)
        cur_corr_p_star = curr_pval.map(
            lambda x: "".join(
                [
                    "*"
                    for t in [
                        0.05,
                        0.01,
                        0.001,
                        0.00001,
                        0.0000001,
                        0.000000001,
                        0.00000000001,
                    ]
                    if x <= t
                ]
            )
        )
        cur_corr_p_rank = cur_corr_p_star.map(lambda x: len(x))
        cur_heatmap_rho = go.Figure(
            data=go.Heatmap(
                z=cur_rho,
                zmin=0.61,
                x=cur_rho.columns,
                y=cur_rho.index,
                colorscale="Earth",
                xgap=2,
                ygap=2,
            )
        )
        cur_heatmap_rho.update_layout(
            autosize=False, width=2040, height=2040
        )
        cur_heatmap_rank = go.Figure(
            data=go.Heatmap(
                z=cur_corr_p_rank,
                zmin=3,
                x=cur_corr_p_rank.columns,
                y=cur_corr_p_rank.index,
                colorscale="Earth",
                xgap=2,
                ygap=2,
            )
        )
        cur_heatmap_rank.update_layout(
            autosize=False, width=2040, height=2040
        )
        d[filename] = {
            "cur_data_raw": cur_data_raw,
            "cur_data": cur_data,
            "cur_summary": cur_summary,
            "volatility": volatility,
            "cur_data_simple": cur_data_simple,
            "cur_rho": cur_rho,
            "curr_pval": curr_pval,
            "cur_corr_p_star": cur_corr_p_star,
            "cur_corr_p_rank": cur_corr_p_rank,
            "cur_heatmap_rho": cur_heatmap_rho,
            "cur_heatmap_rank": cur_heatmap_rank,
        }
    for filename in filelist:
        for key in d[filename]:
            if key != "cur_heatmap_rho" and key != "cur_heatmap_rank":
                full_output_file_name = str(filename)+"_"+str(key)+".csv"
                d[filename][key].to_csv(filepath+"/output/"+full_output_file_name, encoding='utf-8')

    return d
```

Process / Pre-compute the data

This may be compute intensive, use at least 16GB RAM

In [ ]:
```
# process all the files and store the analysis in the dictionary res
res = process_data()
```

Analysis of Cost and Usage Data

Components of each analysis:

- "cur_data_raw" - raw data from the file
- "cur_data" - clean data
- "cur_summary" - .describe() with 10 percentiles
- "volatility" - std/mean as a percentage value
- "cur_data_simple" - remove total costs as well
- "cur_rho" - correlation matrix across all services
- "curr_pval" - p-values over the correlation
- "cur_corr_p_star" - STAR (*) representation of correlations based on p-values for easier visual comparision
- "cur_corr_p_rank" - simple RANK based representation of correlations based on p-values for easier analysis

- "cur_heatmap_rho" - plotly graph object for plotting the heatmap based on raw correlations
- "cur_heatmap_rank" - plotly graph object for plotting the heatmap based on curr_corr_p_rank

Summary

In [10]:
```
component_description = {
    "cur_data_raw": "raw data from the file",
    "cur_data": "clean data",
    "cur_summary": ".describe() with 10 percentiles",
    "volatility": "std/mean as a percentage value",
    "cur_data_simple": "remove total costs as well",
    "cur_rho": "correlation matrix across all services",
    "curr_pval": "p-values over the correlation ",
    "cur_corr_p_star": "STAR (*) representation of correlations based on p-values for easier visual comparision",
    "cur_corr_p_rank": "simple RANK based representation of correlations based on p-values for easier analysis",
    "cur_heatmap_rho": "plotly graph object for plotting the heatmap based on raw correlations",
    "cur_heatmap_rank": "plotly graph object for plotting the heatmap based on curr_corr_p_rank"
}

def show_analysis_for_file(k):
    display(HTML('<h2 style="color:blue;"><br/><br/><hr/><br/></h2>'))
    display(HTML('<h1 style="color:blue;">Analysis for <b>'+k+'</b><br/></h1>'))
    for df in res[k]:
        if df != "cur_heatmap_rho" and df != "cur_heatmap_rank":
            time.sleep(1)
            display(HTML('<h2 style="color:blue;"><br/><br/><br/></h2>'))
            display(HTML('<h2 style="color:tomato;"><b>'+k+'</b><br/>'+'</h2>'+'<h3 style="color:blue;">'+component_description[df]+'</h3>'))
            # print ('\n\n\n\n'+component_description[df])
            if df == "cur_summary":
                display(res[k][df])
            else:
                display(res[k][df].head())
        else:
            if df == "cur_heatmap_rho":
                time.sleep(2)
                msg = "raw correlations of service usage" # for: "+k
                display(HTML('<h2 style="color:blue;"><br/><br/><br/></h2>'))
                display(HTML('<h2 style="color:tomato;"><b>'+k+'</b><br/>'+'</h2>'+'<h3 style="color:blue;">'+msg+'</h3>'))
                # print('\n\n\n\n'+"raw correlations of service usage for: ",k)
            elif df == "cur_heatmap_rank":
                time.sleep(2)
                msg = "statistical significance of usage correlations between services:" # for: "+k
                display(HTML('<h2 style="color:blue;"><br/><br/><br/></h2>'))
                display(HTML('<h2 style="color:tomato;"><b>'+k+'</b><br/>'+'</h2>'+'<h3 style="color:blue;">'+msg+'</h3>'))
                # print('\n\n\n\n'+"statistical significance of usage correlations between services for: ",k)
            res[k][df].show()
```

In [11]:
```
# cmd_list = []
# for k in res.keys():
#     for df in res[k]:
#         if df != "cur_heatmap_rho" and df != "cur_heatmap_rank":
#             cmd_list.append(str("res["+k+"]["+df+"].head()"))
#         else:
#             cmd_list.append(str("res["+k+"]["+df+"].show()"))
# cmd_list
```

In [12]:
```
print(filelist)
```

```
['KIAL-PROD-Daily.csv', 'KMBL-811-PROD-Daily.csv', 'KMBL-Logs-Daily.csv', 'KMBL-MB2-PROD-Daily.csv', 'KMBL-OU-Daily.csv', 'KMBL-PROD-Daily.csv']
```

In [13]:
```
# replace the filename from the list above to see the respective summary
# res["KMBL-PROD-Daily.csv"]["cur_summary"].head()
```

In [14]:
```
# replace the filename from the list above to see the respective volatility data
# res["KMBL-PROD-Daily.csv"]["volatility"]
```

In [15]:
```
# replace the filename from the list above to see the respective heatmap
#
# uncomment the right line to see the relevant heatmap
# print("raw correlations of service usage for KMBL-PROD-Daily")
# res["KMBL-PROD-Daily.csv"]["cur_heatmap_rho"].show()
```

In [16]:
```
# print("statistical significance of usage correlations between services for KMBL-PROD-Daily")
# res['KMBL-PROD-Daily.csv']['cur_heatmap_rank'].show()
```

In [17]:
```
for f in filelist:
    print(f)
    time.sleep(1) #give it time to render...
    show_analysis_for_file(f)
```

```
KIAL-PROD-Daily.csv
```

Analysis for **KIAL-PROD-Daily.csv**

KIAL-PROD-Daily.csv

raw data from the file

	Service	Relational Database Service($)	Tax($)	Savings Plans for Compute usage($)	EC2-Other($)	Support (Business)($)	VPC($)	OpenSearch Service($)	CloudWatch($)	EC2-Instances($)	ElastiCache($)	S3($)	DocumentDB (with MongoDB compatibility) ($)	Managed Streaming for Apache Kafka($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Glacier($)	SES($)	EC2 Container Registry (ECR)($)	Elastic Container Service for Kubernetes($)	Elastic Load Balancing($)	CloudTrail($)	Key Management Service($)	CloudFront($)	SageMaker($)	Rekognition($)	DynamoDB($)	Cost Explorer($)	Lambda($)	Secrets Manager($)	SQS($)	SNS($)	Route 53($)	Service Catalog($)	Glue($)	Athena($)	Direct Connect($)	Config($)	AppFlow($)	Systems Manager($)	Simple Workflow Service($)	Step Functions($)	Clou
0	Service total	120149.249144	53966.15	47172.27	28937.402698	25295.283089	15484.026643	14678.138571	13463.431361	7711.956590	6461.472271	5905.887695	4778.710281	3745.527321	3191.18	1426.313268	1273.831776	1155.951892	942.57834	878.612568	784.828295	502.473721	322.606411	275.000024	132.036362	41.501888	30.0102	13.782509	10.144469	3.495181	2.788037	1.664	1.226673	0.214189	0.141369	0.036103	0.01302	0.004534	0.000435	0.00028	2.797970e-04	
1	2023-04-01	301.203781	3840.25	NaN	86.970440	1941.664303	59.326484	6.986076	14.176990	206.308227	1.071360	31.520309	6.732272	NaN	9.12	11.531895	2.322588	0.032306	2.23200	2.254594	2.201506	5.924474	0.035126	NaN	0.044175	0.099101	NaN	0.014418	0.002669	0.012075	0.006066	NaN	NaN	0.001667	NaN	NaN	0.01302	NaN	NaN	NaN	8.640000e-07	
2	2023-04-02	301.203781	NaN	NaN	86.823475	NaN	58.967452	6.986075	15.039071	206.308226	1.071360	31.369553	6.731861	NaN	9.12	11.603962	2.321190	0.032306	2.23200	2.241766	2.170469	5.917377	0.028114	NaN	0.006975	0.099101	NaN	0.020082	0.002925	0.012056	0.011760	NaN	NaN	0.001875	NaN	NaN	NaN	NaN	NaN	NaN	9.132000e-07	
3	2023-04-03	301.203781	NaN	NaN	86.802266	NaN	57.031061	6.986075	15.212474	206.318386	1.071360	31.477501	6.731977	NaN	9.12	11.684711	2.322598	0.033704	2.23200	2.303296	2.190120	5.936798	0.080835	2.699241	0.019762	0.099101	NaN	0.024352	0.002674	0.012197	0.011759	NaN	NaN	0.001839	NaN	NaN	NaN	NaN	NaN	NaN	8.779000e-07	
4	2023-04-04	301.203781	NaN	NaN	86.801195	NaN	56.492137	6.986075	15.000316	206.308225	1.071360	31.115921	6.731985	NaN	9.12	11.762752	2.323184	0.034430	2.23200	2.257132	2.143892	5.921255	0.038309	2.699337	0.010462	0.099101	NaN	0.022884	0.002590	0.012190	0.011657	NaN	NaN	0.001728	NaN	NaN	NaN	NaN	NaN	NaN	8.162000e-07	

KIAL-PROD-Daily.csv

clean data

	date-time	Relational Database Service($)	Tax($)	Savings Plans for Compute usage($)	EC2-Other($)	Support (Business) ($)	VPC($)	OpenSearch Service($)	CloudWatch($)	EC2-Instances($)	ElastiCache($)	S3($)	DocumentDB (with MongoDB compatibility) ($)	Managed Streaming for Apache Kafka($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Glacier($)	SES($)	EC2 Container Registry (ECR)($)	Elastic Container Service for Kubernetes($)	Elastic Load Balancing($)	CloudTrail($)	Key Management Service($)	CloudFront($)	SageMaker($)	Rekognition($)	DynamoDB($)	Cost Explorer($)	Lambda($)	Secrets Manager($)	SQS($)	SNS($)	Route 53($)	Service Catalog($)	Glue($)	Athena($)	Direct Connect($)	Config($)	AppFlow($)	Systems Manager($)	Simple Workflow Service($)	Step Functions($)	CloudShell($)	El Syste
date-time																																										
2023-04-01	2023-04-01	301.203781	3840.25	0.0	86.970440	1941.664303	59.326484	6.986076	14.176990	206.308227	1.07136	31.520309	6.732272	0.0	9.12	11.531895	2.322588	0.032306	2.232	2.254594	2.201506	5.924474	0.035126	0.000000	0.044175	0.099101	0.0	0.014418	0.002669	0.012075	0.006066	0.0	0.0	0.001667	0.0	0.0	0.01302	0.0	0.0	0.0	8.640000e-07	0.0	
2023-04-02	2023-04-02	301.203781	0.00	0.0	86.823475	0.000000	58.967452	6.986075	15.039071	206.308226	1.07136	31.369553	6.731861	0.0	9.12	11.603962	2.321190	0.032306	2.232	2.241766	2.170469	5.917377	0.028114	0.000000	0.006975	0.099101	0.0	0.020082	0.002925	0.012056	0.011760	0.0	0.0	0.001875	0.0	0.0	0.00000	0.0	0.0	0.0	9.132000e-07	0.0	
2023-04-03	2023-04-03	301.203781	0.00	0.0	86.802266	0.000000	57.031061	6.986075	15.212474	206.318386	1.07136	31.477501	6.731977	0.0	9.12	11.684711	2.322598	0.033704	2.232	2.303296	2.190120	5.936798	0.080835	2.699241	0.019762	0.099101	0.0	0.024352	0.002674	0.012197	0.011759	0.0	0.0	0.001839	0.0	0.0	0.00000	0.0	0.0	0.0	8.779000e-07	0.0	
2023-04-04	2023-04-04	301.203781	0.00	0.0	86.801195	0.000000	56.492137	6.986075	15.000316	206.308225	1.07136	31.115921	6.731985	0.0	9.12	11.762752	2.323184	0.034430	2.232	2.257132	2.143892	5.921255	0.038309	2.699337	0.010462	0.099101	0.0	0.022884	0.002590	0.012190	0.011657	0.0	0.0	0.001728	0.0	0.0	0.00000	0.0	0.0	0.0	8.162000e-07	0.0	
2023-04-05	2023-04-05	301.203781	0.00	0.0	86.977722	0.000000	56.658028	6.986075	15.445492	214.741861	1.07136	31.132996	6.731889	0.0	9.12	11.839737	2.325630	0.034430	2.232	2.353091	2.162604	5.921958	0.063561	2.700063	0.067425	0.099101	0.0	0.035741	0.002344	0.011791	0.011525	0.0	0.0	0.001415	0.0	0.0	0.00000	0.0	0.0	0.0	6.906000e-07	0.0	

KIAL-PROD-Daily.csv

.describe() with 10 percentiles

	date-time	Relational Database Service($)	Tax($)	Savings Plans for Compute usage($)	EC2-Other($)	Support (Business) ($)	VPC($)	OpenSearch Service($)	CloudWatch($)	EC2-Instances($)	ElastiCache($)	S3($)	DocumentDB (with MongoDB compatibility) ($)	Managed Streaming for Apache Kafka($)	Hardened Red Hat Enterprise 7 (RHEL 7) ($)	Glacier($)	SES($)	EC2 Container Registry (ECR)($)	Elastic Container Service for Kubernetes($)	Elastic Load Balancing($)	CloudTrail($)	Key Management Service($)	CloudFront($)	SageMaker($)	Rekognition($)	DynamoDB($)	Cost Explorer($)	Lambda($)	Secrets Manager($)	SQS($)	SNS($)	Route 53($)	Service Catalog($)	Glue($)	Athena($)	Direct Connect($)	Config($)	AppFlow($)	Systems Manager($)	Simple Workflow Service($)	Func
count	396	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	3.960000e+02	3.960
mean	2023-10-15 12:00:00	303.407195	136.278157	119.121894	73.074249	63.876977	39.101077	37.066006	33.998564	19.474638	16.316849	14.913858	12.067450	9.458402	8.058535	3.601801	3.216747	2.919070	2.380248	2.218719	1.981890	1.268873	0.814663	0.694445	0.333425	0.104803	0.075783	0.034804	0.025617	0.008826	0.007040	0.004202	0.003098	0.000541	0.000357	0.000091	0.000033	0.000011	0.000001	7.069980e-07	7.065
min	2023-04-01 00:00:00	120.816049	0.000000	0.000000	62.986595	0.000000	26.643659	6.975248	14.176990	0.000000	1.071360	9.775415	6.731522	0.000000	6.200000	1.868012	2.245500	0.032306	2.112000	1.730315	0.000000	0.475842	0.012771	0.000000	0.005812	0.000000	0.000000	0.006037	0.000079	0.000796	0.000221	0.000000	0.000000	0.000031	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000e+00	0.000
10%	2023-05-10 12:00:00	191.548329	0.000000	122.496000	65.292532	0.000000	27.678069	6.986103	21.273577	0.000000	13.838400	11.615096	6.732613	0.000000	6.470000	1.910467	2.326022	0.037416	2.232000	1.845853	0.000000	0.697785	0.205929	0.000000	0.065681	0.099101	0.000000	0.008084	0.000188	0.001284	0.003058	0.000000	0.000000	0.000098	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000e+00	3.211
20%	2023-06-19 00:00:00	249.149761	0.000000	129.456000	66.220676	0.000000	29.541188	27.779265	24.536395	0.000000	13.838400	12.356708	12.695180	0.000000	6.720000	1.910467	2.541918	0.086688	2.232000	1.896201	0.000000	0.746357	0.269786	0.076800	0.133687	0.099101	0.000000	0.009716	0.000418	0.001509	0.003292	0.000000	0.000000	0.000135	0.000000	0.000000	0.000000	0.000000	0.000000	4.793000e-07	4.674
30%	2023-07-28 12:00:00	258.899365	0.000000	129.456000	67.159077	0.000000	30.924421	30.085360	27.949236	1.156701	13.838400	12.816227	13.412009	0.000000	7.670000	1.910467	2.787704	0.128919	2.232000	1.932674	0.000000	0.828872	0.314748	0.094759	0.181350	0.099101	0.000000	0.011810	0.001548	0.001601	0.003722	0.000000	0.000000	0.000171	0.000000	0.000000	0.000000	0.000000	0.000000	6.022000e-07	6.571
40%	2023-09-06 00:00:00	267.670932	0.000000	129.456000	68.135076	0.000000	34.596997	31.335975	30.555274	3.268869	13.838400	13.392276	13.412368	0.000000	7.680000	1.910471	2.961609	0.144932	2.232000	1.971415	0.109679	0.852377	0.357558	0.153600	0.224362	0.099101	0.000000	0.026973	0.002841	0.008581	0.006923	0.000000	0.000000	0.000195	0.000000	0.000000	0.000000	0.000000	0.000000	7.236000e-07	7.046
50%	2023-10-15 12:00:00	279.018783	0.000000	129.456000	69.622905	0.000000	39.689415	31.603776	32.897991	8.966274	14.731200	13.928967	13.413079	15.055432	7.680000	1.910473	3.240779	0.156090	2.232000	2.050056	0.143140	0.892776	0.425588	0.153600	0.295069	0.099101	0.009300	0.039100	0.022360	0.010456	0.007597	0.000000	0.001302	0.000212	0.000000	0.000000	0.000000	0.000000	0.000000	7.785000e-07	7.162
60%	2023-11-24 00:00:00	286.489131	0.000000	129.456000	73.413070	0.000000	41.959693	34.882200	35.672812	16.343058	17.275680	14.378020	13.416214	15.057300	9.120000	1.974149	3.429302	0.173500	2.232000	2.370282	0.166651	0.959743	0.526153	0.153600	0.374325	0.099101	0.009300	0.047942	0.025592	0.011143	0.007950	0.000000	0.001302	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	8.820000e-07	7.557
70%	2024-01-02 12:00:00	305.704542	0.000000	129.456000	78.378190	0.000000	43.833271	39.800720	39.182653	22.621469	17.298000	14.986054	13.416535	15.061119	9.120000	1.974154	3.578279	0.220391	2.232000	2.462709	0.186328	1.002070	0.909097	0.163852	0.450444	0.099101	0.158100	0.048655	0.029941	0.012042	0.008367	0.000000	0.003696	0.000315	0.000000	0.000000	0.000000	0.000000	0.000000	9.264000e-07	9.060
80%	2024-02-11 00:00:00	341.616023	0.000000	129.456000	80.863136	0.000000	47.904409	55.984414	42.497056	27.817251	17.298000	15.682377	13.416823	15.064430	9.120000	2.042223	3.802488	0.234642	2.232000	2.552178	0.392348	1.096540	1.293744	2.698981	0.524700	0.099101	0.186000	0.055191	0.040384	0.013455	0.009450	0.000000	0.003906	0.001075	0.000000	0.000000	0.000000	0.000000	0.000000	9.617000e-07	9.423
90%	2024-03-21 12:00:00	356.368642	0.000000	129.456000	85.073414	0.000000	52.524521	55.984729	47.414687	34.424153	18.190800	16.625078	13.417096	15.079982	9.120000	11.567929	4.037613	0.288981	2.232000	2.671773	10.771047	1.354530	1.918167	2.703031	0.638794	0.140870	0.223200	0.062148	0.064229	0.016385	0.011314	0.000000	0.004882	0.001667	0.000000	0.000000	0.000000	0.000000	0.000000	1.011300e-06	9.632
max	2024-04-30 00:00:00	9491.740792	4718.220000	129.456000	94.095540	2767.086083	59.326484	231.807389	84.146178	214.741861	32.743440	45.719681	13.802304	26.338267	9.160000	62.536082	6.646546	99.826163	4.464000	3.182700	35.996689	9.074475	5.466119	4.597145	1.142737	0.148874	0.381300	0.074803	0.184645	0.054997	0.042251	0.930000	0.044268	0.002882	0.103695	0.035927	0.013020	0.004534	0.000435	1.176000e-06	1.493
std	NaN	466.979702	720.034158	34.507035	7.701825	350.200687	9.243239	25.721686	10.372885	34.830482	6.013340	4.686674	2.620165	8.427642	1.115915	5.072986	0.651578	11.261390	0.562924	0.346688	4.776228	1.351430	0.908839	1.087325	0.221526	0.016892	0.105066	0.021477	0.030824	0.006600	0.003848	0.050131	0.006392	0.000646	0.005452	0.001805	0.000654	0.000228	0.000022	3.311717e-07	2.578

KIAL-PROD-Daily.csv

std/mean as a percentage value

	std	mean	volatility
Systems Manager($)	0.000022	0.000001	1989.974874
AppFlow($)	0.000228	0.000011	1989.974874
Config($)	0.000654	0.000033	1989.974874
Direct Connect($)	0.001805	0.000091	1980.28024
Athena($)	0.005452	0.000357	1527.122789

KIAL-PROD-Daily.csv

remove total costs as well

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Ma
date-time																																									
2023-04-01	2023-04-01	206.308227	31.520309	301.203781	86.970440	0.001667	6.732272	NaN	14.176990	59.326484	6.986076	NaN	0.0	0.000000	1.07136	NaN	2.254594	NaN	0.0	0.006066	0.014418	2.232	0.044175	9.12	8.640000e-07	11.531895	0.099101	0.0	0.0	0.0	0.012075	0.032306	5.924474	NaN	0.035126	0.0	0.002669	NaN	NaN	NaN	0.0	0.0
2023-04-02	2023-04-02	206.308226	31.369553	301.203781	86.823475	0.001875	6.731861	NaN	15.039071	58.967452	6.986075	NaN	0.0	0.000000	1.07136	NaN	2.241766	NaN	0.0	0.011760	0.020082	2.232	0.006975	9.12	9.132000e-07	11.603962	0.099101	0.0	0.0	0.0	0.012056	0.032306	5.917377	NaN	0.028114	0.0	0.002925	NaN	NaN	NaN	0.0	0.0
2023-04-03	2023-04-03	206.318386	31.477501	301.203781	86.802266	0.001839	6.731977	NaN	15.212474	57.031061	6.986075	NaN	0.0	2.699241	1.07136	NaN	2.303296	NaN	0.0	0.011759	0.024352	2.232	0.019762	9.12	8.779000e-07	11.684711	0.099101	0.0	0.0	0.0	0.012197	0.033704	5.936798	NaN	0.080835	0.0	0.002674	NaN	NaN	NaN	0.0	0.0
2023-04-04	2023-04-04	206.308225	31.115921	301.203781	86.801195	0.001728	6.731985	NaN	15.000316	56.492137	6.986075	NaN	0.0	2.699337	1.07136	NaN	2.257132	NaN	0.0	0.011657	0.022884	2.232	0.010462	9.12	8.162000e-07	11.762752	0.099101	0.0	0.0	0.0	0.012190	0.034430	5.921255	NaN	0.038309	0.0	0.002590	NaN	NaN	NaN	0.0	0.0
2023-04-05	2023-04-05	214.741861	31.132996	301.203781	86.977722	0.001415	6.731889	NaN	15.445492	56.658028	6.986075	NaN	0.0	2.700063	1.07136	NaN	2.353091	NaN	0.0	0.011525	0.035741	2.232	0.067425	9.12	6.906000e-07	11.839737	0.099101	0.0	0.0	0.0	0.011791	0.034430	5.921958	NaN	0.063561	0.0	0.002344	NaN	NaN	NaN	0.0	0.0

KIAL-PROD-Daily.csv

correlation matrix across all services

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	I
date-time	1.000000	-0.279124	-0.180169	-0.125296	-0.800593	-0.655787	0.657661	NaN	0.481908	0.397149	-0.077097	NaN	0.864270	-0.586491	-0.285837	NaN	-0.721392	NaN	0.574590	-0.630913	0.151433	0.358682	0.494853	-0.917299	0.203569	-0.489601	0.583798	0.566517	0.086929	0.068971	-0.668071	0.086013	-0.262246	NaN	-0.375119	-0.018248	0.745620	NaN	NaN	NaN	0.273822	0.002062	
EC2-Instances($)	-0.279124	1.000000	0.580626	0.054310	0.420021	0.356307	-0.482478	NaN	-0.469155	0.221378	-0.137637	NaN	-0.282709	0.335752	-0.256905	NaN	0.063903	NaN	0.176906	0.110037	0.293897	-0.027182	-0.276662	0.149387	-0.100573	0.319683	0.139800	0.205097	0.074757	-0.034909	-0.000399	-0.127817	0.613325	NaN	-0.101601	-0.033611	-0.125002	NaN	NaN	NaN	-0.358252	0.033420	
S3($)	-0.180169	0.580626	1.000000	-0.030120	0.119641	0.188364	-0.347440	NaN	-0.058189	0.591777	-0.270847	NaN	-0.052174	0.086526	-0.479436	NaN	-0.130143	NaN	0.054769	0.176840	-0.019170	-0.055717	-0.198167	0.075960	0.100907	0.192483	0.042790	0.072903	0.014534	-0.034490	0.015290	0.089193	0.952756	NaN	-0.172165	-0.019168	-0.067413	NaN	NaN	NaN	-0.051196	-0.108235	
Relational Database Service($)	-0.125296	0.054310	-0.030120	1.000000	0.163712	0.156746	-0.047780	NaN	-0.095072	-0.110151	0.049657	NaN	-0.150812	0.166868	0.183269	NaN	0.088839	NaN	-0.048000	0.056836	0.067730	-0.065593	-0.076484	0.107106	-0.037955	0.033670	-0.057308	-0.037670	-0.002195	-0.008105	0.058153	-0.024952	-0.010622	NaN	0.028748	-0.001599	-0.100120	NaN	NaN	NaN	-0.094538	0.165516	
EC2-Other($)	-0.800593	0.420021	0.119641	0.163712	1.000000	0.664432	-0.541742	NaN	-0.579678	-0.464257	0.134156	NaN	-0.776920	0.609105	0.398036	NaN	0.722816	NaN	-0.360300	0.410114	0.116967	-0.228357	-0.447827	0.736321	-0.244911	0.334065	-0.395014	-0.358533	-0.051522	-0.059007	0.491623	-0.183541	0.227113	NaN	0.410709	-0.005881	-0.576891	NaN	NaN	NaN	-0.421669	0.123972	

KIAL-PROD-Daily.csv

p-values over the correlation

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)
date-time	0.000000e+00	1.607992e-08	3.139402e-04	0.012584	1.163474e-89	4.837683e-50	2.056109e-50	NaN	2.029196e-24	2.057978e-16	1.256131e-01	NaN	1.242089e-119	5.851945e-38	6.981236e-09	NaN	7.530583e-65	NaN	3.626269e-36	2.373850e-45	2.516098e-03	1.818601e-13	7.503613e-26	1.203448e-159	4.484631e-05	2.908769e-25	1.511384e-37	5.421620e-35	0.084047	0.170750	1.584541e-52	0.087378	1.189597e-07	NaN	1.117899e-14	0.717345	1.882115e-71	NaN
EC2-Instances($)	1.607992e-08	0.000000e+00	4.568477e-37	0.280978	2.344052e-18	2.685854e-13	1.760186e-24	NaN	4.568515e-23	8.718453e-06	6.081507e-03	NaN	1.032698e-08	6.866199e-12	2.178378e-07	NaN	2.044681e-01	NaN	4.044047e-04	2.856446e-02	2.489122e-09	5.896712e-01	2.171849e-08	2.881483e-03	4.548773e-02	7.356491e-11	5.321663e-03	3.917674e-05	0.137538	0.488504	9.936882e-01	0.010899	2.772059e-42	NaN	4.331251e-02	0.504814	1.279552e-02	NaN
S3($)	3.139402e-04	4.568477e-37	0.000000e+00	0.550090	1.722494e-02	1.630140e-04	1.119327e-12	NaN	2.479841e-01	8.857771e-39	4.364852e-08	NaN	3.003588e-01	8.549923e-02	3.748938e-24	NaN	9.523722e-03	NaN	2.769196e-01	4.064536e-04	7.037102e-01	2.686812e-01	7.173434e-05	1.313043e-01	4.477186e-02	1.160331e-04	3.957655e-01	1.475889e-01	0.773106	0.493735	7.616433e-01	0.076256	5.349379e-206	NaN	5.797240e-04	0.703751	1.806438e-01	NaN
Relational Database Service($)	1.258446e-02	2.809779e-01	5.500902e-01	0.000000	1.076945e-03	1.755749e-03	3.429557e-01	NaN	5.873049e-02	2.839941e-02	3.243062e-01	NaN	2.622344e-03	8.575070e-04	2.458119e-04	NaN	7.743249e-02	NaN	3.407297e-01	2.591693e-01	1.785947e-01	1.927242e-01	1.286526e-01	3.310684e-02	4.513448e-01	5.040753e-01	2.552309e-01	4.547535e-01	0.965262	0.872274	2.482753e-01	0.620573	8.331167e-01	NaN	5.684124e-01	0.974700	4.647403e-02	NaN
EC2-Other($)	1.163474e-89	2.344052e-18	1.722494e-02	0.001077	0.000000e+00	8.878452e-52	1.394918e-31	NaN	6.343182e-37	1.459846e-22	7.510478e-03	NaN	3.500272e-81	1.413661e-41	1.741278e-16	NaN	3.222282e-65	NaN	1.391701e-13	1.698884e-17	1.989902e-02	4.418288e-06	6.288799e-21	7.850444e-69	8.072695e-07	8.865057e-12	3.071901e-16	1.863753e-13	0.306446	0.241381	1.731064e-25	0.000241	4.995058e-06	NaN	1.510960e-17	0.907124	1.654515e-36	NaN

KIAL-PROD-Daily.csv

STAR (*) representation of correlations based on p-values for easier visual comparision

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	S
date-time	********	*****	***	*	*******	*******	*******		*******	*******			*******	*******	*****		*******		*******	*******	**	*******	*******	*******	***	*******	*******	*******		*******		*	****		*******		*******				*****			*******	
EC2-Instances($)	*****	********	********		*******	*******	*******		*******	****	**		*****	*******	****				***	*	*****		*****	**	*	*******	**	***			*	*******		*		*					*******			*****	
S3($)	***	********	********		*	***	*******			*******	*****			*******	**				***				***		*	***						*******		***							*		***	
Relational Database Service($)	*			*******	**	**				*			**	***	***								*																		***				
EC2-Other($)	********	********	*	**	*******	*******	*******		*******	*******	**		*******	*******	*******		*******		*******	*******	*	*****	*******	*******	****	*******	*******	*******		*******	***	*****		*******		*******				*******	*		*******	

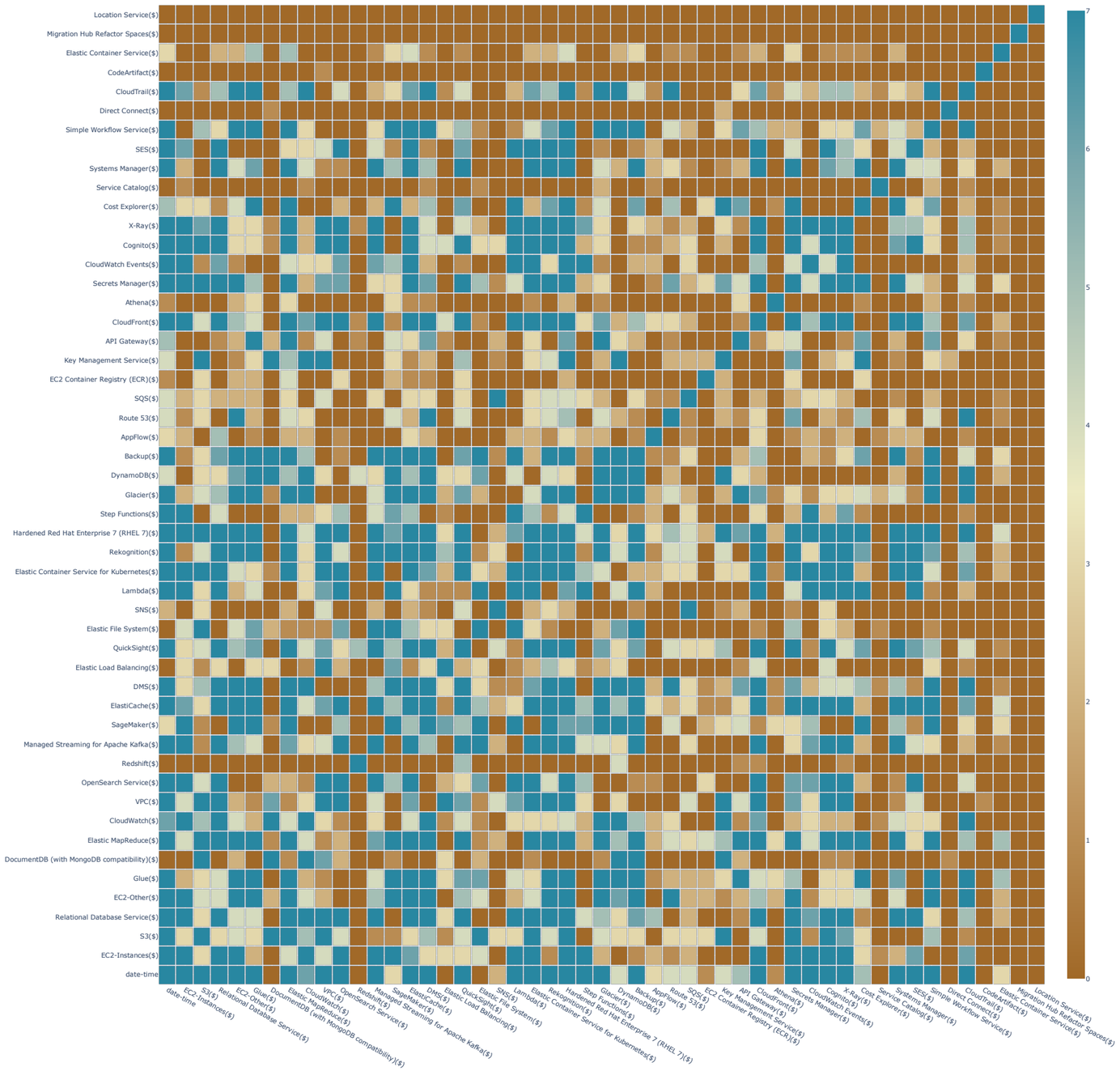
KIAL-PROD-Daily.csv

simple RANK based representation of correlations based on p-values for easier analysis

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	W Se
date-time	7	5	3	1	7	7	7	0	7	7	0	0	7	7	5	0	7	0	7	7	2	7	7	7	3	7	7	7	0	0	7	0	4	0	7	0	7	0	0	0	5	0	0	7	
EC2-Instances($)	5	7	7	0	7	7	7	0	7	4	2	0	5	7	4	0	0	0	3	1	5	0	5	2	1	6	2	3	0	0	0	1	7	0	1	0	1	0	0	0	7	0	0	5	
S3($)	3	7	7	0	1	3	7	0	0	7	5	0	0	0	7	0	2	0	0	3	0	0	3	0	1	3	0	0	0	0	0	0	7	0	3	0	0	0	0	0	0	1	0	3	
Relational Database Service($)	1	0	0	7	2	2	0	0	0	1	0	0	2	3	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	
EC2-Other($)	7	7	1	2	7	7	7	0	7	7	2	0	7	7	7	0	7	0	7	7	1	4	7	7	4	7	7	7	0	0	7	3	4	0	7	0	7	0	0	0	7	1	0	7	

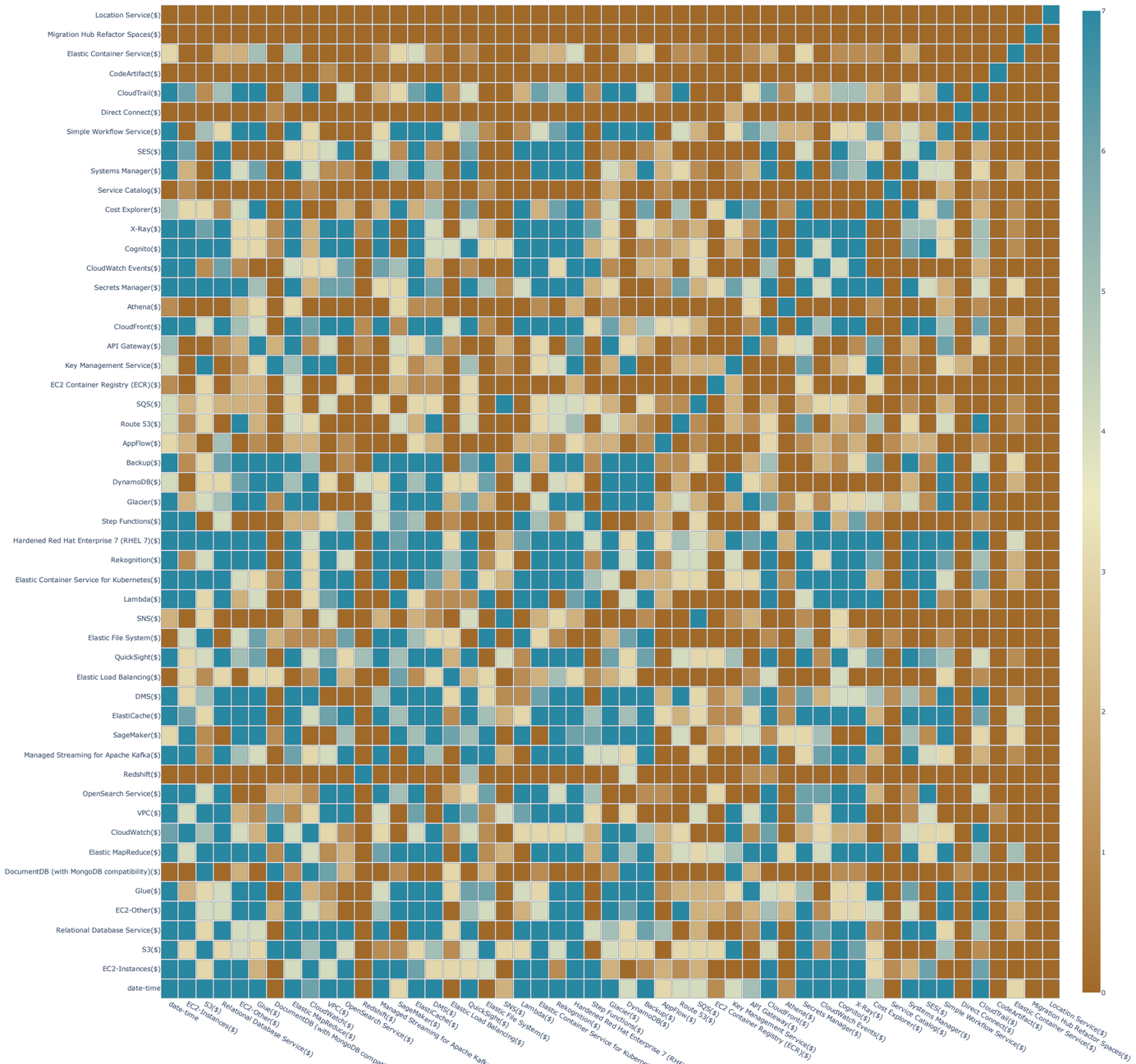
KIAL-PROD-Daily.csv

raw correlations of service usage



KIAL-PROD-Daily.csv

statistical significance of usage correlations between services:



KMBL-811-PROD-Daily.csv

Analysis for **KMBL-811-PROD-Daily.csv**

KMBL-811-PROD-Daily.csv

raw data from the file

	Service	EC2-Other($)	Tax($)	Glue($)	S3($)	Support (Business)($)	CloudWatch($)	Savings Plans for Compute usage($)	Relational Database Service($)	Cognito($)	CloudFront($)	CloudTrail($)	EC2-Instances($)	ElastiCache($)	MQ($)	VPC($)	Managed Streaming for Apache Kafka($)	Systems Manager($)	OpenSearch Service($)	Elastic Load Balancing($)	Elastic Container Service for Kubernetes($)	DynamoDB($)	DocumentDB (with MongoDB compatibility)($)	Certificate Manager($)	Route 53($)	API Gateway($)	QuickSight($)	EC2 Container Registry (ECR)($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	CIS Linux 2 Benchmark - Level 2($)	CIS Ubuntu Linux 20.04 LTS Benchmark - Level 1($)	Redshift($)	DMS($)	Elastic MapReduce($)	Key Management Service($)	SQS($)	Managed Workflows for Apache Airflow($)	WAF($)	Kinesis($)	Lambda
0	Service total	193284.321640	132010.51	129859.257826	68138.579059	56276.346847	49996.793718	39771.45	29962.137024	22295.181973	21374.724644	16185.221464	15779.489904	13657.983885	13259.909678	12878.287565	8195.961984	6943.254958	6685.862157	5129.407550	4419.36	4294.952613	3793.213126	2748.329817	2355.137698	2321.175147	2178.245987	1568.805613	1147.22	796.996	599.756	516.38521	510.001822	481.262326	465.349951	415.349101	368.308032	338.463697	223.3836	214.47
1	2023-04-01	459.141194	9477.68	163.449675	152.571055	3984.291337	61.207821	111.60	33.982042	NaN	0.010805	14.497975	124.521967	22.632480	23.125385	24.450268	NaN	6.510000	17.060324	8.248101	11.16	0.000000	2.578341	NaN	0.186000	0.002065	6.696000	1.037406	2.88	0.480	0.480	NaN	NaN	NaN	0.653157	0.000755	NaN	0.186000	NaN	0.02
2	2023-04-02	461.683472	NaN	194.116625	153.670462	NaN	62.029757	111.60	33.983080	NaN	0.006743	14.476194	125.064384	22.632480	23.124473	17.765903	NaN	NaN	17.060324	8.133072	11.16	0.000000	2.576981	NaN	NaN	0.000109	6.696000	1.037406	2.88	0.480	0.480	NaN	NaN	NaN	0.653606	0.000787	NaN	0.186000	NaN	0.04
3	2023-04-03	467.740160	NaN	351.559010	207.749209	NaN	72.756228	111.60	33.982773	NaN	0.014412	15.576496	125.123743	22.632480	23.125312	16.269905	NaN	NaN	17.060323	8.314704	11.16	0.000143	2.579946	NaN	NaN	0.001115	6.696000	1.038382	2.88	0.500	0.480	NaN	NaN	NaN	0.682136	0.000796	NaN	0.186000	NaN	0.04
4	2023-04-04	467.406064	NaN	476.755835	171.774002	NaN	64.861449	111.60	33.979421	0.000000	0.025381	15.526666	124.560458	22.632480	23.126846	18.624507	NaN	NaN	17.060321	8.213184	11.16	0.000111	2.579381	NaN	NaN	0.001968	6.696000	1.039251	2.88	0.480	0.480	NaN	NaN	NaN	0.711197	0.000805	NaN	0.186000	NaN	0.04

KMBL-811-PROD-Daily.csv

clean data

	date-time	EC2-Other($)	Tax($)	Glue($)	S3($)	Support (Business)($)	CloudWatch($)	Savings Plans for Compute usage($)	Relational Database Service($)	Cognito($)	CloudFront($)	CloudTrail($)	EC2-Instances($)	ElastiCache($)	MQ($)	VPC($)	Managed Streaming for Apache Kafka($)	Systems Manager($)	OpenSearch Service($)	Elastic Load Balancing($)	Elastic Container Service for Kubernetes($)	DynamoDB($)	DocumentDB (with MongoDB compatibility)($)	Certificate Manager($)	Route 53($)	API Gateway($)	QuickSight($)	EC2 Container Registry (ECR)($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	CIS Linux 2 Benchmark - Level 2($)	CIS Ubuntu Linux 20.04 LTS Benchmark - Level 1($)	Redshift($)	DMS($)	Elastic MapReduce($)	Key Management Service($)	SQS($)	Managed Workflows for Apache Airflow($)	WAF($)	Kinesis($)	Lambda($)	Kinesis Firehose($)	Athena($)	Se Manag
date-time																																											
2023-04-01	2023-04-01	459.141194	9477.68	163.449675	152.571055	3984.291337	61.207821	111.6	33.982042	0.0	0.010805	14.497975	124.521967	22.63248	23.125385	24.450268	0.0	6.51	17.060324	8.248101	11.16	0.000000	2.578341	0.0	0.186	0.002065	6.696	1.037406	2.88	0.48	0.48	0.0	0.0	0.0	0.653157	0.000755	0.0	0.186	0.0	0.029955	0.030622	0.000000	0.0
2023-04-02	2023-04-02	461.683472	0.00	194.116625	153.670462	0.000000	62.029757	111.6	33.983080	0.0	0.006743	14.476194	125.064384	22.63248	23.124473	17.765903	0.0	0.00	17.060324	8.133072	11.16	0.000000	2.576981	0.0	0.000	0.000109	6.696	1.037406	2.88	0.48	0.48	0.0	0.0	0.0	0.653606	0.000787	0.0	0.186	0.0	0.047450	0.030587	0.000000	0.0
2023-04-03	2023-04-03	467.740160	0.00	351.559010	207.749209	0.000000	72.756228	111.6	33.982773	0.0	0.014412	15.576496	125.123743	22.63248	23.125312	16.269905	0.0	0.00	17.060323	8.314704	11.16	0.000143	2.579946	0.0	0.000	0.001115	6.696	1.038382	2.88	0.50	0.48	0.0	0.0	0.0	0.682136	0.000796	0.0	0.186	0.0	0.049930	0.030901	0.000660	0.0
2023-04-04	2023-04-04	467.406064	0.00	476.755835	171.774002	0.000000	64.861449	111.6	33.979421	0.0	0.025381	15.526666	124.560458	22.63248	23.126846	18.624507	0.0	0.00	17.060321	8.213184	11.16	0.000111	2.579381	0.0	0.000	0.001968	6.696	1.039251	2.88	0.48	0.48	0.0	0.0	0.0	0.711197	0.000805	0.0	0.186	0.0	0.049318	0.031157	0.067258	0.0
2023-04-05	2023-04-05	473.034060	0.00	235.284475	157.636570	0.000000	63.973417	111.6	33.972522	0.0	0.020904	15.242588	124.689758	22.63248	23.124411	14.964331	0.0	0.00	17.060322	8.249709	11.16	0.000043	2.582812	0.0	0.000	0.000828	6.696	1.040640	2.88	0.48	0.48	0.0	0.0	0.0	0.709942	0.024237	0.0	0.186	0.0	0.049298	0.031101	0.005966	0.0

KMBL-811-PROD-Daily.csv

.describe() with 10 percentiles

	date-time	EC2-Other($)	Tax($)	Glue($)	S3($)	Support (Business)($)	CloudWatch($)	Savings Plans for Compute usage($)	Relational Database Service($)	Cognito($)	CloudFront($)	CloudTrail($)	EC2-Instances($)	ElastiCache($)	MQ($)	VPC($)	Managed Streaming for Apache Kafka($)	Systems Manager($)	OpenSearch Service($)	Elastic Load Balancing($)	Elastic Container Service for Kubernetes($)	DynamoDB($)	DocumentDB (with MongoDB compatibility)($)	Certificate Manager($)	Route 53($)	API Gateway($)	QuickSight($)	EC2 Container Registry (ECR)($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	CIS Linux 2 Benchmark - Level 2($)	CIS Ubuntu Linux 20.04 LTS Benchmark - Level 1($)	Redshift($)	DMS($)	Elastic MapReduce($)	Key Management Service($)	SQS($)	Managed Workflows for Apache Airflow($)	WAF($)	Kinesis($)	Lambda($)	K Firehe
count	396	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	3.960000e+02	3.960000e+02	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000
mean	2023-10-15 12:00:00	488.091721	333.359874	327.927419	172.067119	142.111987	126.254530	100.432955	75.661962	56.300965	53.976577	40.871771	39.847197	34.489858	33.484620	32.520928	20.696874	17.533472	16.883490	12.953049	1.116000e+01	1.084584e+01	9.578821	6.940227	5.947317	5.861553	5.500621	3.961630	2.897020	2.012616	1.514535	1.304003	1.287883	1.215309	1.175126	1.048861	0.930071	0.854706	0.564100	0.541591	0.4
min	2023-04-01 00:00:00	242.093251	0.000000	163.449675	112.306809	0.000000	53.394101	0.000000	33.970606	0.000000	0.006743	0.000000	0.247406	22.632480	23.052602	11.531095	0.000000	0.000000	9.792434	8.133072	1.116000e+01	0.000000e+00	2.576981	0.000000	0.000000	0.000109	5.040000	1.037406	2.860000	0.480000	0.460000	0.000000	0.000000	0.000000	0.653157	0.000755	0.000000	0.180000	0.000000	0.001690	0.0
10%	2023-05-10 12:00:00	346.339749	0.000000	221.863406	129.844503	0.000000	67.817187	76.725000	48.133389	0.000000	12.273489	0.000000	0.379881	22.632480	23.073556	16.374041	0.000000	0.000035	9.806354	9.488475	1.116000e+01	1.932000e-07	2.623864	0.000000	0.000000	0.006500	5.040000	1.100753	2.880000	1.440000	0.480000	0.000000	0.000000	0.000000	0.718431	0.029443	0.000000	0.180552	0.000000	0.002729	0.0
20%	2023-06-19 00:00:00	438.725582	0.000000	240.470854	136.013094	0.000000	72.656352	111.600000	48.229463	0.000000	22.621854	14.553384	0.541036	22.632480	23.132098	19.180640	0.000000	0.001770	17.046447	10.043761	1.116000e+01	2.928000e-07	2.740462	0.000000	0.000000	2.402747	5.040000	1.208181	2.880000	1.920000	0.480000	0.000000	0.000000	0.000000	1.007018	0.091992	0.000000	0.181507	0.000000	0.003504	0.0
30%	2023-07-28 12:00:00	455.074446	0.000000	257.755872	141.800372	0.000000	83.441205	111.600000	69.813967	0.000000	27.509962	15.644227	0.779094	32.051520	30.499531	22.108507	0.000000	0.003512	17.046491	10.911663	1.116000e+01	2.885495e-05	5.323948	0.000000	8.358827	2.855834	5.040000	1.290001	2.880000	1.920000	1.440000	0.000000	0.000000	0.000000	1.051381	0.138542	0.000000	0.186000	0.000000	0.048113	0.0
40%	2023-09-06 00:00:00	473.913933	0.000000	272.361327	152.292484	0.000000	95.216000	111.600000	75.920159	0.000000	31.464765	27.730126	2.647238	32.051520	30.512421	26.003610	15.858360	0.031046	17.060318	11.374240	1.116000e+01	1.432345e-04	5.392374	0.000000	8.370356	3.076246	5.040000	1.413344	2.880000	1.920000	1.584000	0.000000	0.000000	0.000000	1.164726	0.152312	0.000000	0.186975	0.000000	0.053369	0.0
50%	2023-10-15 12:00:00	489.261766	0.000000	284.938164	165.500061	0.000000	109.628677	111.600000	76.060458	0.000000	35.828030	29.221195	5.795668	32.051520	30.529513	29.990686	31.683774	0.072070	17.060411	11.840194	1.116000e+01	1.189489e-01	5.453877	0.000000	8.370381	3.359330	5.208000	1.519529	2.880000	1.920000	1.920000	0.000000	0.000000	0.000000	1.259008	0.167943	0.000000	0.855609	0.000000	0.064669	0.0
60%	2023-11-24 00:00:00	506.483111	0.000000	306.925004	179.629685	0.000000	117.094185	111.600000	76.160799	0.000000	43.086712	31.249897	28.702443	41.470560	30.586783	34.086663	31.741574	0.178293	18.276731	12.316520	1.116000e+01	1.599585e+01	5.552710	0.000000	8.370589	3.745047	5.208000	1.646702	2.880000	2.112000	1.920000	0.000000	0.000000	0.000000	1.325974	0.237508	0.000000	0.900696	1.153944	0.159211	0.9
70%	2024-01-02 12:00:00	527.497390	0.000000	331.538439	191.714662	0.000000	163.375583	111.600000	77.447676	71.711835	49.932246	54.292563	40.396666	41.470560	30.621152	38.363942	31.749722	0.303567	18.276810	12.906161	1.116000e+01	1.907138e+01	5.704509	0.000000	8.370663	7.078109	5.387586	1.783020	2.880000	2.400000	1.920000	0.000000	0.000000	0.000000	1.362713	2.516758	0.000000	1.147401	1.153944	0.406874	0.9
80%	2024-02-11 00:00:00	564.071020	0.000000	377.543720	208.538309	0.000000	193.390285	111.600000	93.294591	141.687360	68.094041	73.366193	114.625616	43.122242	37.259545	44.437715	31.778740	1.653523	18.332286	16.660677	1.116000e+01	2.581754e+01	6.153157	0.000000	8.376232	9.633906	6.480000	1.863034	2.880000	2.400000	1.920000	0.000000	4.827604	1.928448	1.393829	2.629327	0.000000	1.396969	1.153944	0.951047	0.9
90%	2024-03-21 12:00:00	615.229828	0.000000	469.259246	224.589234	0.000000	211.266132	111.600000	132.793100	191.322855	95.469835	97.499386	139.495248	45.086400	37.453934	50.168796	31.917480	94.814794	18.332431	18.982354	1.116000e+01	3.376684e+01	32.487384	0.000000	8.377132	16.446390	6.696000	2.001695	2.930000	2.400000	1.940000	0.000080	4.830796	3.519232	1.454239	2.851122	0.000000	2.069962	1.153944	2.263224	0.9
max	2024-04-30 00:00:00	712.191777	14077.250000	1512.323668	330.273201	5781.180054	329.283318	111.600000	139.566996	1160.822280	382.710151	146.910333	158.043062	45.086401	89.531997	86.409517	63.615392	268.336502	18.391923	25.707299	1.116000e+01	3.385876e+01	57.997942	372.000000	10.230681	28.764094	7.440000	89.776985	3.360000	2.880000	2.640000	92.517738	4.834212	18.334426	1.487098	4.607003	11.498773	3.004498	1.153944	3.701191	1.0
std	NaN	97.929779	1843.385554	148.614477	38.290045	784.146446	55.505042	33.421381	27.230141	98.436139	61.456573	35.615327	53.692719	8.398651	13.831782	14.900901	18.075760	44.738289	2.524759	3.497573	6.047254e-14	1.335716e+01	13.300640	49.566349	3.809541	6.165272	0.719186	9.991696	0.067266	0.417718	0.601871	8.276993	2.135290	2.872211	0.257365	1.292361	3.102248	0.732076	0.576848	0.890607	0.4

KMBL-811-PROD-Daily.csv

std/mean as a percentage value

	std	mean	volatility
Budgets($)	0.000467	0.000023	1989.974874
Config($)	0.000234	0.000012	1989.974874
Direct Connect($)	0.009718	0.000488	1989.629459
X-Ray($)	0.000001	0.0	1017.817531
Certificate Manager($)	49.566349	6.940227	714.18918

KMBL-811-PROD-Daily.csv

remove total costs as well

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)
date-time																																									
2023-04-01	2023-04-01	124.521967	152.571055	33.982042	459.141194	163.449675	2.578341	0.0	61.207821	24.450268	17.060324	0.0	0.0	NaN	22.63248	0.0	8.248101	6.696	NaN	0.002425	0.029955	11.16	NaN	2.88	8.654000e-07	0.000002	0.000000	NaN	NaN	0.186	0.000755	1.037406	0.653157	0.002065	0.010805	0.000000	0.053697	0.0	0.0	0.0	0.0	0.0
2023-04-02	2023-04-02	125.064384	153.670462	33.983080	461.683472	194.116625	2.576981	0.0	62.029757	17.765903	17.060324	0.0	0.0	NaN	22.63248	0.0	8.133072	6.696	NaN	0.014940	0.047450	11.16	NaN	2.88	8.982000e-07	0.000002	0.000000	NaN	NaN	0.000	0.000787	1.037406	0.653606	0.000109	0.006743	0.000000	0.053892	0.0	0.0	0.0	0.0	0.0
2023-04-03	2023-04-03	125.123743	207.749209	33.982773	467.740160	351.559010	2.579946	0.0	72.756228	16.269905	17.060323	0.0	0.0	NaN	22.63248	0.0	8.314704	6.696	NaN	0.012652	0.049930	11.16	NaN	2.88	9.013000e-07	0.000002	0.000143	NaN	NaN	0.000	0.000796	1.038382	0.682136	0.001115	0.014412	0.000660	0.053906	0.0	0.0	0.0	0.0	0.0
2023-04-04	2023-04-04	124.560458	171.774002	33.979421	467.406064	476.755835	2.579381	0.0	64.861449	18.624507	17.060321	0.0	0.0	NaN	22.63248	0.0	8.213184	6.696	NaN	0.011867	0.049318	11.16	NaN	2.88	8.176000e-07	0.000002	0.000111	NaN	NaN	0.000	0.000805	1.039251	0.711197	0.001968	0.025381	0.067258	0.053799	0.0	0.0	0.0	0.0	0.0
2023-04-05	2023-04-05	124.689758	157.636570	33.972522	473.034060	235.284475	2.582812	0.0	63.973417	14.964331	17.060322	0.0	0.0	NaN	22.63248	0.0	8.249709	6.696	NaN	0.012273	0.049298	11.16	NaN	2.88	7.056000e-07	0.000002	0.000043	NaN	NaN	0.000	0.024237	1.040640	0.709942	0.000828	0.020904	0.005966	0.053287	0.0	0.0	0.0	0.0	0.0

KMBL-811-PROD-Daily.csv

correlation matrix across all services

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Servic Catalog($
date-time	1.000000	-0.549767	0.467089	0.917700	0.346097	-0.294615	0.622561	0.457874	0.870937	0.453693	0.262905	0.247778	0.880956	NaN	0.946032	0.767095	0.889332	-0.655938	NaN	0.793070	0.750122	NaN	NaN	-0.044749	-0.240597	-0.216320	0.897678	NaN	NaN	0.786960	0.857931	0.110001	0.266608	0.838215	0.391995	0.086522	0.909575	0.114817	0.649009	0.089862	0.277336	0.30492
EC2-Instances($)	-0.549767	1.000000	0.057339	-0.442686	-0.170964	0.187303	-0.090934	-0.080616	-0.404891	-0.218356	0.130027	-0.018596	-0.504559	NaN	-0.628633	-0.100356	-0.278600	0.911990	NaN	-0.134693	-0.055271	NaN	NaN	-0.151260	0.562257	-0.007723	-0.225096	NaN	NaN	-0.791574	-0.224420	-0.184940	-0.822571	-0.242462	-0.305485	-0.022793	-0.335449	-0.098978	-0.161655	-0.029484	-0.487896	0.06358
S3($)	0.467089	0.057339	1.000000	0.332264	0.190834	-0.019069	0.224099	0.394083	0.682170	0.163421	0.370318	0.084294	0.351458	NaN	0.459532	0.524538	0.463609	-0.067942	NaN	0.456016	0.404671	NaN	NaN	-0.053421	0.167469	-0.153180	0.627064	NaN	NaN	0.194581	0.666913	-0.131230	-0.317832	0.432621	0.562238	0.070063	0.414530	0.033365	0.592945	0.032308	0.154919	0.26486
Relational Database Service($)	0.917700	-0.442686	0.332264	1.000000	0.327386	-0.251201	0.815486	0.326208	0.749941	0.433924	0.169627	0.278755	0.816248	NaN	0.807038	0.763285	0.883043	-0.582866	NaN	0.875084	0.850649	NaN	NaN	-0.012385	-0.263967	-0.209989	0.826618	NaN	NaN	0.732073	0.786572	0.031230	0.167639	0.908435	0.185687	0.111549	0.932297	0.099645	0.575125	0.103140	0.098165	0.31441
EC2-Other($)	0.346097	-0.170964	0.190834	0.327386	1.000000	0.077425	0.310460	0.092353	0.332438	0.167633	0.477182	0.090680	0.285263	NaN	0.366497	0.315798	0.313897	-0.147336	NaN	0.343913	0.314654	NaN	NaN	0.164111	-0.051876	0.040080	0.355736	NaN	NaN	0.209417	0.348792	0.125188	-0.027824	0.351867	0.120800	0.102834	0.310219	0.055592	0.279666	-0.047210	-0.074818	0.05979

KMBL-811-PROD-Daily.csv

p-values over the correlation

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	Cl
date-time	0.000000e+00	1.177383e-32	7.473807e-23	4.818712e-160	1.384101e-12	2.267040e-09	7.185080e-44	6.451773e-22	1.222681e-123	1.679556e-21	1.102939e-07	5.938245e-07	4.222863e-130	NaN	6.633778e-195	5.788919e-78	5.751908e-136	4.515910e-50	NaN	7.581316e-87	9.219060e-73	NaN	NaN	0.374479	1.272393e-06	0.000014	2.656873e-142	NaN	NaN	1.204705e-84	5.146772e-116	0.028618	7.185978e-08	8.448241e-106	5.383868e-16	0.085515	2.389789e-152
EC2-Instances($)	1.177383e-32	0.000000e+00	2.549710e-01	1.958697e-20	6.341472e-04	1.777367e-04	7.066912e-02	1.092075e-01	4.701606e-17	1.162400e-05	9.588455e-03	7.121928e-01	5.765578e-27	NaN	6.085679e-45	4.595811e-02	1.714735e-08	1.475671e-154	NaN	7.271797e-03	2.725352e-01	NaN	NaN	0.002545	2.193261e-34	0.878245	6.086065e-06	NaN	NaN	2.664988e-86	6.500126e-06	0.000215	1.260946e-98	1.046285e-06	5.335736e-10	0.651126	7.189454e-12
S3($)	7.473807e-23	2.549710e-01	0.000000e+00	1.162648e-11	1.330673e-04	7.052100e-01	6.705747e-06	3.654483e-16	1.575599e-55	1.099549e-03	2.566856e-14	9.391371e-02	5.894996e-13	NaN	4.399056e-22	2.245400e-29	1.700154e-22	1.772337e-01	NaN	9.887515e-22	4.905968e-17	NaN	NaN	0.288934	8.207049e-04	0.002238	1.157665e-44	NaN	NaN	9.731352e-05	2.748786e-52	0.008936	9.582987e-11	1.714229e-19	2.207009e-34	0.164064	7.082736e-18
Relational Database Service($)	4.818712e-160	1.958697e-20	1.162648e-11	0.000000e+00	2.401433e-11	4.095607e-07	1.321999e-95	2.855797e-11	1.042167e-72	1.299763e-19	7.002915e-04	1.682464e-08	6.352758e-96	NaN	3.606181e-92	9.297390e-77	1.607714e-131	2.094479e-37	NaN	3.020727e-126	4.526459e-112	NaN	NaN	0.805929	9.760851e-08	0.000025	2.063869e-100	NaN	NaN	1.135657e-67	1.651846e-84	0.535485	8.105916e-04	2.510770e-151	2.025578e-04	0.026439	4.175575e-176
EC2-Other($)	1.384101e-12	6.341472e-04	1.330673e-04	2.401433e-11	0.000000e+00	1.240041e-01	2.696899e-10	6.637022e-02	1.132668e-11	8.109063e-04	6.533805e-24	7.146474e-02	7.503754e-09	NaN	4.925746e-14	1.278537e-10	1.670725e-10	3.295474e-03	NaN	1.950472e-12	1.502221e-10	NaN	NaN	0.001047	3.031274e-01	0.426395	2.948692e-13	NaN	NaN	2.659145e-05	9.030894e-13	0.012661	5.809192e-01	5.519938e-13	1.616824e-02	0.040822	2.788326e-10

KMBL-811-PROD-Daily.csv

STAR (*) representation of correlations based on p-values for easier visual comparision

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	
date-time	*******	*******	*******	*******	*******	*****	*******	*******	*******	*******	****	****	*******		*******	*******	*******	*******		*******	*******				****	***	*******			*******	*******	*	*****	*******	*******	*	*******		*******		******	*******	*******		
EC2-Instances($)	*******	*******		*******	*******	*****	*******	*******	*******	***	****	**	*******		*******	*	*****	*******		*******	**			**	*******	***	******			*******	****	***	*******	*******	*******		*******		*******	*	*******	******	*****		*
S3($)	*******		*******	******	***	*****	****	*******	*******	**	*******		*******		*******	*******	*******			*******	*******				***	**	*******			***	*******	**	*******	*******	*******		*******		*******		******	*****	***		
Relational Database Service($)	*******	*******	******	*******	******	*****	*******	******	*******	*******	***	*****	*******		*******	*******	*******	*******		*******	*******				*****	***	*******			*******	*******		***	*******	***	*	*******	*	*******	*	******	*******	*******		
EC2-Other($)	*******	***	***	******	*******		******		******	***	*******		*****		*******	******	******	**		*******	******			**			*******			***	*******	*	*****	*******	*	*	******		*****			*****			

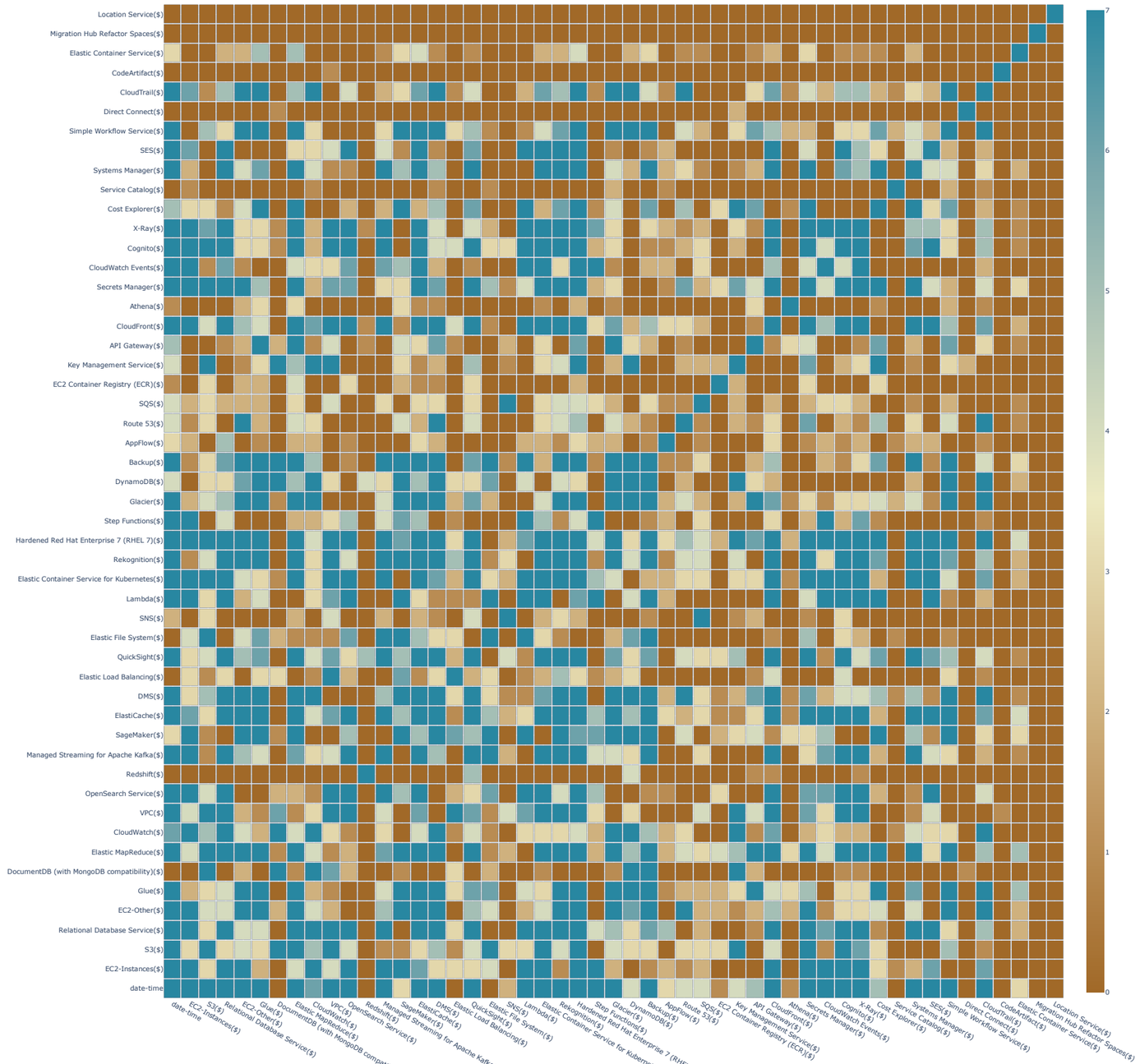
KMBL-811-PROD-Daily.csv

simple RANK based representation of correlations based on p-values for easier analysis

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	W Se
date-time	7	7	7	7	7	5	7	7	7	7	4	4	7	0	7	7	7	7	0	7	7	0	0	0	4	3	7	0	0	7	7	1	5	7	7	0	7	1	7	0	5	6	7	0	
EC2-Instances($)	7	7	0	7	3	3	0	0	7	3	2	0	7	0	7	1	5	7	0	2	0	0	0	2	7	0	4	0	0	7	4	3	7	4	6	0	7	1	2	0	7	0	0	1	
S3($)	7	0	7	6	3	0	4	7	7	2	7	0	7	0	7	7	7	0	0	7	7	0	0	0	3	2	7	0	0	3	7	2	6	7	7	0	7	0	7	0	2	5	3	0	
Relational Database Service($)	7	7	6	7	6	4	7	6	7	7	3	5	7	0	7	7	7	7	0	7	7	0	0	0	5	3	7	0	0	7	7	0	3	7	3	1	7	1	7	1	0	6	7	0	
EC2-Other($)	7	3	3	6	7	0	6	0	6	3	7	0	5	0	7	6	6	2	0	7	6	0	0	2	0	0	7	0	0	3	7	1	0	7	1	1	6	0	5	0	0	0	5	0	

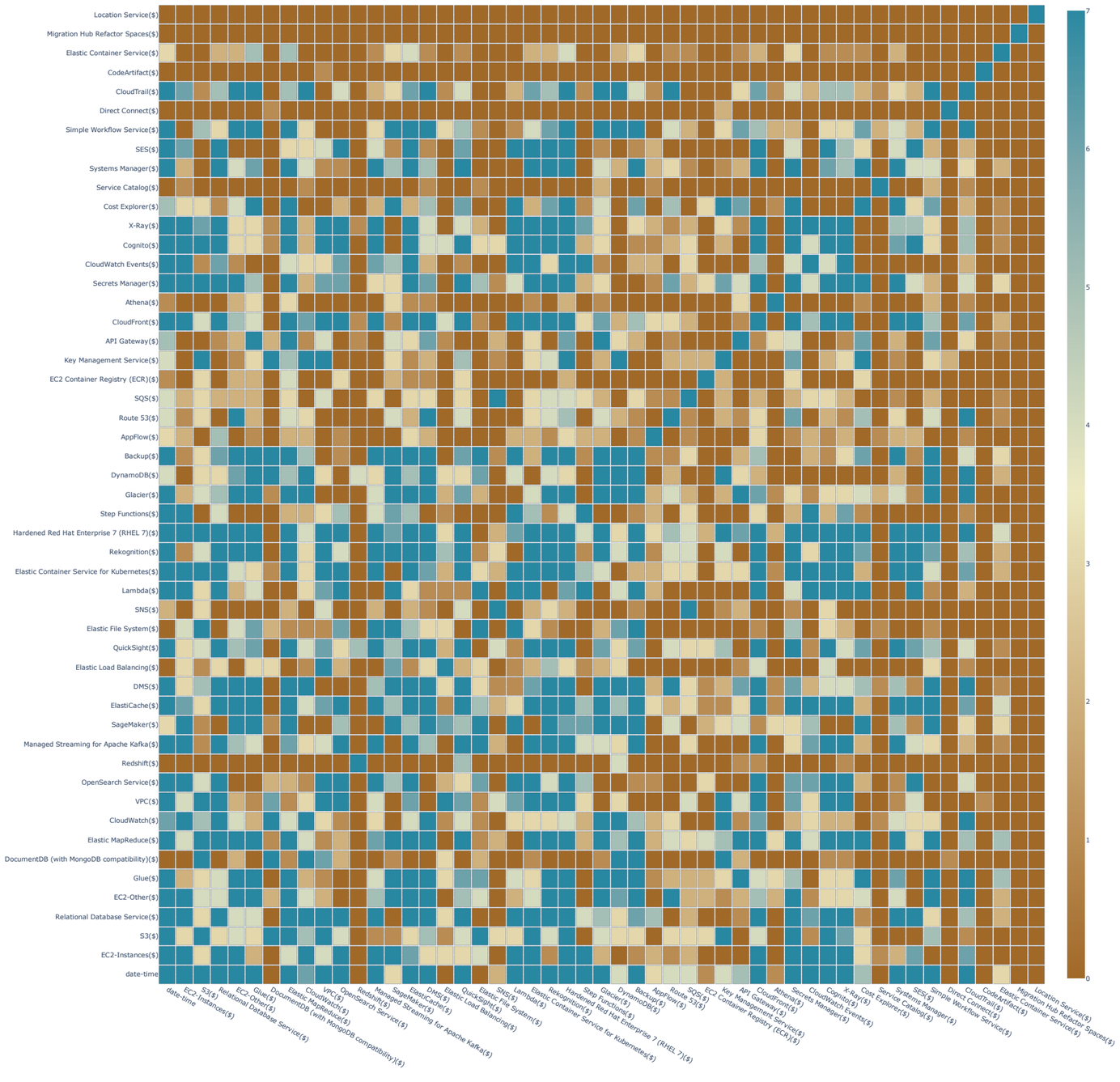
KMBL-811-PROD-Daily.csv

raw correlations of service usage



KMBL-811-PROD-Daily.csv

statistical significance of usage correlations between services:



KMBL-Logs-Daily.csv

Analysis for **KMBL-Logs-Daily.csv**

KMBL-Logs-Daily.csv

raw data from the file

	Service	S3($)	Kinesis($)	Tax($)	CloudTrail($)	Kinesis Firehose($)	Key Management Service($)	SQS($)	CloudWatch($)	QuickSight($)	Lambda($)	Cost Explorer($)	Athena($)	Config($)	Glue($)	Service Catalog($)	SNS($)	Secrets Manager($)	Simple Workflow Service($)	Step Functions($)	CloudShell($)	Glacier($)	CodeArtifact($)	Systems Manager($)	Total costs($)
0	Service total	1817.048188	1475.576055	920.63	669.461270	655.095167	146.130018	9.138921e+01	83.704694	72.81	55.621631	30.1698	8.669004	6.898041	1.210231	0.566629	5.360944e-01	0.065349	0.000191	0.000185	0.000027	0.000013	0.0	0.0	6035.581795
1	2023-04-01	2.729042	3.816048	43.25	0.011405	1.285316	0.000145	3.720000e-07	0.076586	NaN	0.081218	NaN	NaN	NaN	NaN	NaN	1.860000e-06	0.000005	NaN	NaN	NaN	NaN	NaN	NaN	51.249766
2	2023-04-02	2.734484	3.812915	NaN	0.011981	1.259223	0.000098	3.720000e-07	0.077318	NaN	0.144746	NaN	NaN	NaN	NaN	NaN	1.395000e-06	0.000005	NaN	NaN	NaN	NaN	NaN	NaN	8.040771
3	2023-04-03	2.701606	3.819635	NaN	0.012276	1.333087	0.000014	7.440000e-07	0.078862	NaN	0.153914	NaN	NaN	NaN	NaN	NaN	9.300000e-07	0.000009	NaN	NaN	NaN	NaN	0.0	NaN	8.099405
4	2023-04-04	2.684521	3.819316	NaN	0.011103	1.300377	0.000162	3.720000e-07	0.075433	NaN	0.144718	NaN	NaN	NaN	NaN	NaN	1.860000e-06	0.000005	NaN	NaN	NaN	NaN	NaN	NaN	8.035637

KMBL-Logs-Daily.csv

clean data

	date-time	S3($)	Kinesis($)	Tax($)	CloudTrail($)	Kinesis Firehose($)	Key Management Service($)	SQS($)	CloudWatch($)	QuickSight($)	Lambda($)	Cost Explorer($)	Athena($)	Config($)	Glue($)	Service Catalog($)	SNS($)	Secrets Manager($)	Simple Workflow Service($)	Step Functions($)	CloudShell($)	Glacier($)	CodeArtifact($)	Systems Manager($)	Total costs($)
date-time																									
2023-04-01	2023-04-01	2.729042	3.816048	43.25	0.011405	1.285316	0.000145	3.720000e-07	0.076586	0.0	0.081218	0.0	0.0	0.0	0.0	0.0	1.860000e-06	0.000005	0.0	0.0	0.0	0.0	0.0	0.0	51.249766
2023-04-02	2023-04-02	2.734484	3.812915	0.00	0.011981	1.259223	0.000098	3.720000e-07	0.077318	0.0	0.144746	0.0	0.0	0.0	0.0	0.0	1.395000e-06	0.000005	0.0	0.0	0.0	0.0	0.0	0.0	8.040771
2023-04-03	2023-04-03	2.701606	3.819635	0.00	0.012276	1.333087	0.000014	7.440000e-07	0.078862	0.0	0.153914	0.0	0.0	0.0	0.0	0.0	9.300000e-07	0.000009	0.0	0.0	0.0	0.0	0.0	0.0	8.099405
2023-04-04	2023-04-04	2.684521	3.819316	0.00	0.011103	1.300377	0.000162	3.720000e-07	0.075433	0.0	0.144718	0.0	0.0	0.0	0.0	0.0	1.860000e-06	0.000005	0.0	0.0	0.0	0.0	0.0	0.0	8.035637
2023-04-05	2023-04-05	2.684990	3.819560	0.00	0.011608	1.315611	0.000100	7.440000e-07	0.075370	0.0	0.151046	0.0	0.0	0.0	0.0	0.0	1.860000e-06	0.000009	0.0	0.0	0.0	0.0	0.0	0.0	8.058299

KMBL-Logs-Daily.csv

.describe() with 10 percentiles

	date-time	S3($)	Kinesis($)	Tax($)	CloudTrail($)	Kinesis Firehose($)	Key Management Service($)	SQS($)	CloudWatch($)	QuickSight($)	Lambda($)	Cost Explorer($)	Athena($)	Config($)	Glue($)	Service Catalog($)	SNS($)	Secrets Manager($)	Simple Workflow Service($)	Step Functions($)	CloudShell($)	Glacier($)	CodeArtifact($)	Systems Manager($)	Total costs($)
count	396	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	3.960000e+02	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	3.960000e+02	3.960000e+02	3.960000e+02	3.960000e+02	396.0	396.0	396.000000
mean	2023-10-15 12:00:00	4.588506	3.726202	2.324823	1.690559	1.654281	0.369015	2.307808e-01	0.211375	0.183864	0.140459	0.076186	0.021891	0.017419	0.003056	0.001431	0.001354	0.000165	4.814136e-07	4.669510e-07	6.935455e-08	3.316187e-08	0.0	0.0	15.241368
min	2023-04-01 00:00:00	2.259119	1.698656	0.000000	0.000000	1.174924	0.000003	3.720000e-07	0.010790	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000005	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.0	0.0	6.264350
10%	2023-05-10 12:00:00	2.628202	3.642784	0.000000	0.000000	1.315002	0.000006	3.720000e-07	0.012574	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000001	0.000005	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.0	0.0	7.977867
20%	2023-06-19 00:00:00	2.872376	3.817414	0.000000	0.000000	1.363974	0.000006	1.116000e-06	0.013406	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000002	0.000005	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.0	0.0	8.495061
30%	2023-07-28 12:00:00	3.224002	3.825939	0.000000	0.000000	1.420553	0.000098	1.449312e-03	0.023135	0.000000	0.069870	0.000000	0.000000	0.000000	0.000000	0.000000	0.000041	0.000005	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.0	0.0	8.733770
40%	2023-09-06 00:00:00	3.373849	3.828780	0.000000	0.008287	1.470462	0.000106	2.004708e-03	0.027938	0.000000	0.133217	0.000000	0.000000	0.000000	0.000000	0.000000	0.000059	0.000009	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.0	0.0	9.086553
50%	2023-10-15 12:00:00	3.805847	3.832957	0.000000	0.008948	1.537919	0.059202	9.242898e-03	0.034300	0.000000	0.149651	0.009300	0.000000	0.013392	0.000149	0.000000	0.000076	0.000167	7.126500e-07	6.915000e-07	0.000000e+00	3.770000e-08	0.0	0.0	10.706410
60%	2023-11-24 00:00:00	4.557405	3.837449	0.000000	0.010319	1.594792	0.094344	1.347124e-02	0.046798	0.000000	0.163181	0.009300	0.000000	0.021390	0.000181	0.001302	0.000313	0.000219	7.360000e-07	7.143000e-07	0.000000e+00	5.330000e-08	0.0	0.0	13.378582
70%	2024-01-02 12:00:00	5.234563	3.840842	0.000000	0.011882	1.625956	0.955706	5.653042e-01	0.075334	0.000000	0.190164	0.158100	0.000000	0.024180	0.000203	0.001302	0.000318	0.000265	7.859500e-07	7.427500e-07	0.000000e+00	6.400000e-08	0.0	0.0	15.221325
80%	2024-02-11 00:00:00	6.758083	3.843545	0.000000	0.020423	1.811912	1.029566	6.038616e-01	0.241336	0.000000	0.202723	0.186000	0.000000	0.027156	0.000270	0.003696	0.004971	0.000312	9.555000e-07	9.391000e-07	0.000000e+00	7.200000e-08	0.0	0.0	17.504128
90%	2024-03-21 12:00:00	7.904313	3.854175	0.000000	7.241854	2.317073	1.088119	7.164700e-01	0.773385	0.000000	0.274473	0.218550	0.119828	0.032922	0.017232	0.003906	0.005353	0.000393	9.911500e-07	9.581500e-07	0.000000e+00	7.710000e-08	0.0	0.0	19.951280
max	2024-04-30 00:00:00	8.541813	3.882082	124.450000	145.275037	3.240317	1.424761	8.533415e-01	6.187616	2.160000	0.552980	0.381300	0.268198	0.435240	0.026991	0.019530	0.036499	0.000525	1.052100e-06	9.867000e-07	1.160670e-05	1.109000e-07	0.0	0.0	166.442307
std	NaN	1.916501	0.438822	13.501591	9.278749	0.416247	0.486476	3.067085e-01	0.603724	0.593784	0.115385	0.105543	0.054399	0.030282	0.006826	0.002392	0.002807	0.000160	4.312443e-07	4.183960e-07	6.750188e-07	3.416407e-08	0.0	0.0	17.265738

KMBL-Logs-Daily.csv

std/mean as a percentage value

	std	mean	volatility
CloudShell($)	0.000001	0.0	973.287061
Tax($)	13.501591	2.324823	580.75773
CloudTrail($)	9.278749	1.690559	548.856917
QuickSight($)	0.593784	0.183864	322.94807
CloudWatch($)	0.603724	0.211375	285.617048

KMBL-Logs-Daily.csv

remove total costs as well

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Ma
date-time																																											
2023-04-01	2023-04-01	NaN	2.729042	NaN	NaN	0.0	NaN	NaN	0.076586	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.0	NaN	1.860000e-06	0.081218	NaN	NaN	NaN	0.0	0.0	NaN	NaN	NaN	NaN	3.720000e-07	NaN	0.000145	NaN	NaN	0.0	0.000005	NaN	NaN	NaN	0.0	0.0	
2023-04-02	2023-04-02	NaN	2.734484	NaN	NaN	0.0	NaN	NaN	0.077318	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.0	NaN	1.395000e-06	0.144746	NaN	NaN	NaN	0.0	0.0	NaN	NaN	NaN	NaN	3.720000e-07	NaN	0.000098	NaN	NaN	0.0	0.000005	NaN	NaN	NaN	0.0	0.0	
2023-04-03	2023-04-03	NaN	2.701606	NaN	NaN	0.0	NaN	NaN	0.078862	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.0	NaN	9.300000e-07	0.153914	NaN	NaN	NaN	0.0	0.0	NaN	NaN	NaN	NaN	7.440000e-07	NaN	0.000014	NaN	NaN	0.0	0.000009	NaN	NaN	NaN	0.0	0.0	
2023-04-04	2023-04-04	NaN	2.684521	NaN	NaN	0.0	NaN	NaN	0.075433	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.0	NaN	1.860000e-06	0.144718	NaN	NaN	NaN	0.0	0.0	NaN	NaN	NaN	NaN	3.720000e-07	NaN	0.000162	NaN	NaN	0.0	0.000005	NaN	NaN	NaN	0.0	0.0	
2023-04-05	2023-04-05	NaN	2.684990	NaN	NaN	0.0	NaN	NaN	0.075370	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.0	NaN	1.860000e-06	0.151046	NaN	NaN	NaN	0.0	0.0	NaN	NaN	NaN	NaN	7.440000e-07	NaN	0.000100	NaN	NaN	0.0	0.000009	NaN	NaN	NaN	0.0	0.0	

KMBL-Logs-Daily.csv

correlation matrix across all services

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility)($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	
date-time	1.000000	NaN	0.821019	NaN	NaN	0.639808	NaN	NaN	0.019150	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.490255	NaN	0.058052	0.160152	NaN	NaN	NaN	0.789954	0.754162	NaN	NaN	NaN	NaN	0.856638	NaN	0.853959	NaN	NaN	0.609350	0.774088	NaN	NaN	NaN	NaN	NaN	NaN
EC2-Instances($)	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
S3($)	0.821019	NaN	1.000000	NaN	NaN	0.484522	NaN	NaN	0.126987	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.462955	NaN	-0.053248	0.180667	NaN	NaN	NaN	0.720781	0.572489	NaN	NaN	NaN	NaN	0.772411	NaN	0.766666	NaN	NaN	0.481061	0.818481	NaN	NaN	NaN	0.180172	0.383742	NaN
Relational Database Service($)	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
EC2-Other($)	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

KMBL-Logs-Daily.csv

p-values over the correlation

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility)($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	C Explorer
date-time	0.000000e+00	NaN	5.944276e-98	NaN	NaN	5.594207e-47	NaN	NaN	0.704012	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2.459902e-25	NaN	0.249097	0.001386	NaN	NaN	NaN	1.026640e-85	5.822246e-74	NaN	NaN	NaN	NaN	2.674871e-115	NaN	7.753536e-114	NaN	NaN	1.286742e-41	3.079396e-80	NaN	NaN	NaN	2.763665e
EC2-Instances($)	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	N
S3($)	5.944276e-98	NaN	0.000000e+00	NaN	NaN	1.054431e-24	NaN	NaN	0.011430	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	1.981610e-22	NaN	0.290505	0.000302	NaN	NaN	NaN	1.081820e-64	7.385175e-36	NaN	NaN	NaN	NaN	1.099622e-79	NaN	7.934784e-78	NaN	NaN	2.505769e-24	7.256032e-97	NaN	NaN	NaN	3.138569e
Relational Database Service($)	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	N
EC2-Other($)	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	N

KMBL-Logs-Daily.csv

STAR (*) representation of correlations based on p-values for easier visual comparision

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility)($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	
date-time	*******		*******			*******												*******		**					*******	*******						*******		*******			*******	*******			*****	*******			
EC2-Instances($)																																												
S3($)	*******		*******			*******			*									*******		***					*******	*******						*******		*******			*******	*******			***	*******			
Relational Database Service($)																																												
EC2-Other($)																																												

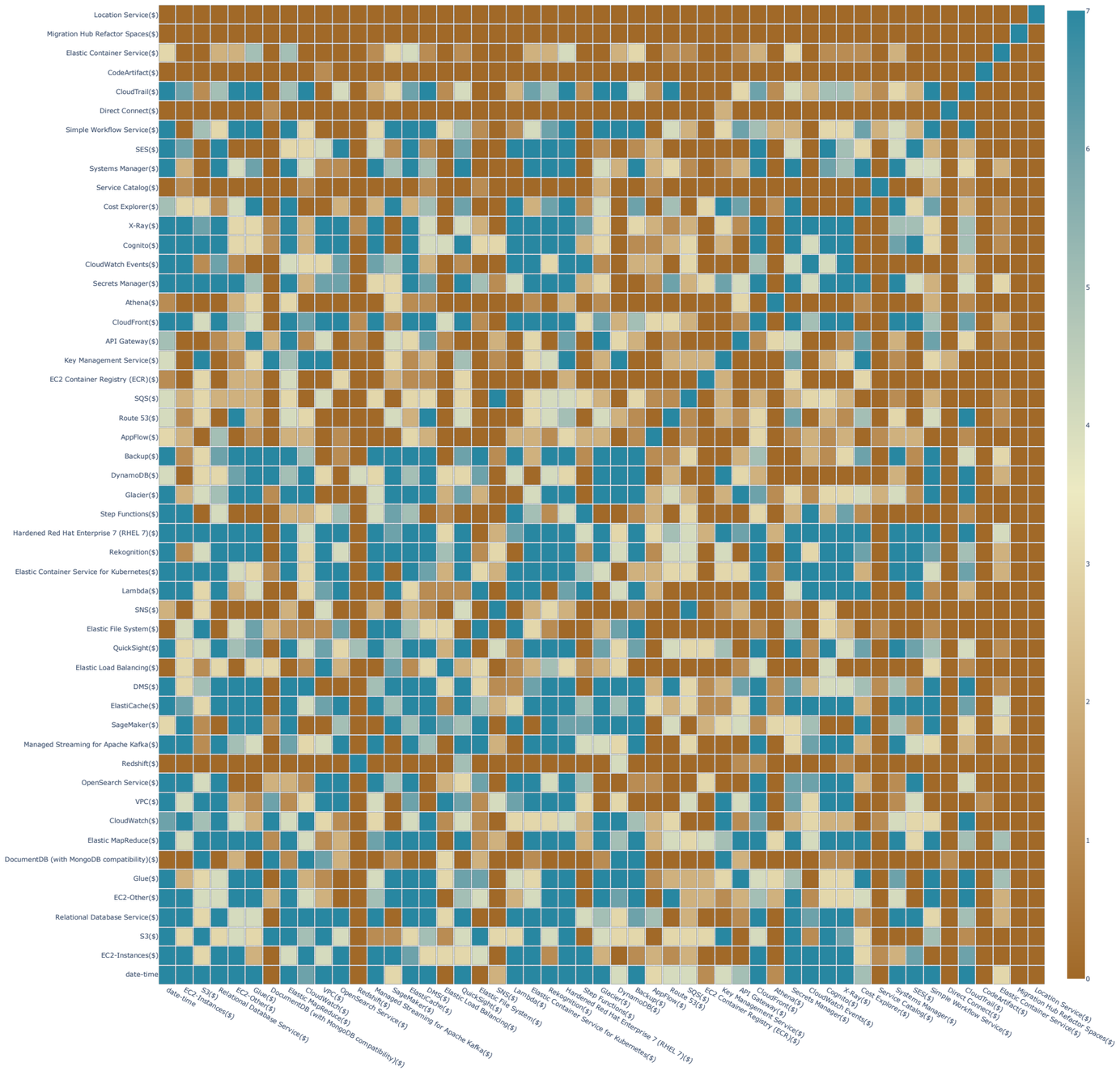
KMBL-Logs-Daily.csv

simple RANK based representation of correlations based on p-values for easier analysis

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility)($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	W Se
date-time	7	0	7	0	0	7	0	0	0	0	0	0	0	0	0	0	0	7	0	0	2	0	0	0	7	7	0	0	0	0	7	0	7	0	0	7	7	0	0	0	5	7	0	0	
EC2-Instances($)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
S3($)	7	0	7	0	0	7	0	0	1	0	0	0	0	0	0	0	0	7	0	0	3	0	0	0	7	7	0	0	0	0	7	0	7	0	0	7	7	0	0	0	3	7	0	0	
Relational Database Service($)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
EC2-Other($)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

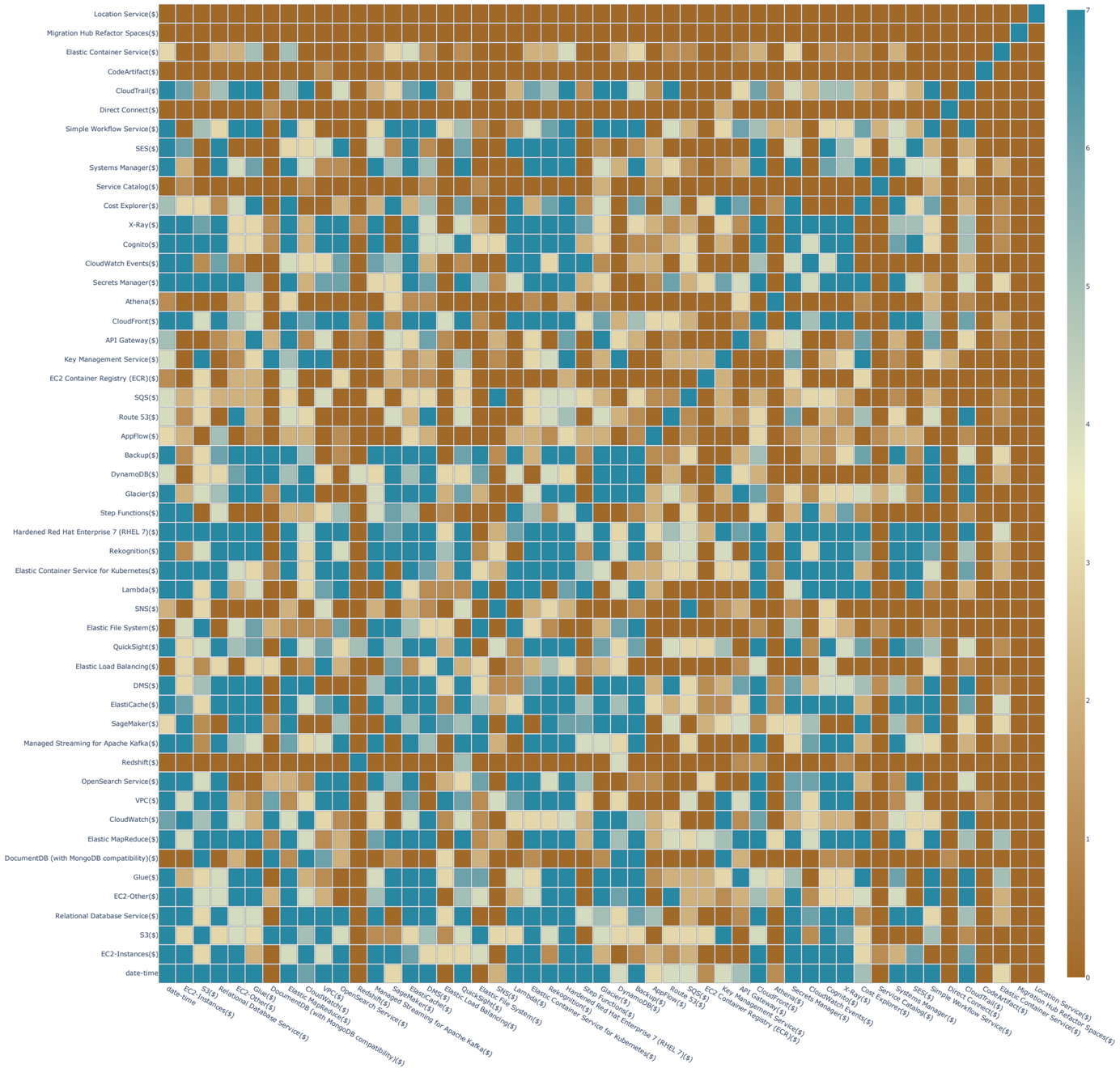
KMBL-Logs-Daily.csv

raw correlations of service usage



KMBL-Logs-Daily.csv

statistical significance of usage correlations between services:



KMBL-MB2-PROD-Daily.csv

Analysis for **KMBL-MB2-PROD-Daily.csv**

KMBL-MB2-PROD-Daily.csv

raw data from the file

	Service	Relational Database Service($)	Tax($)	EC2-Other($)	OpenSearch Service($)	EC2-Instances($)	Support (Business)($)	ElastiCache($)	CloudWatch($)	Certificate Manager($)	Elastic File System($)	Elastic Load Balancing($)	Managed Streaming for Apache Kafka($)	VPC($)	Elastic Container Service for Kubernetes($)	CIS Linux 2 Benchmark - Level 2($)	S3($)	EC2 Container Registry (ECR)($)	CloudTrail($)	Secrets Manager($)	Key Management Service($)	FSx($)	Inspector($)	DynamoDB($)	Cost Explorer($)	Lambda($)	SQS($)	SNS($)	CloudFront($)	Service Catalog($)	Athena($)	Glue($)	Fault Injection Simulator($)	Direct Connect($)	CloudWatch Events($)	SES($)	Simple Workflow Service($)	Glacier($)	Step Functions($)	Systems Manager($)	CloudShell($)
0	Service total	180655.804385	100372.5	92027.942034	61793.033835	45737.505951	39400.517465	30963.840866	25696.222397	22824.012808	12492.593782	11598.046246	10947.313818	10602.612593	10454.002237	3660.94	1691.503399	944.296091	859.673288	786.435759	694.637890	92.375181	39.973354	36.343666	29.8251	6.12208	3.033951	1.861828	1.341474	1.199793	0.360738	0.211260	0.1209	0.110761	0.002344	0.000854	0.000283	0.000280	2.752114e-04	0.000145	0.000052
1	2023-04-01	648.182762	11276.9	300.419082	364.169296	219.508804	4687.434585	105.729840	93.657471	1488.000000	14.956827	28.514646	42.461826	19.104387	24.552000	17.68	8.309295	0.305008	0.000000	1.462845	0.795646	NaN	1.862594	0.079282	NaN	NaN	0.000348	0.002069	0.000000	NaN	NaN	0.001659	NaN	NaN	0.000099	NaN	NaN	0.000002	7.998000e-07	NaN	NaN
2	2023-04-02	640.635053	NaN	298.528247	364.176570	208.935977	NaN	105.729840	103.591755	NaN	15.044351	28.653741	42.461714	32.443318	24.552000	15.82	8.382068	0.305008	0.000000	1.415782	0.796090	NaN	1.724592	0.079281	NaN	NaN	0.000362	0.000242	0.000000	NaN	NaN	0.001851	NaN	NaN	0.000000	NaN	NaN	0.000002	8.818000e-07	NaN	NaN
3	2023-04-03	652.403935	NaN	306.484289	364.152763	266.388313	NaN	105.729840	104.364553	NaN	15.117827	28.481126	42.463279	21.487030	24.552000	19.06	8.450901	0.305663	0.000000	1.527322	0.796131	NaN	2.616649	0.079281	NaN	NaN	0.000362	0.002053	0.000027	NaN	NaN	0.001867	NaN	NaN	0.000195	NaN	NaN	0.000002	8.818000e-07	NaN	NaN
4	2023-04-04	647.330632	NaN	306.289195	364.145535	283.110699	NaN	105.729840	104.080727	NaN	15.188953	28.510925	42.465356	16.973016	24.552000	18.78	8.206696	0.306445	0.000000	1.538305	0.793888	NaN	2.181230	0.079281	NaN	NaN	0.000261	0.003259	0.000002	NaN	NaN	0.001654	NaN	NaN	0.000147	NaN	NaN	0.000002	6.736000e-07	NaN	NaN

KMBL-MB2-PROD-Daily.csv

clean data

date-time	date-time	Relational Database Service($)	Tax($)	EC2-Other($)	OpenSearch Service($)	EC2-Instances($)	Support (Business)($)	ElastiCache($)	CloudWatch($)	Certificate Manager($)	Elastic File System($)	Elastic Load Balancing($)	Managed Streaming for Apache Kafka($)	VPC($)	Elastic Container Service for Kubernetes($)	CIS Linux 2 Benchmark - Level 2($)	S3($)	EC2 Container Registry (ECR)($)	CloudTrail($)	Secrets Manager($)	Key Management Service($)	FSx($)	Inspector($)	DynamoDB($)	Cost Explorer($)	Lambda($)	SQS($)	SNS($)	CloudFront($)	Service Catalog($)	Athena($)	Glue($)	Fault Injection Simulator($)	Direct Connect($)	CloudWatch Events($)	SES($)	Simple Workflow Service($)	Glacier($)	Step Functions($)	Systems Manager($)	CloudShell($)	CodeArtifact($)	Migr... Ref... Spac...
2023-04-01	2023-04-01	648.182762	11276.9	300.419082	364.169296	219.508804	4687.434585	105.72984	93.657471	1488.0	14.956827	28.514646	42.461826	19.104387	24.552	17.68	8.309295	0.305008	0.0	1.462845	0.795646	0.0	1.862594	0.079282	0.0	0.0	0.000348	0.002069	0.000000	0.0	0.0	0.001659	0.0	0.0	0.000099	0.0	0.0	0.000002	7.998000e-07	0.0	0.0	4.400000e-08
2023-04-02	2023-04-02	640.635053	0.0	298.528247	364.176570	208.935977	0.000000	105.72984	103.591755	0.0	15.044351	28.653741	42.461714	32.443318	24.552	15.82	8.382068	0.305008	0.0	1.415782	0.796090	0.0	1.724592	0.079281	0.0	0.0	0.000362	0.000242	0.000000	0.0	0.0	0.001851	0.0	0.0	0.000000	0.0	0.0	0.000002	8.818000e-07	0.0	0.0	5.280000e-08
2023-04-03	2023-04-03	652.403935	0.0	306.484289	364.152763	266.388313	0.000000	105.72984	104.364553	0.0	15.117827	28.481126	42.463279	21.487030	24.552	19.06	8.450901	0.305663	0.0	1.527322	0.796131	0.0	2.616649	0.079281	0.0	0.0	0.000362	0.002053	0.000027	0.0	0.0	0.001867	0.0	0.0	0.000195	0.0	0.0	0.000002	8.818000e-07	0.0	0.0	5.280000e-08
2023-04-04	2023-04-04	647.330632	0.0	306.289195	364.145535	283.110699	0.000000	105.72984	104.080727	0.0	15.188953	28.510925	42.465356	16.973016	24.552	18.78	8.206696	0.306445	0.0	1.538305	0.793888	0.0	2.181230	0.079281	0.0	0.0	0.000261	0.003259	0.000002	0.0	0.0	0.001654	0.0	0.0	0.000147	0.0	0.0	0.000002	6.736000e-07	0.0	0.0	5.150000e-08
2023-04-05	2023-04-05	643.589804	0.0	303.727591	364.148108	262.924419	0.000000	105.72984	103.454940	0.0	15.263354	28.501964	42.463925	16.999593	24.552	18.98	8.262750	0.306872	0.0	1.539323	0.793322	0.0	2.021153	0.079281	0.0	0.0	0.000288	0.003203	0.000012	0.0	0.0	0.001430	0.0	0.0	0.000105	0.0	0.0	0.000002	7.248000e-07	0.0	0.0	5.150000e-08

KMBL-MB2-PROD-Daily.csv

.describe() with 10 percentiles

	date-time	Relational Database Service($)	Tax($)	EC2-Other($)	OpenSearch Service($)	EC2-Instances($)	Support (Business)($)	ElastiCache($)	CloudWatch($)	Certificate Manager($)	Elastic File System($)	Elastic Load Balancing($)	Managed Streaming for Apache Kafka($)	VPC($)	Elastic Container Service for Kubernetes($)	CIS Linux 2 Benchmark - Level 2($)	S3($)	EC2 Container Registry (ECR)($)	CloudTrail($)	Secrets Manager($)	Key Management Service($)	FSx($)	Inspector($)	DynamoDB($)	Cost Explorer($)	Lambda($)	SQS($)	SNS($)	CloudFront($)	Service Catalog($)	Athena($)	Glue($)	Fault Injection Simulator($)	Direct Connect($)	CloudWatch Events($)	SES($)	Simple Workflow Service($)	Glacier($)	Step Functions($)	Systems Manager($)	Clo...
count	396	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	3.960000e+02	3.960000e+02	3.960000e+02	3.960000e+02	3.96
mean	2023-10-15 12:00:00	456.201526	253.465909	232.393793	156.043015	115.498752	99.496256	78.191517	64.889450	57.636396	31.546954	29.287996	27.644732	26.774274	26.398996	9.244798	4.271473	2.384586	2.170892	1.985949	1.754136	0.233271	0.100943	0.091777	0.075316	0.015460	0.007661	0.004702	0.003388	0.003030	0.000911	0.000533	0.000305	0.000280	0.000006	0.000002	7.153518e-07	7.068831e-07	6.949783e-07	3.663636e-07	1.3
min	2023-04-01 00:00:00	174.227756	0.000000	148.087055	20.724929	0.001332	0.000000	12.655440	12.893089	0.000000	6.711950	25.785848	8.215560	16.587425	17.856000	0.960000	1.590225	0.305008	0.000000	1.298085	0.757264	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000061	0.000000	0.000000	0.000000	0.000010	0.000000	0.000000	0.000000	0.000000	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.00
10%	2023-05-10 12:00:00	206.298801	0.000000	160.204660	20.725113	0.439909	0.000000	12.655440	36.788733	0.000000	18.885771	26.378628	8.251283	16.786185	22.320000	1.920000	1.792772	0.331395	0.000000	1.383891	0.776708	0.000000	0.000000	0.079281	0.000000	0.000000	0.000020	0.001310	0.000000	0.000000	0.000000	0.000089	0.000000	0.000000	0.000000	0.000000	0.000000e+00	3.800000e-08	2.298500e-07	0.000000e+00	0.00
20%	2023-06-19 00:00:00	250.366076	0.000000	169.434618	20.933728	2.996603	0.000000	12.655440	48.919304	0.000000	23.073682	26.609780	8.324211	17.004166	23.285992	2.112000	1.905552	0.365686	0.000000	1.435040	0.795361	0.000000	0.000000	0.079281	0.000000	0.000000	0.000348	0.001829	0.000069	0.000000	0.000000	0.000143	0.000000	0.000000	0.000000	0.000000	4.669000e-07	4.920000e-08	4.630000e-07	0.000000e+00	0.00
30%	2023-07-28 12:00:00	356.534953	0.000000	186.389285	128.758784	27.172678	0.000000	60.777360	52.012208	0.000000	25.455317	26.711537	23.542785	17.172262	24.552000	4.830000	1.973033	0.404358	0.000000	1.532834	0.835290	0.000000	0.000000	0.079281	0.000000	0.000000	0.003209	0.002271	0.000444	0.000000	0.000000	0.000168	0.000000	0.000000	0.000000	0.000000	6.022000e-07	5.350000e-08	6.474000e-07	0.000000e+00	0.00
40%	2023-09-06 00:00:00	494.855294	0.000000	209.098111	140.205422	39.896494	0.000000	60.777361	56.824915	0.000000	28.891521	26.778971	23.555810	17.930333	24.552000	6.500000	2.068468	0.415927	0.000000	1.597193	1.146378	0.000000	0.000000	0.079281	0.000000	0.000000	0.004075	0.003147	0.000959	0.000000	0.000000	0.000189	0.000000	0.000000	0.000000	0.000000	7.298000e-07	5.880000e-08	7.082000e-07	0.000000e+00	0.00
50%	2023-10-15 12:00:00	511.205664	0.000000	249.534439	149.375465	64.409271	0.000000	83.186640	60.569168	0.000000	32.550983	27.360833	34.527405	20.889152	24.552000	9.120000	2.199587	0.428772	0.000000	1.682244	1.640686	0.000000	0.000000	0.079281	0.009300	0.000000	0.008581	0.004610	0.001453	0.001302	0.000000	0.000213	0.000000	0.000000	0.000000	0.000000	7.826000e-07	6.500000e-08	7.166500e-07	0.000000e+00	0.00
60%	2023-11-24 00:00:00	522.701190	0.000000	260.805870	155.374080	102.344186	0.000000	103.631760	64.598275	0.000000	37.212922	31.759807	34.619639	32.536929	24.552000	9.600000	2.307534	0.645894	0.000000	2.432854	2.580908	0.000000	0.000000	0.079281	0.009300	0.000000	0.008908	0.005407	0.002386	0.001302	0.000000	0.000245	0.000000	0.000000	0.000000	0.000000	8.820000e-07	1.828000e-07	7.427000e-07	0.000000e+00	0.00
70%	2024-01-02 12:00:00	577.798310	0.000000	271.306127	180.496068	190.217311	0.000000	110.612340	68.328865	0.000000	39.191151	32.299472	35.056008	35.216179	26.784000	10.080000	2.540858	0.742389	0.000000	2.496559	2.618213	0.000000	0.000000	0.079281	0.148800	0.009019	0.009645	0.005952	0.003605	0.002604	0.000000	0.000313	0.000000	0.000000	0.000000	0.000000	9.555000e-07	1.639500e-06	9.349500e-07	0.000000e+00	0.00
80%	2024-02-11 00:00:00	593.705607	0.000000	279.269369	220.259833	253.604342	0.000000	125.058960	77.642704	0.000000	39.736761	32.645413	35.284570	35.650040	29.016000	14.400000	8.991288	0.820459	0.000000	2.551238	2.712204	0.000000	0.000000	0.079281	0.186000	0.013123	0.013266	0.007733	0.005191	0.003906	0.000000	0.001052	0.000000	0.000000	0.000000	0.000000	9.772000e-07	1.921700e-06	9.484000e-07	0.000000e+00	0.00
90%	2024-03-21 12:00:00	612.264348	0.000000	296.878752	354.271146	292.308107	0.000000	131.978160	105.071437	0.697500	41.196981	33.195853	42.466176	37.769899	33.480000	20.080000	11.196705	0.964214	10.500658	2.629784	2.857005	0.000000	0.000000	0.079281	0.213900	0.043935	0.017395	0.008540	0.009195	0.003906	0.000000	0.001656	0.000000	0.000000	0.000000	0.000000	1.011300e-06	1.993000e-06	9.633500e-07	0.000000e+00	0.00
max	2024-04-30 00:00:00	802.302174	11276.900000	324.340778	364.406724	397.807411	4687.434585	161.083440	140.156228	2378.481365	43.386597	33.934231	60.795424	57.504453	37.944000	24.360000	14.816757	61.947770	24.419717	2.926488	2.924594	4.681758	4.233374	0.277482	0.381300	2.607366	0.018973	0.018170	0.034384	0.077469	0.360738	0.002849	0.120900	0.110761	0.000380	0.000282	1.176000e-06	2.201800e-06	1.463300e-06	1.450800e-04	4.7
std	NaN	153.353293	1460.291839	52.711875	106.930411	118.097411	607.557502	45.938529	25.559014	303.004108	8.550932	2.921723	13.444744	10.411866	4.596814	6.595558	3.984828	7.402572	5.692536	0.546190	0.878575	1.001826	0.504975	0.051434	0.106021	0.131655	0.005934	0.003124	0.005004	0.006597	0.018128	0.000628	0.006075	0.005566	0.000035	0.000021	3.339713e-07	8.789710e-07	2.717864e-07	7.290544e-06	5.7

KMBL-MB2-PROD-Daily.csv

std/mean as a percentage value

	std	mean	volatility
Athena($)	0.018128	0.000911	1989.974874
Fault Injection Simulator($)	0.006075	0.000305	1989.974874
Systems Manager($)	0.000007	0.0	1989.974874
Direct Connect($)	0.005566	0.00028	1989.974874
SES($)	0.000021	0.000002	958.885734

KMBL-MB2-PROD-Daily.csv

remove total costs as well

date-time	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Ma
2023-04-01	2023-04-01	219.508804	8.309295	648.182762	300.419082	0.001659	NaN	NaN	93.657471	19.104387	364.169296	NaN	42.461826	NaN	105.72984	NaN	28.514646	NaN	14.956827	0.002069	0.0	24.552	NaN	NaN	7.998000e-07	0.000002	0.079282	NaN	NaN	NaN	0.000348	0.305008	0.795646	NaN	0.000000	0.0	1.462845	0.000099	NaN	0.0	0.0	0.0	
2023-04-02	2023-04-02	208.935977	8.382068	640.635053	298.528247	0.001851	NaN	NaN	103.591755	32.443318	364.176570	NaN	42.461714	NaN	105.72984	NaN	28.653741	NaN	15.044351	0.000242	0.0	24.552	NaN	NaN	8.818000e-07	0.000002	0.079281	NaN	NaN	NaN	0.000362	0.305008	0.796090	NaN	0.000000	0.0	1.415782	0.000000	NaN	0.0	0.0	0.0	
2023-04-03	2023-04-03	266.388313	8.450901	652.403935	306.484289	0.001867	NaN	NaN	104.364553	21.487030	364.152763	NaN	42.463279	NaN	105.72984	NaN	28.481126	NaN	15.117827	0.002053	0.0	24.552	NaN	NaN	8.818000e-07	0.000002	0.079281	NaN	NaN	NaN	0.000362	0.305663	0.796131	NaN	0.000027	0.0	1.527322	0.000195	NaN	0.0	0.0	0.0	
2023-04-04	2023-04-04	283.110699	8.206696	647.330632	306.289195	0.001654	NaN	NaN	104.080727	16.973016	364.145535	NaN	42.465356	NaN	105.72984	NaN	28.510925	NaN	15.188953	0.003259	0.0	24.552	NaN	NaN	6.736000e-07	0.000002	0.079281	NaN	NaN	NaN	0.000261	0.306445	0.793888	NaN	0.000002	0.0	1.538305	0.000147	NaN	0.0	0.0	0.0	
2023-04-05	2023-04-05	262.924419	8.262750	643.589804	303.727591	0.001430	NaN	NaN	103.454940	16.999593	364.148108	NaN	42.463925	NaN	105.72984	NaN	28.501964	NaN	15.263354	0.003203	0.0	24.552	NaN	NaN	7.248000e-07	0.000002	0.079281	NaN	NaN	NaN	0.000288	0.306872	0.793322	NaN	0.000012	0.0	1.539323	0.000105	NaN	0.0	0.0	0.0	

KMBL-MB2-PROD-Daily.csv

correlation matrix across all services

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Ma
date-time	1.000000	0.068157	-0.656577	0.320171	0.350744	-0.663406	NaN	NaN	-0.558281	0.861351	-0.252930	NaN	0.087464	NaN	0.461860	NaN	0.868488	NaN	0.913457	-0.140629	0.116583	-0.094088	NaN	NaN	0.230232	-0.792682	0.445195	NaN	NaN	NaN	0.880459	0.107223	0.946096	NaN	0.129067	-0.021787	0.856096	-0.279548	NaN	NaN	0.269500	-0.012003	0.0
EC2-Instances($)	0.068157	1.000000	0.399706	0.667499	0.671459	0.371786	NaN	NaN	0.557774	0.369208	0.783659	NaN	0.841688	NaN	0.672411	NaN	0.231973	NaN	-0.093277	-0.564015	0.050963	-0.330146	NaN	NaN	0.067337	0.249321	0.536969	NaN	NaN	NaN	0.131550	-0.075808	0.125032	NaN	0.637503	-0.047912	0.365997	0.255368	NaN	NaN	-0.457690	0.089448	-0.0
S3($)	-0.656577	0.399706	1.000000	0.249224	0.057741	0.841682	NaN	NaN	0.669537	-0.403492	0.598153	NaN	0.438141	NaN	0.074714	NaN	-0.468447	NaN	-0.666365	-0.336291	-0.057426	-0.234745	NaN	NaN	0.022133	0.773968	-0.123047	NaN	NaN	NaN	-0.569178	-0.151651	-0.569258	NaN	0.151962	-0.004717	-0.339625	0.181189	NaN	NaN	-0.397991	0.197085	-0.0
Relational Database Service($)	0.320171	0.667499	0.249224	1.000000	0.884434	0.242994	NaN	NaN	0.405920	0.619452	0.740037	NaN	0.786538	NaN	0.910903	NaN	0.605806	NaN	0.199914	-0.674334	0.065443	-0.405345	NaN	NaN	0.224340	0.045362	0.246840	NaN	NaN	NaN	0.216851	0.074907	0.510971	NaN	0.424481	-0.085274	0.710935	0.198863	NaN	NaN	-0.169686	0.071650	0.0
EC2-Other($)	0.350744	0.671459	0.057741	0.884434	1.000000	0.120375	NaN	NaN	0.381009	0.668802	0.714152	NaN	0.724588	NaN	0.893264	NaN	0.635223	NaN	0.229860	-0.573789	0.081266	-0.271786	NaN	NaN	0.261438	-0.085923	0.329074	NaN	NaN	NaN	0.294835	0.177333	0.556062	NaN	0.529497	-0.069301	0.711751	0.254504	NaN	NaN	-0.065115	-0.070928	0.0

KMBL-MB2-PROD-Daily.csv

p-values over the correlation

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	W Se
date-time	0.000000e+00	1.758688e-01	3.374377e-50	6.859989e-11	6.610732e-13	1.436964e-51	NaN	NaN	7.937748e-34	6.054765e-118	3.387596e-07	NaN	8.214935e-02	NaN	2.559862e-22	NaN	3.841916e-122	NaN	6.251035e-156	5.053902e-03	0.020311	6.140723e-02	NaN	NaN	3.666979e-06	1.051545e-86	1.127803e-20	NaN	NaN	NaN	9.116822e-130	0.032915	5.275497e-195	NaN	1.013927e-02	0.665565	5.317009e-115	1.526449e-08					
EC2-Instances($)	1.758688e-01	0.000000e+00	1.269354e-16	2.080985e-52	3.115312e-53	1.993495e-14	NaN	NaN	9.340184e-34	3.104859e-14	1.737221e-83	NaN	1.699070e-107	NaN	1.965564e-53	NaN	3.080072e-06	NaN	6.368800e-02	1.235031e-34	0.311732	1.595606e-11	NaN	NaN	1.811328e-01	5.026238e-07	5.881603e-31	NaN	NaN	NaN	8.768986e-03	0.132079	1.277400e-02	NaN	1.494971e-46	0.341624	5.360746e-14	2.586128e-07					
S3($)	3.374377e-50	1.269354e-16	0.000000e+00	5.079015e-07	2.516480e-01	1.709351e-107	NaN	NaN	7.859676e-53	6.156970e-17	8.668075e-40	NaN	5.263141e-20	NaN	1.377670e-01	NaN	5.409747e-23	NaN	3.564465e-52	6.325778e-12	0.254248	2.326738e-06	NaN	NaN	6.605917e-01	3.375026e-80	1.427831e-02	NaN	NaN	NaN	2.241683e-35	0.002480	2.182681e-35	NaN	2.428794e-03	0.925452	3.795865e-12	2.897849e-04					
Relational Database Service($)	6.859989e-11	2.080985e-52	5.079015e-07	0.000000e+00	1.757370e-132	9.891644e-07	NaN	NaN	3.853046e-17	2.490443e-43	7.266905e-70	NaN	1.698250e-84	NaN	1.482938e-153	NaN	4.967037e-41	NaN	6.170800e-05	7.706269e-54	0.193749	4.306906e-17	NaN	NaN	6.550731e-06	3.679591e-01	6.568493e-07	NaN	NaN	NaN	1.339495e-05	0.136750	1.011102e-27	NaN	9.404237e-19	0.090142	3.267139e-62	6.757242e-05					
EC2-Other($)	6.610732e-13	3.115312e-53	2.516480e-01	1.757370e-132	0.000000e+00	1.654880e-02	NaN	NaN	3.955937e-15	1.117520e-52	5.193471e-63	NaN	1.112973e-65	NaN	6.927411e-139	NaN	3.920933e-46	NaN	3.805490e-06	4.759175e-36	0.106371	3.903546e-08	NaN	NaN	1.304751e-07	8.771007e-02	1.871001e-11	NaN	NaN	NaN	2.203036e-09	0.000391	1.615248e-33	NaN	5.346789e-30	0.168707	2.053762e-62	2.846797e-07					

KMBL-MB2-PROD-Daily.csv

STAR (*) representation of correlations based on p-values for easier visual comparision

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	S
date-time	*******		*******	******	*******	*******			*******	*******	****				*******		*******		*******	**	*						****	*******	*******			*******	*	*******		*******		*******	******			*******				
EC2-Instances($)		*******	*******	*******	*******	*******			*******	*******	*******		*******		*******		****		*******	*******		******					****	*******	*			*******	**		*	*******		*******	****			*******				
S3($)	*******	*******	*******	****		*******			*******	*******	*******		*******		*******		********		*******	*******		******					*******	*			*******	**	*******		*******		*******	***			*******	***			
Relational Database Service($)	*******	*******	****	*******	*******	****			*******	*******	*******		*******		*******		********		***	*******		*******				****		****			***		*******		*******		*******				***				
EC2-Other($)	*******	*******		*******	*******	*			*******	*******	*******		*******		*******		********		****	*******		******				****		******			*****	***	*******		*******		*******	****			*******				

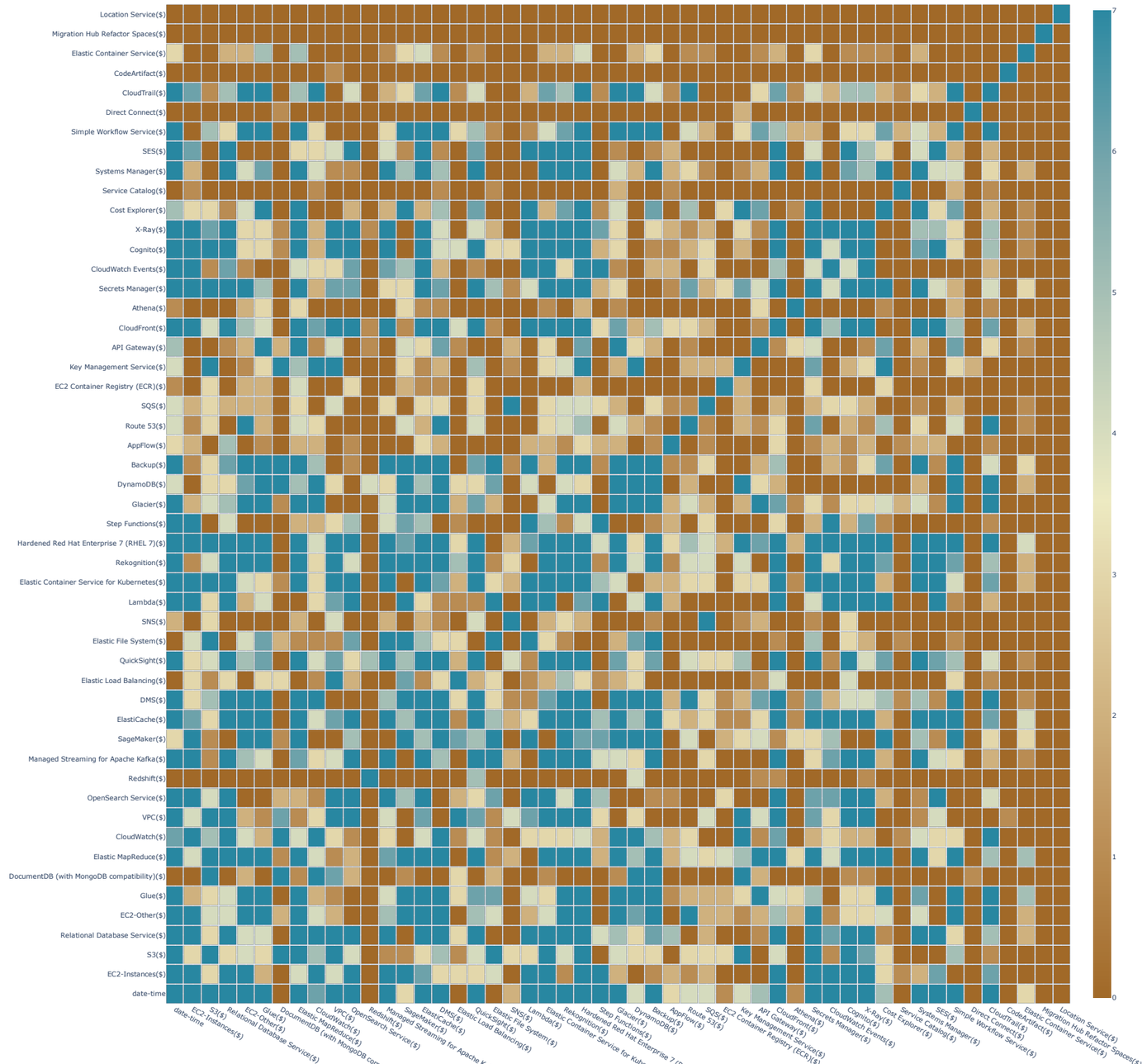
KMBL-MB2-PROD-Daily.csv

simple RANK based representation of correlations based on p-values for easier analysis

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	W Se
date-time	7	0	7	6	7	7	0	0	7	7	4	0	0	0	7	0	7	0	7	2	1	0	0	0	4	7	7	0	0	0	7	1	7	0	1	0	7	5	0	0	5	0	0	0	
EC2-Instances($)	0	7	7	7	7	7	0	0	7	7	7	0	7	0	7	0	4	0	0	7	0	6	0	0	0	4	7	0	0	0	2	0	1	0	7	0	7	4	0	0	7	0	0	0	
S3($)	7	7	7	4	0	7	0	0	7	7	7	0	7	0	0	0	7	0	7	7	0	4	0	0	0	7	1	0	0	0	7	2	7	0	2	0	7	3	0	0	7	3	0	0	
Relational Database Service($)	6	7	4	7	7	4	0	0	7	7	7	0	7	0	7	0	7	0	3	7	0	7	0	0	4	0	4	0	0	0	3	0	7	0	7	0	7	3	0	0	3	0	0	0	
EC2-Other($)	7	7	0	7	7	1	0	0	7	7	7	0	7	0	7	0	7	0	4	7	0	5	0	0	4	0	6	0	0	0	5	3	7	0	7	0	7	4	0	0	0	0	0	0	

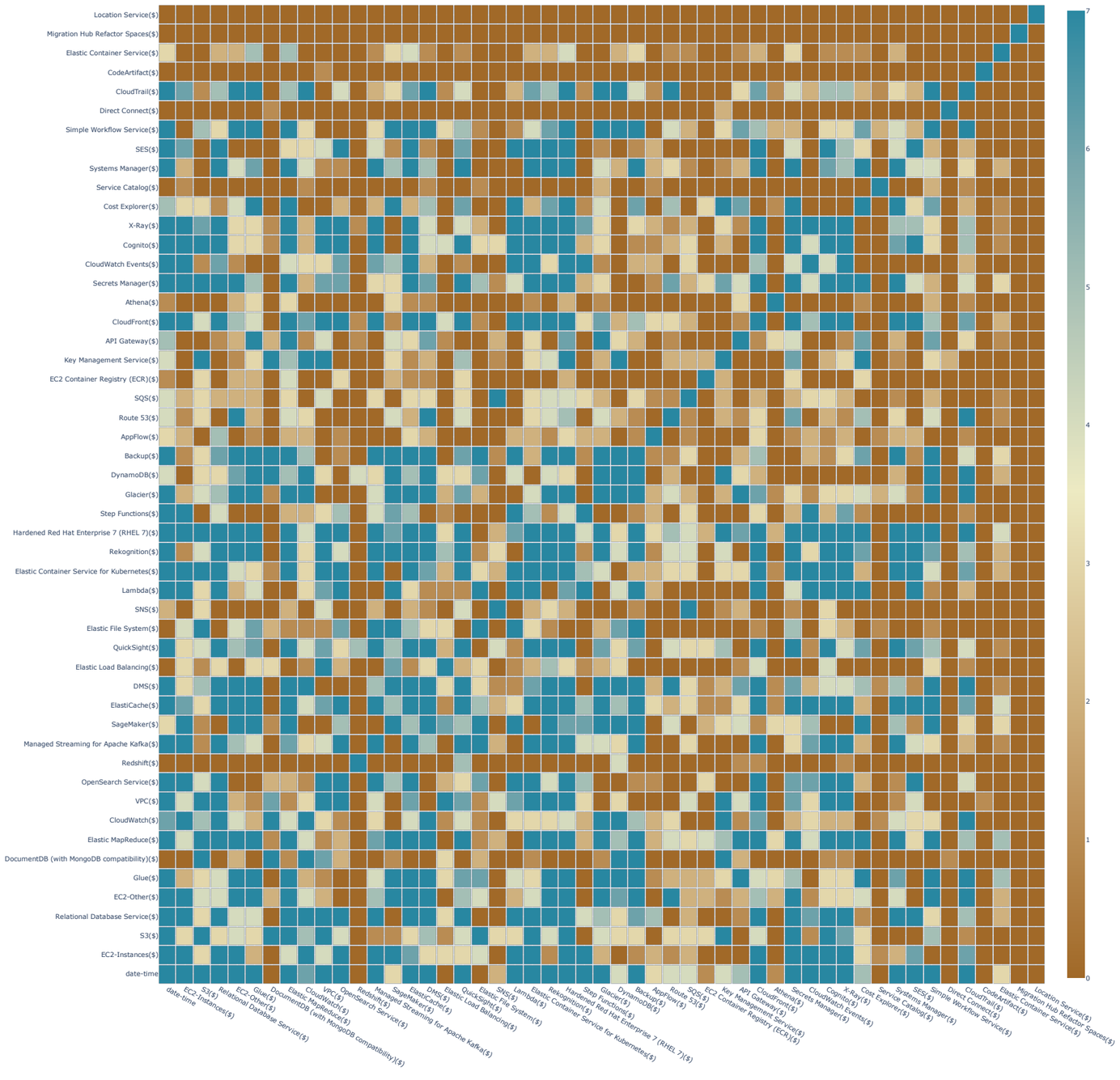
KMBL-MB2-PROD-Daily.csv

raw correlations of service usage



KMBL-MB2-PROD-Daily.csv

statistical significance of usage correlations between services:



KMBL-OU-Daily.csv

Analysis for **KMBL-OU-Daily.csv**

KMBL-OU-Daily.csv

raw data from the file

	Service	Tax($)	Savings Plans for Compute usage($)	Relational Database Service($)	EC2-Other($)	CloudWatch($)	S3($)	Support (Business)($)	VPC($)	EC2-Instances($)	Tetrate Service Bridge($)	Glue($)	OpenSearch Service($)	Elastic Load Balancing($)	ElastiCache($)	Redshift($)	DocumentDB (with MongoDB compatibility) ($)	Elastic File System($)	Elastic Container Service for Kubernetes($)	Elastic MapReduce($)	Managed Streaming for Apache Kafka($)	CloudTrail($)	Certificate Manager($)	DynamoDB($)	Direct Connect($)	SageMaker($)	QuickSight($)	OCBLateFee($)	DMS($)	Route 53($)	MQ($)	Cognito($)	CloudFront($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	EC2 Container Registry (ECR)($)	Config($)	SNS($)
0	Service total	1024058.15	845475.6289	745913.773838	694040.569548	429423.191814	416632.223386	309650.742943	297929.615037	275612.928180	275000.0	225349.524128	188192.722797	160818.831362	142763.738173	134519.367554	95688.782915	77769.979729	64235.714596	63209.454429	56307.065299	51858.199914	51631.031128	50684.620276	37215.102370	32627.606830	28944.978099	28159.96	23525.695788	22465.783708	22428.387066	22355.708318	22202.778408	20310.58	13041.274242	12869.74508	12600.360558
1	2023-04-01	69312.17	111.6000	1959.621354	1678.825237	1112.223411	708.707228	25253.503403	789.684962	1101.092693	NaN	425.581831	642.122315	493.775342	381.694683	4758.075705	184.438189	51.223256	140.616000	184.209717	84.023875	387.698501	2604.000000	35.692605	74.594555	42.432800	58.221720	NaN	151.591867	66.437874	41.636616	0.000000	0.047888	65.44	13.314754	2.85603	25.120054
2	2023-04-02	NaN	111.6000	1951.296921	1695.010169	1139.732032	765.410340	NaN	833.640199	1021.185285	NaN	631.237908	642.129557	542.805690	381.694683	126.319054	177.342086	51.286897	140.616000	188.681437	86.437302	411.247761	NaN	50.969009	74.566043	42.432800	57.663720	NaN	151.591891	51.454534	41.635699	NaN	0.041454	64.64	13.306573	NaN	53.084817
3	2023-04-03	NaN	111.6000	1971.537765	1762.674745	1217.136823	1203.071863	NaN	838.259325	1354.091055	NaN	844.270581	642.361495	553.743659	381.694683	147.589978	185.974351	51.425530	140.616000	197.273429	82.497667	411.340337	NaN	51.295408	74.510701	45.329094	61.569720	NaN	151.591881	51.551373	41.637188	0.000000	0.116351	77.38	13.327953	NaN	9.590042
4	2023-04-04	NaN	111.6000	2009.253200	1716.615616	1099.989543	884.297637	NaN	725.144768	1371.889323	NaN	1198.008460	642.570785	510.456915	381.694683	147.794392	184.270418	51.481242	140.616000	194.276557	82.593711	359.191333	NaN	51.080662	74.415669	45.380137	59.058720	NaN	166.239382	51.682150	41.638226	0.000000	0.073729	77.10	13.379009	NaN	20.976053

KMBL-OU-Daily.csv

clean data

date-time		Tax($)	Savings Plans for Compute usage($)	Relational Database Service($)	EC2-Other($)	CloudWatch($)	S3($)	Support (Business)($)	VPC($)	EC2-Instances($)	Tetrate Service Bridge($)	Glue($)	OpenSearch Service($)	Elastic Load Balancing($)	ElastiCache($)	Redshift($)	DocumentDB (with MongoDB compatibility) ($)	Elastic File System($)	Elastic Container Service for Kubernetes($)	Elastic MapReduce($)	Managed Streaming for Apache Kafka($)	CloudTrail($)	Certificate Manager($)	DynamoDB($)	Direct Connect($)	SageMaker($)	QuickSight($)	OCBLateFee($)	DMS($)	Route 53($)	MQ($)	Cognito($)	CloudFront($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	EC2 Container Registry (ECR)($)	Config($)	SNS($)	Rekognition($)	Glacier($)	CIS Linux 2 Benchmark - Level 2($)	Sa Plan Mac Learni
2023-04-01	2023-04-01	69312.17	111.6	1959.621354	1678.825237	1112.223411	708.707228	25253.503403	789.684962	1101.092693	0.0	425.581831	642.122315	493.775342	381.694683	4758.075705	184.438189	51.223256	140.616	184.209717	84.023875	387.698501	2604.0	35.692605	74.594555	42.432800	58.22172	0.0	151.591867	66.437874	41.636616	0.0	0.047888	65.44	13.314754	2.85603	25.120054	18.610463	46.945537	34.22	
2023-04-02	2023-04-02	0.00	111.6	1951.296921	1695.010169	1139.732032	765.410340	0.000000	833.640199	1021.185285	0.0	631.237908	642.129557	542.805690	381.694683	126.319054	177.342086	51.286897	140.616	188.681437	86.437302	411.247761	0.0	50.969009	74.566043	42.432800	57.66372	0.0	151.591891	51.454534	41.635699	0.0	0.041454	64.64	13.306573	0.00000	53.084817	17.132925	64.374130	32.40	
2023-04-03	2023-04-03	0.00	111.6	1971.537765	1762.674745	1217.136823	1203.071863	0.000000	838.259325	1354.091055	0.0	844.270581	642.361495	553.743659	381.694683	147.589978	185.974351	51.425530	140.616	197.273429	82.497667	411.340337	0.0	51.295408	74.510701	45.329094	61.56972	0.0	151.591881	51.551373	41.637188	0.0	0.116351	77.38	13.327953	0.00000	9.590042	21.140062	80.103287	37.84	
2023-04-04	2023-04-04	0.00	111.6	2009.253200	1716.615616	1099.989543	884.297637	0.000000	725.144768	1371.889323	0.0	1198.008460	642.570785	510.456915	381.694683	147.794392	184.270418	51.481242	140.616	194.276557	82.593711	359.191333	0.0	51.080662	74.415669	45.380137	59.05872	0.0	166.239382	51.682150	41.638226	0.0	0.073729	77.10	13.379009	0.00000	20.976053	20.697150	82.812278	37.34	
2023-04-05	2023-04-05	0.00	111.6	2043.512197	1740.673985	1155.499632	845.047816	0.000000	748.199042	1352.471570	0.0	740.626183	642.573363	542.141820	381.694683	146.888885	188.700812	51.624338	140.616	195.710578	88.425923	392.119466	0.0	51.215011	74.439086	45.380863	64.17372	0.0	175.027880	51.591888	41.635590	0.0	0.105730	74.90	14.608952	0.00000	26.124886	19.975237	79.975952	37.56	

KMBL-OU-Daily.csv

.describe() with 10 percentiles

	date-time	Tax($)	Savings Plans for Compute usage($)	Relational Database Service($)	EC2-Other($)	CloudWatch($)	S3($)	Support (Business)($)	VPC($)	EC2-Instances($)	Tetrate Service Bridge($)	Glue($)	OpenSearch Service($)	Elastic Load Balancing($)	ElastiCache($)	Redshift($)	DocumentDB (with MongoDB compatibility) ($)	Elastic File System($)	Elastic Container Service for Kubernetes($)	Elastic MapReduce($)	Managed Streaming for Apache Kafka($)	CloudTrail($)	Certificate Manager($)	DynamoDB($)	Direct Connect($)	SageMaker($)	QuickSight($)	OCBLateFee($)	DMS($)	Route 53($)	MQ($)	Cognito($)	CloudFront($)	Hardened Red Hat Enterprise 7 (RHEL 7) ($)	EC2 Container Registry (ECR)($)	Config($)	SNS($)	Rekognition($)	Glacie
count	396	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	3.960000e+02	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.00(
mean	2023-10-15 12:00:00	2586.005429	2135.039467	1883.620641	1752.627701	1084.402000	1052.101574	781.946321	752.347513	695.992243	694.444444	569.064455	475.234148	406.108160	360.514490	339.695373	241.638341	196.388838	162.211400	159.619834	142.189559	130.955050	130.381392	127.991465	9.397753e+01	82.392947	73.093379	71.111010	59.408323	56.731777	56.637341	56.453809	56.067622	51.289343	32.932511	32.499356	31.819092	31.071989	23.775
min	2023-04-01 00:00:00	0.000000	111.600000	1356.377847	976.478874	367.339586	262.344678	0.000000	421.250917	105.937896	0.000000	320.269442	254.702338	216.542889	277.839864	52.939349	158.628315	42.549289	136.152000	107.281459	48.129068	0.000000	0.000000	1.533502	-9.000000e-10	0.000000	57.663720	0.000000	43.434727	43.284913	34.782264	0.000000	0.041454	34.840000	13.306573	0.000000	0.011713	1.107862	16.984
10%	2023-05-10 12:00:00	0.000000	352.656000	1452.413579	1267.676092	544.534306	670.700328	0.000000	551.945187	182.923218	0.000000	386.734296	338.483968	270.160096	283.464464	69.350669	169.749186	51.356213	138.384000	118.605850	74.102070	10.959670	0.000000	12.970316	7.403377e+01	0.039897	64.523040	0.000000	43.434728	43.708416	41.538434	0.000000	13.549225	39.600000	14.581542	0.000000	8.465405	20.005463	16.984
20%	2023-06-19 00:00:00	0.000000	1703.016000	1553.145099	1587.815662	650.811552	928.533039	0.000000	599.332053	267.053568	0.000000	417.764777	373.939157	291.924589	292.570106	94.126830	181.266152	77.936948	140.616000	125.307246	77.431517	35.231070	0.000000	21.292316	7.418948e+01	0.079360	66.141524	0.000000	43.434730	51.520913	48.514942	0.000000	24.778873	40.540000	16.947577	6.743430	10.185584	22.747800	16.984
30%	2023-07-28 12:00:00	0.000000	2459.961000	1710.186902	1663.550800	717.296179	979.798630	0.000000	649.877611	343.494432	0.000000	439.601983	382.244603	317.785082	349.977981	134.570950	206.336776	101.387382	140.616000	131.060405	84.038266	41.591621	0.000000	22.881827	7.454423e+01	0.157834	69.906622	0.000000	45.800649	52.442660	55.673700	0.000000	29.620865	42.380000	18.296460	12.723795	15.898735	25.230174	16.984
40%	2023-09-06 00:00:00	0.000000	2595.816000	1747.994743	1722.430870	767.743582	1028.877812	0.000000	705.057717	425.534493	0.000000	468.328378	395.019296	355.125810	365.222918	146.295703	231.506572	118.688554	144.470776	137.586663	88.898283	47.036993	0.000000	27.889649	7.467343e+01	0.182001	72.261000	0.000000	47.456289	52.794002	55.686888	0.000000	33.540674	48.080000	20.057401	17.212350	20.285326	29.107050	16.984
50%	2023-10-15 12:00:00	0.000000	2595.816000	1837.190236	1780.125616	807.200566	1092.384296	0.000000	750.643700	489.806284	0.000000	488.610976	415.025486	382.837490	376.070045	178.916027	238.191089	132.551907	158.472000	146.157892	115.487367	68.339534	0.000000	46.774639	7.910219e+01	42.408000	73.534942	0.000000	51.198747	58.800108	55.704100	0.000000	37.837143	49.970000	21.042759	25.494462	25.114553	31.529713	17.444
60%	2023-11-24 00:00:00	0.000000	2595.816000	1891.894179	1829.791303	856.998803	1142.310408	0.000000	786.491481	660.368968	0.000000	522.552991	513.054968	422.325844	381.694683	183.403855	248.473376	149.599358	165.121642	171.812377	119.433577	108.913011	0.000000	52.878054	1.256532e+02	45.125525	75.320744	0.000000	52.283905	59.965752	55.837957	0.000000	45.906426	57.760000	22.731345	36.068562	31.496023	34.478820	17.550
70%	2024-01-02 12:00:00	0.000000	2595.816000	1955.459138	1878.976697	948.516771	1186.290878	0.000000	818.788716	924.763909	0.000000	566.071777	557.019013	472.807155	388.351073	187.205015	262.567229	185.433592	171.864000	187.475784	126.329220	156.727418	0.000000	65.269453	1.258663e+02	45.381335	77.021977	0.000000	53.484289	60.410047	55.871558	71.865983	54.043758	58.560000	26.763849	44.848060	36.937583	36.811144	17.550
80%	2024-02-11 00:00:00	0.000000	2595.816000	2224.062753	1948.626132	1191.997994	1229.153278	0.000000	878.837524	1151.398518	0.000000	685.531876	585.157821	512.572173	403.177731	190.873648	277.163815	229.312458	178.533956	195.431779	153.077697	187.412198	0.697500	127.277729	1.261398e+02	207.706533	79.062164	0.000000	58.876571	60.546562	62.429859	142.008210	71.937766	61.380000	28.472498	51.539670	45.111366	38.955375	18.155
90%	2024-03-21 12:00:00	0.185000	2595.816000	2335.375619	2105.469332	1703.718878	1345.626887	0.000000	972.281253	1480.223032	0.000000	867.755308	642.665661	545.537994	411.151998	194.758389	299.141235	338.522140	199.435926	217.355018	346.973021	366.949642	1.395000	576.511805	1.262235e+02	308.705199	80.515529	0.000000	91.740369	66.581919	62.788749	191.939073	98.849744	62.310000	32.196996	68.273208	63.056298	41.773856	43.272
max	2024-04-30 00:00:00	113119.570000	2595.816000	10940.965036	2463.610987	9982.289617	1848.682182	34773.954034	1199.281419	1976.152777	275000.000000	2050.244579	903.183512	848.239573	460.908352	8385.738102	449.173271	4145.544572	239.805884	228.440507	407.871823	613.576459	6676.000000	1783.199857	1.405530e+02	347.669333	90.458746	12225.410000	177.923902	82.433978	113.151830	1161.353976	385.499214	77.380000	392.024345	169.784695	177.699143	54.392212	133.592
std	NaN	14283.121956	837.648410	548.944558	316.789349	978.645001	301.107789	4276.978742	159.877162	491.546037	13819.269960	231.798646	128.276667	121.644129	47.249151	1028.258792	59.908389	355.554384	25.256239	36.523616	99.106282	134.142656	706.392582	253.152714	3.658390e+01	113.491125	6.462986	855.135069	28.561842	7.284568	15.128760	98.600857	61.654678	9.726243	45.398340	30.195662	26.030235	9.241575	18.966

KMBL-OU-Daily.csv

std/mean as a percentage value

	std	mean	volatility
Fault Injection Simulator($)	0.006075	0.000305	1989.974874
Tetrate Service Bridge($)	13819.26996	694.444444	1989.974874
Red Hat Enterprise Linux (RHEL) 8.4 with support by ProComputers($)	0.01005	0.000505	1989.974874
Textract($)	0.031796	0.00179	1776.78404
IoT($)	0.0	0.0	1553.888455

KMBL-OU-Daily.csv

remove total costs as well

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Explore
date-time																																								
2023-04-01	2023-04-01	1101.092693	708.707228	1959.621354	1678.825237	425.581831	184.438189	184.209717	1112.223411	789.684962	642.122315	4758.075705	84.023875	42.432800	381.694683	151.591867	493.775342	58.22172	51.223256	25.120054	7.316088	140.616	18.610463	65.44	0.000037	46.945537	35.692605	3.457800	0.922732	66.437874	3.722453	13.314754	11.601292	1.948597	0.047888	0.510793	3.972931	0.013865	0.0	0.000000
2023-04-02	2023-04-02	1021.185285	765.410340	1951.296921	1695.010169	631.237908	177.342086	188.681437	1139.732032	833.640199	642.129557	126.319054	86.437302	42.432800	381.694683	151.591891	542.805690	57.66372	51.286897	53.084817	14.256147	140.616	17.132925	64.64	0.000042	64.374130	50.969009	3.460219	0.171495	51.454534	7.698723	13.306573	11.599812	1.894752	0.041454	0.634311	4.040314	0.017253	0.0	0.000000
2023-04-03	2023-04-03	1354.091055	1203.071863	1971.537765	1762.674745	844.270581	185.974351	197.273429	1217.136823	838.259325	642.361495	147.589978	82.497667	45.329094	381.694683	151.591881	553.743659	61.56972	51.425530	9.590042	14.193210	140.616	21.140062	77.38	0.000041	80.103287	51.295408	3.462832	0.184152	51.551373	1.876516	13.327953	12.655753	1.895965	0.116351	1.748944	4.171182	0.003954	0.0	0.000000
2023-04-04	2023-04-04	1371.889323	884.297637	2009.253200	1716.615616	1198.008460	184.270418	194.276557	1099.989543	725.144768	642.570785	147.794392	82.593711	45.380137	381.694683	166.239382	510.456915	59.05872	51.481242	20.976053	14.085937	140.616	20.697150	77.10	0.000037	82.812278	51.080662	3.465016	2.805403	51.682150	3.325687	13.379009	12.840308	1.827781	0.073729	1.162616	4.148163	0.002649	0.0	0.000000
2023-04-05	2023-04-05	1352.471570	845.047816	2043.512197	1740.673985	740.626183	188.700812	195.710578	1155.499632	748.199042	642.573363	146.888885	88.425923	45.380863	381.694683	175.027880	542.141820	64.17372	51.624338	26.124886	14.040518	140.616	19.975237	74.90	0.000032	79.975952	51.215011	3.465759	2.159810	51.591888	4.055079	14.608952	12.640581	1.850579	0.105730	0.763023	4.237281	0.002661	0.0	0.040934

KMBL-OU-Daily.csv

correlation matrix across all services

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	
date-time	1.000000	0.057481	0.503787	0.244867	0.555702	-0.487571	0.156104	-0.780521	0.410621	0.454667	-0.344542	-0.008767	0.782682	0.707039	0.253494	-0.559009	-0.121779	0.768076	0.168249	0.115988	0.373897	0.889284	0.581299	-0.929455	0.344802	-0.524398	0.557897	0.085874	0.246055	0.618402	0.562248	0.193705	0.830925	0.819423	0.395431	0.081195	0.827797	0.421545	0.649571	0.405051	0.333983	0.433936	
EC2-Instances($)	0.057481	1.000000	0.058762	0.363854	0.435992	0.459375	0.142847	0.237457	0.352557	0.701904	0.759130	-0.030476	0.571973	0.577262	0.648829	0.420114	0.184133	-0.017103	0.062807	-0.037842	0.580992	0.410348	-0.277669	-0.028332	0.353637	0.381820	0.472289	-0.347182	0.100642	-0.128914	0.020440	-0.143205	0.222404	0.436367	-0.276134	0.263923	0.415481	0.338414	0.231686	0.514371	-0.327567	0.244908	
S3($)	0.503787	0.058762	1.000000	0.206742	0.496827	-0.184396	0.530977	-0.450527	0.306038	0.380478	-0.125694	0.015576	0.282773	0.348801	0.375669	-0.287627	0.271170	0.427421	0.000646	0.061672	0.283998	0.463432	0.325463	-0.562463	0.114949	-0.275752	0.212661	-0.279723	0.101578	0.429830	0.283534	0.202413	0.500857	0.371444	0.444699	0.057375	0.425313	0.147642	0.407795	0.143764	0.199150	0.247760	
Relational Database Service($)	0.244867	0.363854	0.206742	1.000000	0.233566	0.064905	0.152543	-0.012260	0.216588	0.459411	0.312957	-0.019349	0.377806	0.473253	0.459001	0.098482	0.241337	0.181854	0.067388	0.002151	0.420392	0.333658	0.019770	-0.256444	0.186909	0.042824	0.296313	-0.231038	0.127222	-0.008109	0.132360	-0.025869	0.304626	0.361422	0.020595	0.071412	0.445239	0.200056	0.292027	0.225177	-0.121385	0.328902	
EC2-Other($)	0.555702	0.435992	0.496827	0.233566	1.000000	0.032092	0.165308	-0.412959	0.342524	0.525061	0.078829	0.030272	0.548507	0.528352	0.401820	-0.035789	0.076241	0.364740	-0.010404	0.072464	0.472167	0.662491	0.227052	-0.547737	0.276453	-0.020717	0.410596	-0.118745	0.075013	0.418670	0.327529	0.220049	0.559083	0.576803	0.104493	0.117452	0.543348	0.312140	0.429747	0.422865	-0.025356	0.263014	

KMBL-OU-Daily.csv

p-values over the correlation

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	C
date-time	0.000000e+00	2.537893e-01	7.093683e-27	8.111101e-07	1.811270e-33	4.879553e-25	1.834910e-03	2.104085e-82	1.537452e-17	1.345584e-21	1.767474e-12	0.861939	3.792754e-83	2.929240e-61	3.183284e-07	6.279120e-34	1.531917e-02	2.809395e-78	0.000775	0.020964	1.383095e-14	6.227840e-136	3.615818e-37	1.031765e-172	1.696816e-12	2.337970e-29	8.977970e-34	8.789303e-02	7.144966e-07	3.778383e-43	2.199523e-34	0.000105	2.299036e-102	2.880838e-97	2.840968e-16	1.066749e-01	6.101771e-101	1.
EC2-Instances($)	2.537893e-01	0.000000e+00	2.433499e-01	7.691494e-14	8.357189e-20	4.561806e-22	4.395909e-03	1.762367e-06	4.939009e-13	4.998282e-60	1.810227e-75	0.545388	8.787629e-36	1.457104e-36	1.099289e-48	2.299976e-18	2.294507e-04	7.343814e-01	0.212350	0.452694	4.023301e-37	1.622221e-17	1.921140e-08	5.740322e-01	4.147819e-13	3.422977e-15	2.150920e-23	1.166038e-12	4.533753e-02	1.022953e-02	6.851074e-01	0.004297	7.900231e-06	7.711557e-20	2.315408e-08	9.810864e-08	5.856911e-18	4.
S3($)	7.093683e-27	2.433499e-01	0.000000e+00	3.383668e-05	4.482542e-26	2.246753e-04	3.468862e-30	3.435721e-21	4.949289e-10	4.348638e-15	1.230413e-02	0.757328	1.024524e-08	9.017697e-13	1.015434e-14	5.567854e-09	4.200693e-08	5.112577e-19	0.989779	0.220750	8.793660e-09	1.772153e-22	3.185426e-11	2.050707e-34	2.214881e-02	2.425017e-08	1.977339e-05	1.493978e-08	4.336119e-02	3.089067e-19	9.318019e-09	0.000050	1.549192e-26	2.114847e-14	1.258169e-20	2.546740e-01	7.918489e-19	3.
Relational Database Service($)	8.111101e-07	7.691494e-14	3.383668e-05	0.000000e+00	2.622548e-06	1.974441e-01	2.336108e-03	8.078373e-01	1.372909e-05	4.524114e-22	1.905696e-10	0.701089	6.977886e-15	1.703694e-23	4.973907e-22	5.019083e-02	1.177601e-06	2.749964e-04	0.180801	0.965972	2.173446e-18	9.426885e-12	6.949082e-01	2.293754e-07	1.835046e-04	3.953908e-01	1.815732e-09	3.383148e-06	1.127713e-02	8.721992e-01	8.359117e-03	0.607782	5.995084e-10	1.154995e-13	6.828405e-01	1.560764e-01	1.116784e-20	6.
EC2-Other($)	1.811270e-33	8.357189e-20	4.482542e-26	2.622548e-06	0.000000e+00	5.242803e-01	9.601896e-04	9.684037e-18	2.422965e-12	1.932207e-29	1.173112e-01	0.548087	1.743539e-32	7.462981e-30	8.484245e-17	4.776044e-01	1.298763e-01	6.627207e-14	0.836486	0.150051	2.215080e-23	2.203552e-51	5.024977e-06	2.213993e-32	2.227474e-08	6.810655e-01	1.545149e-17	1.808404e-02	1.361929e-01	3.083059e-18	2.351345e-11	0.000010	6.132487e-34	1.704990e-36	3.766384e-02	1.938910e-02	8.550741e-32	2.

KMBL-OU-Daily.csv

STAR (*) representation of correlations based on p-values for easier visual comparision

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	
date-time	********		*******	****	*******	********	**	*******	*******	*******	*******		*******	*******	****	*******	*	*******	***	*	*******	*******	*******	*******	*******	*******	*******		****	*******	*******	***	*******	*******	*******		*******	*******	*******	*******	*******	*******	*******	*******	
EC2-Instances($)		*******		*******	*******	*******	**	****	*******	*******	*******		*******	*******	*******	*******	***				*******	*******	*****		*******	*******	*******	*******	*	*		**	****	*******	*******	*****	*******	*******	****	*******		*******	****			
S3($)	********		*******	***	*******	***	*******	*******	******	*******	*		*****	*******	*******	*****	*****	*******			*****	*******	*******	********	*	*****	***	*****	*	*******	*****	***	*******	*******	*******		*******	**	*******	**	***	****	***	****	
Relational Database Service($)	****	*******	***	*******	****		**		***	*******	******		*******	*******	*******		****	***			*******	*******		****	***		*****	****	*		**		******	*******			*******	***	*****	****	*	******	******		
EC2-Other($)	********	*******	*******	****	*******		***	*******	*******	*******			*******	*******	*******			*******			*******	*******	****	********	*****		*******	*		*******	******	****	*******	*******	*	*	*******	******	*******	*******		****	*******	*****	

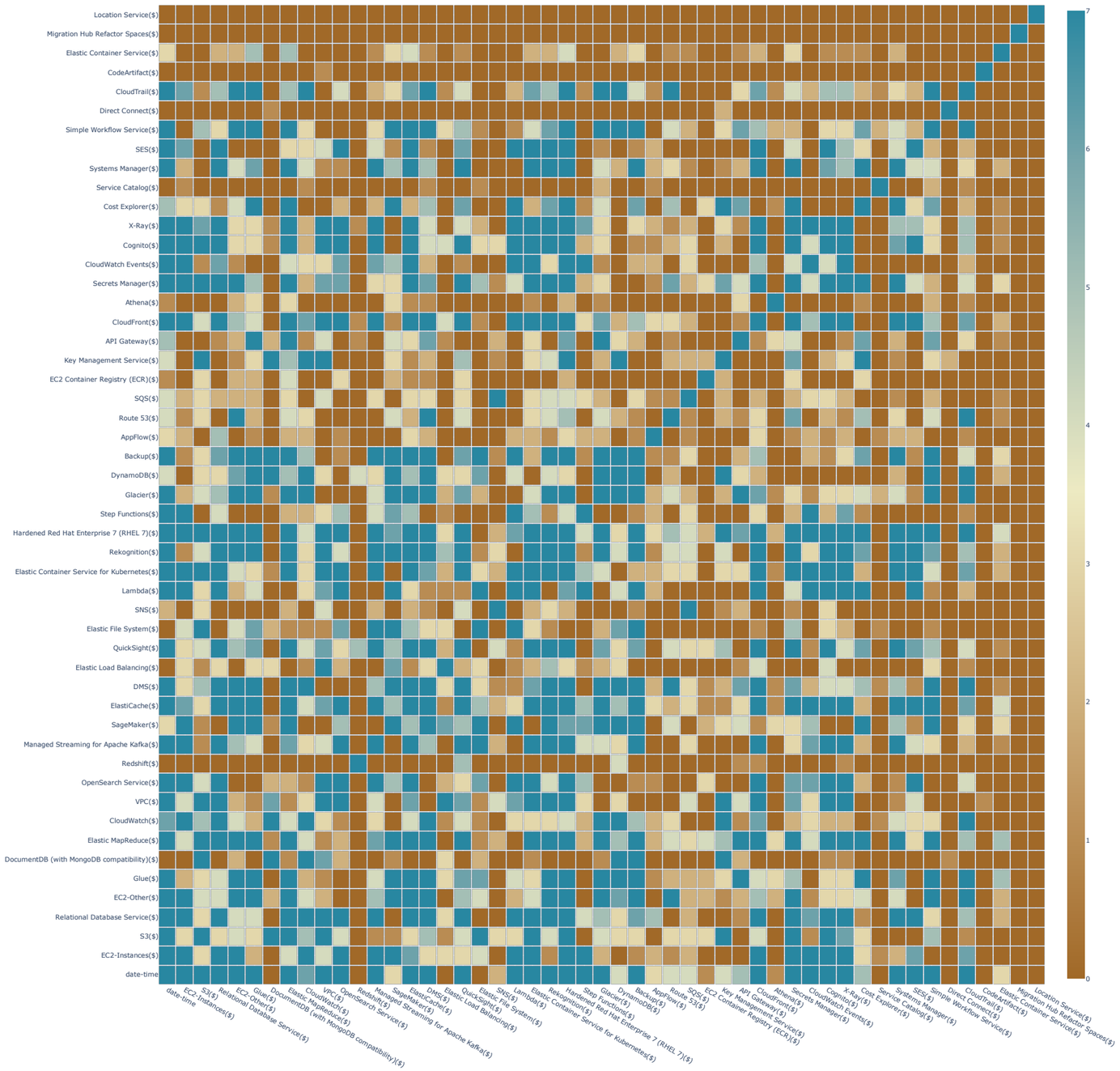
KMBL-OU-Daily.csv

simple RANK based representation of correlations based on p-values for easier analysis

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	W Se
date-time	7	0	7	4	7	7	2	7	7	7	7	0	7	7	4	7	1	7	3	1	7	7	7	7	7	7	7	0	4	7	7	3	7	7	7	0	7	7	7	7	7	7	7	7
EC2-Instances($)	0	7	0	7	7	7	2	4	7	7	7	0	7	7	7	7	3	0	0	0	7	7	5	0	7	7	7	7	1	1	0	2	4	7	5	5	7	7	4	7	6	4	7	0
S3($)	7	0	7	3	7	3	7	7	6	7	1	0	5	7	7	5	5	7	0	0	5	7	6	7	1	5	3	5	1	7	5	3	7	7	7	0	7	2	7	2	3	4	3	4
Relational Database Service($)	4	7	3	7	4	0	2	0	3	7	6	0	7	7	7	0	4	3	0	0	7	7	0	4	3	0	5	4	1	0	2	0	6	7	0	0	7	3	5	4	1	6	6	0
EC2-Other($)	7	7	7	4	7	0	3	7	7	7	0	0	7	7	7	0	0	7	0	0	7	7	4	7	5	0	7	1	0	7	6	4	7	7	1	1	7	6	7	7	0	4	7	5

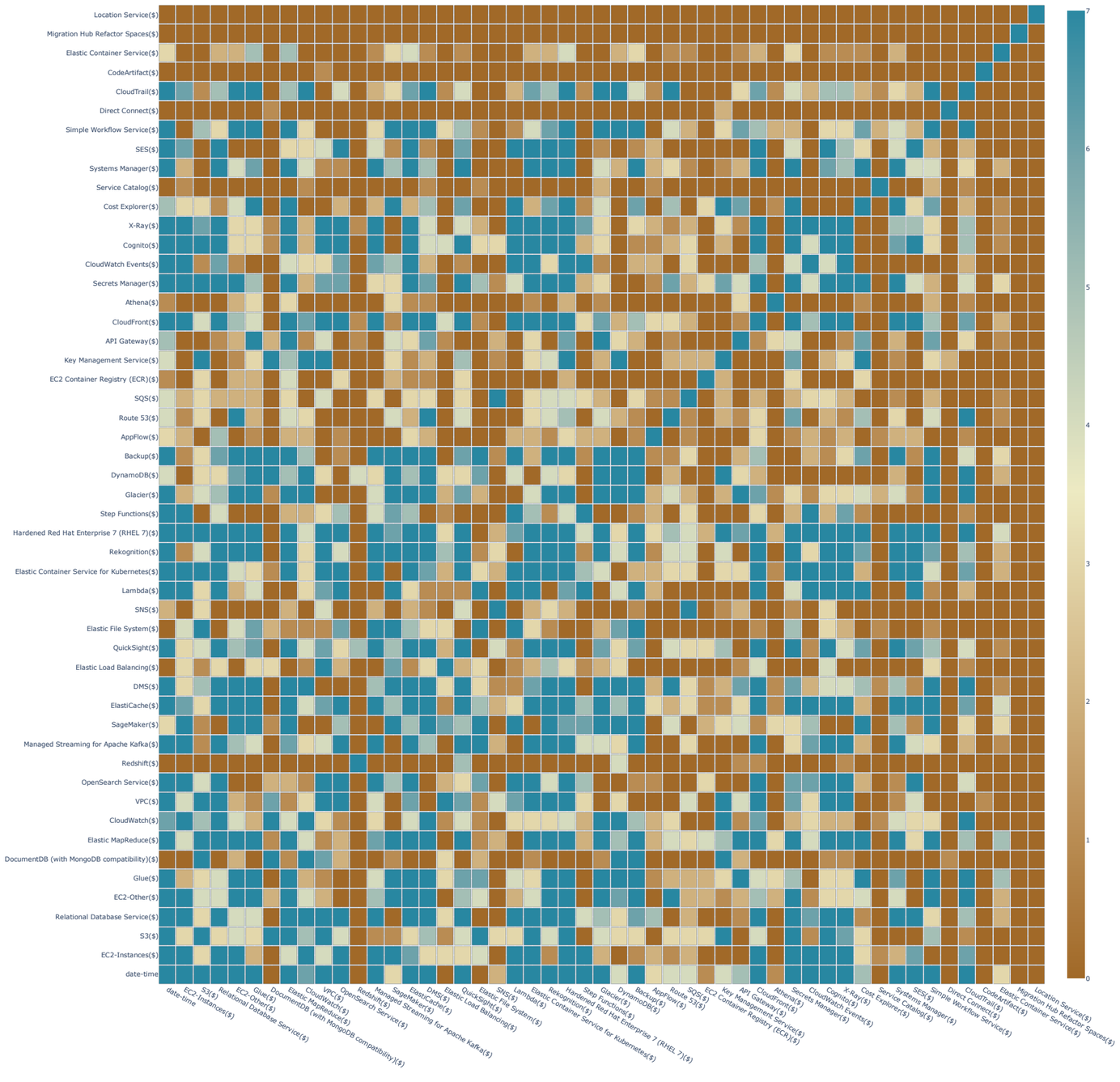
KMBL-OU-Daily.csv

raw correlations of service usage



KMBL-OU-Daily.csv

statistical significance of usage correlations between services:



KMBL-PROD-Daily.csv

Analysis for **KMBL-PROD-Daily.csv**

KMBL-PROD-Daily.csv

raw data from the file

	Service	S3($)	Tax($)	Relational Database Service($)	EC2-Other($)	CloudWatch($)	Support (Business)($)	EC2-Instances($)	Glue($)	Redshift($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	VPC($)	OpenSearch Service($)	ElastiCache($)	Elastic Load Balancing($)	DMS($)	CloudTrail($)	Managed Streaming for Apache Kafka($)	Elastic File System($)	QuickSight($)	Rekognition($)	Elastic Container Service for Kubernetes($)	SNS($)	Glacier($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	SageMaker($)	DynamoDB($)	Lambda($)	Backup($)	Kinesis($)	Route 53($)	AppFlow($)	SQS($)	Step Functions($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)
0	Service total	287125.054943	271582.16	191578.342792	154821.212917	108280.897828	105603.375134	95703.756959	95221.049412	92802.085255	74022.588759	60439.167893	30213.256953	25320.167733	21531.230156	21287.649127	19391.151168	17264.638415	16449.631648	14805.314737	14595.078625	12158.002532	8616.779826	8124.289764	7990.516605	7238.96	6131.861304	5241.535295	4640.444284	3492.494839	2473.755356	2252.165030	2086.221162	1590.212274	961.963505	842.098510	747.822029	492.171243
1	2023-04-01	428.012248	21142.42	351.018836	30.224449	736.451554	10022.846800	0.166706	262.110144	4674.837994	158.137232	171.732837	75.953166	62.334996	70.598160	39.238168	138.936420	366.811761	35.756190	34.414440	29.949720	18.566288	20.088000	16.540644	35.413605	21.12	42.432800	11.503639	6.987642	3.004002	26.142365	5.951490	0.922732	2.416037	0.000025	1.356918	1.337502	1.331964
2	2023-04-02	476.117376	NaN	351.186585	30.883021	747.315702	NaN	0.160413	437.097418	43.087499	151.044234	176.204557	100.089628	62.334972	70.598160	38.180089	138.936441	389.190169	38.174423	34.415653	29.391720	17.125950	20.088000	34.257068	52.770132	21.12	42.432800	23.988705	13.226624	3.006734	22.406618	6.004979	0.171495	5.039598	0.000029	1.346157	1.340826	1.250050
3	2023-04-03	872.782956	NaN	351.415108	34.742191	808.077981	NaN	2.923493	492.687774	45.412007	159.671999	184.796549	78.280836	62.334940	70.598160	43.448051	138.936434	391.551019	34.231704	34.475989	33.297720	21.099375	20.088000	8.005200	68.418540	21.12	42.432518	24.314952	13.551919	3.009265	26.573932	5.962722	0.184152	1.389743	0.000028	1.347954	1.930225	1.387634
4	2023-04-04	584.488101	NaN	384.453621	31.856321	707.870550	NaN	0.174982	721.231030	45.413769	157.968458	181.799677	74.759622	62.334951	70.598160	41.302046	153.583936	336.898583	34.324684	34.460049	29.949720	20.671575	20.088000	8.749756	71.049491	21.12	42.432800	24.100247	13.310254	3.009959	28.026213	6.032753	2.805403	1.426240	0.000025	1.350592	2.043183	1.340761

KMBL-PROD-Daily.csv

clean data

	date-time	S3($)	Tax($)	Relational Database Service($)	EC2-Other($)	CloudWatch($)	Support (Business)($)	EC2-Instances($)	Glue($)	Redshift($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	VPC($)	OpenSearch Service($)	ElastiCache($)	Elastic Load Balancing($)	DMS($)	CloudTrail($)	Managed Streaming for Apache Kafka($)	Elastic File System($)	QuickSight($)	Rekognition($)	Elastic Container Service for Kubernetes($)	SNS($)	Glacier($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	SageMaker($)	DynamoDB($)	Lambda($)	Backup($)	Kinesis($)	Route 53($)	AppFlow($)	SQS($)	Step Functions($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	Managed Workflows for Apache Airflow($)	CloudFront($)	Secrets Manager($)
date-time																																								
2023-04-01	2023-04-01	428.012248	21142.42	351.018836	30.224449	736.451554	10022.8468	0.166706	262.110144	4674.837994	158.137232	171.732837	75.953166	62.334996	70.59816	39.238168	138.936420	366.811761	35.756190	34.414440	29.94972	18.566288	20.088	16.540644	35.413605	21.12	42.432800	11.503639	6.987642	3.004002	26.142365	5.951490	0.922732	2.416037	0.000025	1.356918	1.337502	1.331964	0.0	0.000318	0.968964
2023-04-02	2023-04-02	476.117376	0.00	351.186585	30.883021	747.315702	0.0000	0.160413	437.097418	43.087499	151.044234	176.204557	100.089628	62.334972	70.59816	38.180089	138.936441	389.190169	38.174423	34.415653	29.39172	17.125950	20.088	34.257068	52.770132	21.12	42.432800	23.988705	13.226624	3.006734	22.406618	6.004979	0.171495	5.039598	0.000029	1.346157	1.340826	1.250050	0.0	0.005078	1.077690
2023-04-03	2023-04-03	872.782956	0.00	351.415108	34.742191	808.077981	0.0000	2.923493	492.687774	45.412007	159.671999	184.796549	78.280836	62.334940	70.59816	43.448051	138.936434	391.551019	34.231704	34.475989	33.29772	21.099375	20.088	8.005200	68.418540	21.12	42.432518	24.314952	13.551919	3.009265	26.573932	5.962722	0.184152	1.389743	0.000028	1.347954	1.930225	1.387634	0.0	0.004433	1.094086
2023-04-04	2023-04-04	584.488101	0.00	384.453621	31.856321	707.870550	0.0000	0.174982	721.231030	45.413769	157.968458	181.799677	74.759622	62.334951	70.59816	41.302046	153.583936	336.898583	34.324684	34.460049	29.94972	20.671575	20.088	8.749756	71.049491	21.12	42.432800	24.100247	13.310254	3.009959	28.026213	6.032753	2.805403	1.426240	0.000025	1.350592	2.043183	1.340761	0.0	0.005179	1.072415
2023-04-05	2023-04-05	559.403308	0.00	394.826868	41.890072	755.669472	0.0000	0.221887	505.323140	44.400716	162.395688	183.233698	81.301526	62.334951	70.59816	46.052489	162.372434	370.069840	40.160193	34.486079	34.50672	19.876425	20.088	16.045925	68.136179	21.12	42.432800	24.234663	13.533247	3.010059	30.172042	6.063027	2.159810	2.424677	0.000021	1.370180	1.838562	1.348593	0.0	0.000607	1.092145

KMBL-PROD-Daily.csv

.describe() with 10 percentiles

	date-time	S3($)	Tax($)	Relational Database Service($)	EC2-Other($)	CloudWatch($)	Support (Business)($)	EC2-Instances($)	Glue($)	Redshift($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	VPC($)	OpenSearch Service($)	ElastiCache($)	Elastic Load Balancing($)	DMS($)	CloudTrail($)	Managed Streaming for Apache Kafka($)	Elastic File System($)	QuickSight($)	Rekognition($)	Elastic Container Service for Kubernetes($)	SNS($)	Glacier($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	SageMaker($)	DynamoDB($)	Lambda($)	Backup($)	Kinesis($)	Route 53($)	AppFlow($)	SQS($)	Step Functions($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	Managed Workflows for Apache Airflow($)	CloudFront($)
count	396	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	396.000000	3.960000e+02	396.000000	396.000000	396.000000	396.000000	396.000000
mean	2023-10-15 12:00:00	725.063270	685.813535	483.783694	390.962659	273.436611	266.675190	241.676154	240.457195	234.348700	186.925729	152.624161	76.296103	63.939818	54.371793	53.756690	48.967553	43.597572	41.539474	37.387158	36.856259	30.702027	21.759545	20.515883	20.178072	18.280202	15.484498	13.236200	11.718294	8.819431	6.246857	5.687285	5.268235	4.015688	2.429201e+00	2.126511	1.888439	1.242857	1.179288	1.07724
min	2023-04-01 00:00:00	1.412346	0.000000	351.018836	24.521917	73.566657	0.000000	0.049826	100.983432	40.200911	111.511790	103.956811	50.555785	49.656655	27.877685	32.514794	26.588524	0.000000	30.751727	22.449112	29.391720	1.003238	20.088000	0.002221	15.074002	15.820000	0.000000	1.306262	0.000001	2.950123	0.000000	5.600351	0.164402	0.051625	0.000000e+00	1.346157	1.323834	0.998955	0.000000	0.00031
10%	2023-05-10 12:00:00	383.657570	0.000000	369.622884	36.844861	100.350130	0.000000	0.180007	135.856588	43.787422	116.249216	116.621390	62.186042	51.814377	36.189557	38.614757	37.631525	0.000000	33.285717	26.577793	31.154040	19.864219	20.088000	7.451156	15.074002	16.280000	0.000000	7.678123	0.000744	3.046095	0.000000	5.642172	0.978399	1.619743	7.150000e-07	1.490543	1.406599	1.132758	0.000000	0.12015
20%	2023-06-19 00:00:00	625.101961	0.000000	395.463165	391.587041	108.179112	0.000000	54.196007	149.251878	45.228850	126.435088	123.158894	66.166628	56.765051	45.105930	40.553319	37.631525	0.000000	34.599843	28.461300	32.922000	22.514138	20.088000	8.365747	15.074002	16.320000	0.000000	8.342073	0.003729	4.114254	0.000000	5.660030	1.947150	1.874488	8.004000e-07	1.623023	1.479487	1.175921	0.000000	0.37256
30%	2023-07-28 12:00:00	703.650579	0.000000	420.774214	426.676313	118.753589	0.000000	61.343685	158.717123	47.764134	160.798114	129.102320	69.905895	62.132725	47.296082	41.822833	37.631526	0.000000	35.282395	31.624081	34.796999	24.894356	20.088000	10.188448	15.074002	16.800000	0.000000	8.658668	5.621176	6.930518	0.000000	5.664913	2.291610	2.489253	9.598000e-07	1.653313	1.535542	1.210431	0.000000	0.50681
40%	2023-09-06 00:00:00	744.139720	0.000000	427.370011	447.642148	138.706495	0.000000	118.360189	175.900751	50.753233	180.299923	131.399928	72.245220	62.334951	47.742480	43.900232	38.418125	7.623581	36.164765	32.801749	35.534639	28.906725	20.088000	15.595338	15.074006	17.280000	0.000616	9.955111	12.723853	7.438889	0.000000	5.674409	2.874848	3.141152	1.023700e-06	1.721474	1.567856	1.233990	0.000000	0.60235
50%	2023-10-15 12:00:00	770.560983	0.000000	436.936048	459.440079	174.934858	0.000000	166.078264	195.097301	52.352416	183.960533	140.854146	75.075923	62.834083	47.893605	45.482072	38.418128	10.006282	37.406919	33.683876	36.593640	31.245094	20.088000	16.866926	15.074006	17.760000	0.004393	11.957661	13.548422	8.199801	0.000000	5.685237	3.587357	3.573587	2.896800e-06	1.752101	1.617332	1.246749	0.000000	0.81449
60%	2023-11-24 00:00:00	790.291628	0.000000	445.342598	466.850216	232.383609	0.000000	226.710224	210.315344	53.441040	188.089040	159.335497	77.344503	63.059669	57.112230	48.546646	38.444349	12.941847	43.665439	34.506000	37.709640	34.094730	20.088000	20.749878	15.576469	19.200000	0.076800	13.594088	14.574976	9.767060	1.153950	5.690159	4.202793	4.209044	9.551400e-06	1.776814	1.724773	1.262646	0.000000	1.14249
70%	2024-01-02 12:00:00	817.415832	0.000000	464.000932	475.069813	307.485571	0.000000	287.993222	228.221590	55.385236	195.400427	174.998904	81.379474	72.488607	62.106330	53.514437	38.472379	24.824919	46.804409	35.504734	38.680191	36.226987	24.552000	24.538536	15.576469	19.660000	42.408000	14.909269	15.377148	10.284718	1.156171	5.692942	5.119231	4.847905	1.826945e-05	1.832203	1.797593	1.281445	0.000000	1.34201
80%	2024-02-11 00:00:00	850.217077	0.000000	577.807113	480.834182	376.576275	0.000000	430.362217	269.095905	57.979380	211.199083	182.954899	85.513265	72.488699	70.598160	64.193271	50.050743	43.969089	48.965756	37.281970	40.346639	38.399700	24.552000	30.303387	15.576473	19.680000	42.432800	19.727615	20.761881	11.484274	12.850243	5.695900	5.975255	5.926811	2.667200e-05	1.960796	1.917450	1.305287	0.000000	1.73134
90%	2024-03-21 12:00:00	977.126417	0.000000	719.324233	490.465374	602.543135	0.000000	617.735380	504.744070	62.695938	253.284761	204.878138	90.448942	73.183743	70.900410	72.886775	79.430889	81.599783	54.679589	54.351480	42.235942	41.210044	24.552000	37.330615	28.970725	20.670000	43.074018	23.417032	22.922179	17.111711	29.495744	5.700769	8.682792	6.738239	8.045766e+00	2.008593	2.190881	1.340379	0.000000	2.39898
max	2024-04-30 00:00:00	1492.207931	24689.260000	984.442238	510.410375	1675.273982	10022.846800	951.646887	750.468310	7235.697633	407.998475	215.963627	131.531313	74.196068	79.967910	233.438081	165.268457	570.516216	67.528450	107.745849	50.111639	53.585437	24.552000	116.184915	87.702382	21.120000	53.029650	26.120515	29.027015	19.209023	41.050761	6.095623	114.510921	16.219051	1.637053e+02	35.907069	5.955169	1.450574	15.413605	4.25023
std	NaN	277.060593	3765.973694	126.259513	156.648820	246.407175	1456.342236	237.813764	137.910924	969.351581	59.982407	31.839119	12.254943	7.872883	13.620797	25.584296	27.512457	100.054485	8.071538	15.934817	4.212516	9.105806	2.157811	13.709210	15.003094	1.771284	20.429468	5.868103	8.467261	4.593463	11.499901	0.061020	9.502418	2.219932	1.054443e+01	2.237347	0.849268	0.079983	4.064349	0.88749

KMBL-PROD-Daily.csv

std/mean as a percentage value

	std	mean	volatility
Red Hat Enterprise Linux (RHEL) 8.4 with support by ProComputers($)	0.01005	0.000505	1989.974874
IoT($)	0.0	0.0	1989.974874
Direct Connect($)	0.149896	0.007535	1989.281162
Textract($)	0.031663	0.001726	1834.323915
Config($)	3.485764	0.22842	1526.034624

KMBL-PROD-Daily.csv

remove total costs as well

date-time	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Cat
2023-04-01	2023-04-01	0.166706	428.012248	351.018836	30.224449	262.110144	158.137232	171.732837	736.451554	75.953166	62.334996	4674.837994	35.756190	42.432800	70.59816	138.936420	39.238168	29.94972	34.414440	16.540644	6.987642	20.088	18.566288	21.12	0.000025	35.413605	11.503639	3.004002	0.922732	5.951490	2.416037	1.356918	1.337502	1.331964	0.000318	0.510793	0.968964	0.000047	0.0	0.0	0.0	
2023-04-02	2023-04-02	0.160413	476.117376	351.186585	30.883021	437.097418	151.044234	176.204557	747.315702	100.089628	62.334972	43.087499	38.174423	42.432800	70.59816	138.936441	38.180089	29.39172	34.415653	34.257068	13.226624	20.088	17.125950	21.12	0.000029	52.770132	23.988705	3.006734	0.171495	6.004979	5.039598	1.346157	1.340826	1.250050	0.005078	0.634311	1.077690	0.000052	0.0	0.0	0.0	
2023-04-03	2023-04-03	2.923493	872.782956	351.415108	34.742191	492.687774	159.671999	184.796549	808.077981	78.280836	62.334940	45.412007	34.231704	42.432518	70.59816	138.936434	43.448051	33.29772	34.475989	8.005200	13.551919	20.088	21.099375	21.12	0.000028	68.418540	24.314952	3.009265	0.184152	5.962722	1.389743	1.347954	1.930225	1.387634	0.004433	1.422551	1.094086	0.000052	0.0	0.0	0.0	
2023-04-04	2023-04-04	0.174982	584.488101	384.453621	31.856321	721.231030	157.968458	181.799677	707.870550	74.759622	62.334951	45.413769	34.324684	42.432800	70.59816	153.583936	41.302046	29.94972	34.460049	8.749756	13.310254	20.088	20.671575	21.12	0.000025	71.049491	24.100247	3.009959	2.805403	6.032753	1.426240	1.350592	2.043183	1.340761	0.005179	1.095359	1.072415	0.000050	0.0	0.0	0.0	
2023-04-05	2023-04-05	0.221887	559.403308	394.826868	41.890072	505.323140	162.395688	183.233698	755.669472	81.301526	62.334951	44.400716	40.160193	42.432800	70.59816	162.372434	46.052489	34.50672	34.486079	16.045925	13.533247	20.088	19.876425	21.12	0.000021	68.136179	24.234663	3.010059	2.159810	6.063027	2.424677	1.370180	1.838562	1.348593	0.000607	0.757057	1.092145	0.000041	0.0	0.0	0.0	

KMBL-PROD-Daily.csv

correlation matrix across all services

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	M
date-time	1.000000	0.551500	0.405958	0.761173	0.465768	-0.506830	-0.013354	-0.779353	-0.327993	0.353684	0.545460	0.014259	0.601385	-0.185509	-0.836204	-0.589453	0.096541	0.599318	-0.016561	0.164535	0.377109	0.840138	0.577186	-0.959537	0.344725	-0.497373	-0.222609	0.473528	0.215197	-0.262334	0.245153	0.125633	0.250129	-0.280618	0.721572	-0.128631	-0.722410	0.423371	0.693873	0.729779	0.278257	0.063139	
EC2-Instances($)	0.551500	1.000000	0.194395	0.449311	0.412035	0.145717	-0.061218	-0.253956	-0.357921	0.258951	0.469550	-0.000705	0.343377	0.368783	-0.322126	-0.210770	-0.204648	0.189328	-0.254711	0.085280	0.575934	0.513606	0.116354	-0.402143	0.399912	-0.135606	0.085539	0.101043	0.161174	-0.117965	0.141236	-0.026788	-0.012054	0.040215	0.422674	0.006233	-0.335215	0.426092	0.364563	0.486546	-0.214884	0.106353	
S3($)	0.405958	0.194395	1.000000	0.166792	0.253121	-0.192621	0.506655	-0.403732	0.266921	0.358561	0.233634	0.013939	-0.108635	-0.115099	-0.210690	-0.284955	0.115440	0.263538	-0.346100	0.172774	0.208683	0.393628	0.253908	-0.518703	0.072203	-0.263483	0.185274	-0.218791	0.088926	-0.206478	0.215206	0.176024	0.497362	-0.091305	0.250478	-0.046508	-0.590916	0.099628	0.335003	0.333100	0.218016	-0.042287	
Relational Database Service($)	0.761173	0.449311	0.166792	1.000000	0.226112	-0.259153	-0.076852	-0.439086	-0.347170	0.399504	0.541786	0.009626	0.469894	-0.047419	-0.765834	-0.337092	0.214454	0.432248	-0.044123	0.077100	0.488643	0.695827	0.533796	-0.698994	0.262611	-0.283493	-0.180820	0.311095	0.293632	-0.061559	0.142965	0.022484	0.014859	-0.120495	0.756647	-0.068617	-0.462365	0.329170	0.645517	0.597326	-0.099809	0.088913	
EC2-Other($)	0.465768	0.412035	0.253121	0.226112	1.000000	-0.353712	-0.139257	-0.464020	-0.255798	0.162952	-0.005768	0.014405	0.271135	-0.481028	-0.481920	-0.615775	0.091142	0.283937	0.221950	0.089581	-0.136469	0.230903	0.411115	-0.446617	0.080130	-0.481724	-0.332168	0.392670	0.055557	-0.348055	0.140338	0.133124	0.114016	-0.158405	0.285211	-0.142195	-0.364260	0.115900	0.201533	0.186900	0.245625	-0.024243	

KMBL-PROD-Daily.csv

p-values over the correlation

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Clo
date-time	0.000000e+00	6.842035e-33	3.824835e-17	4.236863e-76	1.022098e-22	3.125860e-27	7.910691e-01	5.268571e-82	2.195799e-11	4.116122e-13	4.473688e-32	0.777285	2.615880e-40	2.054778e-04	7.787109e-105	2.040668e-38	0.054915	5.637644e-40	7.425089e-01	0.001015	7.888575e-15	9.832652e-107	1.495682e-36	5.851270e-219	1.717548e-12	3.884958e-26	7.745848e-06	1.593596e-23	1.563577e-05	1.177719e-07	7.867172e-07	0.012346	4.603424e-07	1.338098e-08	6.765444e-65	0.010399	4.106584e-65	1.18
EC2-Instances($)	6.842035e-33	0.000000e+00	9.885708e-05	4.513518e-21	1.163090e-17	3.659855e-03	2.241707e-01	3.024675e-07	2.061504e-13	1.730534e-07	4.156369e-23	0.988847	2.121085e-12	3.338660e-14	5.175970e-11	2.351352e-05	0.000041	1.506503e-04	2.781973e-07	0.090117	2.295114e-36	4.891523e-28	2.055998e-02	7.975436e-17	1.220521e-16	6.882429e-03	8.914278e-02	4.448199e-02	1.289787e-03	1.886179e-02	4.865451e-03	0.595082	8.110150e-01	4.248310e-01	1.363672e-18	0.901601	7.448611e-12	6.73
S3($)	3.824835e-17	9.885708e-05	0.000000e+00	8.622406e-04	3.316912e-07	1.147071e-04	3.276999e-27	5.879414e-17	6.927822e-08	1.855262e-13	2.604561e-06	0.782152	3.066679e-02	2.197366e-02	2.368552e-05	7.800461e-09	0.021581	1.025530e-07	1.383508e-12	0.000554	2.841738e-05	3.977050e-16	3.041027e-07	1.179240e-28	1.515266e-01	1.032082e-07	2.093922e-04	1.115618e-05	7.714056e-02	3.464440e-05	1.562274e-05	0.000433	3.896271e-26	6.952350e-02	4.431593e-07	0.355974	1.207555e-38	4.75
Relational Database Service($)	4.236863e-76	4.513518e-21	8.622406e-04	0.000000e+00	5.511033e-06	1.691440e-07	1.268203e-01	4.290428e-20	1.168268e-12	1.318982e-16	1.376075e-31	0.848562	3.827857e-23	3.466190e-01	1.460204e-77	5.598627e-12	0.000017	1.855208e-19	3.811972e-01	0.125597	3.715005e-25	1.327954e-58	1.511863e-30	2.428578e-59	1.140857e-07	9.366018e-09	2.983107e-04	2.469785e-10	2.576384e-09	2.215980e-01	4.363244e-03	0.655554	7.681733e-01	1.644041e-02	1.037118e-74	0.172961	2.275388e-22	1.84
EC2-Other($)	1.022098e-22	1.163090e-17	3.316912e-07	5.511033e-06	0.000000e+00	4.097829e-13	5.503830e-03	1.543308e-22	2.465073e-07	1.136978e-03	9.089049e-01	0.775063	4.217934e-08	2.526336e-24	2.023383e-24	1.064355e-42	0.070026	8.860893e-09	8.252699e-06	0.074981	6.531334e-03	3.429113e-06	1.394757e-17	8.229608e-21	1.113654e-01	2.124307e-24	1.179520e-11	4.751618e-16	2.700611e-01	1.015288e-12	5.146568e-03	0.007988	2.326122e-02	1.565608e-03	7.553268e-09	0.004581	7.184769e-14	2.10

KMBL-PROD-Daily.csv

STAR (*) representation of correlations based on p-values for easier visual comparision

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	
date-time	*******	*******	*******	*******	*******	*******		*******	******	*******	*******		*******	***	*******	*******		*******		**	*******	*******	*******	*******	*******	*******	****	*******	***	****	****		*****	*****	*******	*	*******	*******	*******	*******	*****		*******	*******	
EC2-Instances($)	*******	*******	***	*******	*******	**		*****	*******	****	*******		*******	*******	******	*****	***	***	****		*******	*******	*******	*	*******	*******	**	****	*******	**	*	****	**		********		*******			*******		***	*	**	******	
S3($)	*******	***	*******	***	****	***	*******	*******	*****	*******	****		*	*	***	*****	*	****	*******	***	***	*******	****	*******	*******	****	*****	***	*******		***	***	***	********		*******	*	*******	******	***		*****			
Relational Database Service($)	*******	*******	***	*******	****	****		*******	*******	*******	*******		*******		*******	*******	***	*******			*******	*******	*******	*******	****	*****	***	******	*****		**		*	*******		*******	*******	*******	*******	*		*******	*******	
EC2-Other($)	*******	*******	****	****	*******	*******	**	*******	****	**			*****	*******	*******	*******		*****	****		**	****	*******	*******		*******	******	*******		*******	**	**	*	**	*****	**	*******	*	***	***	****		****		

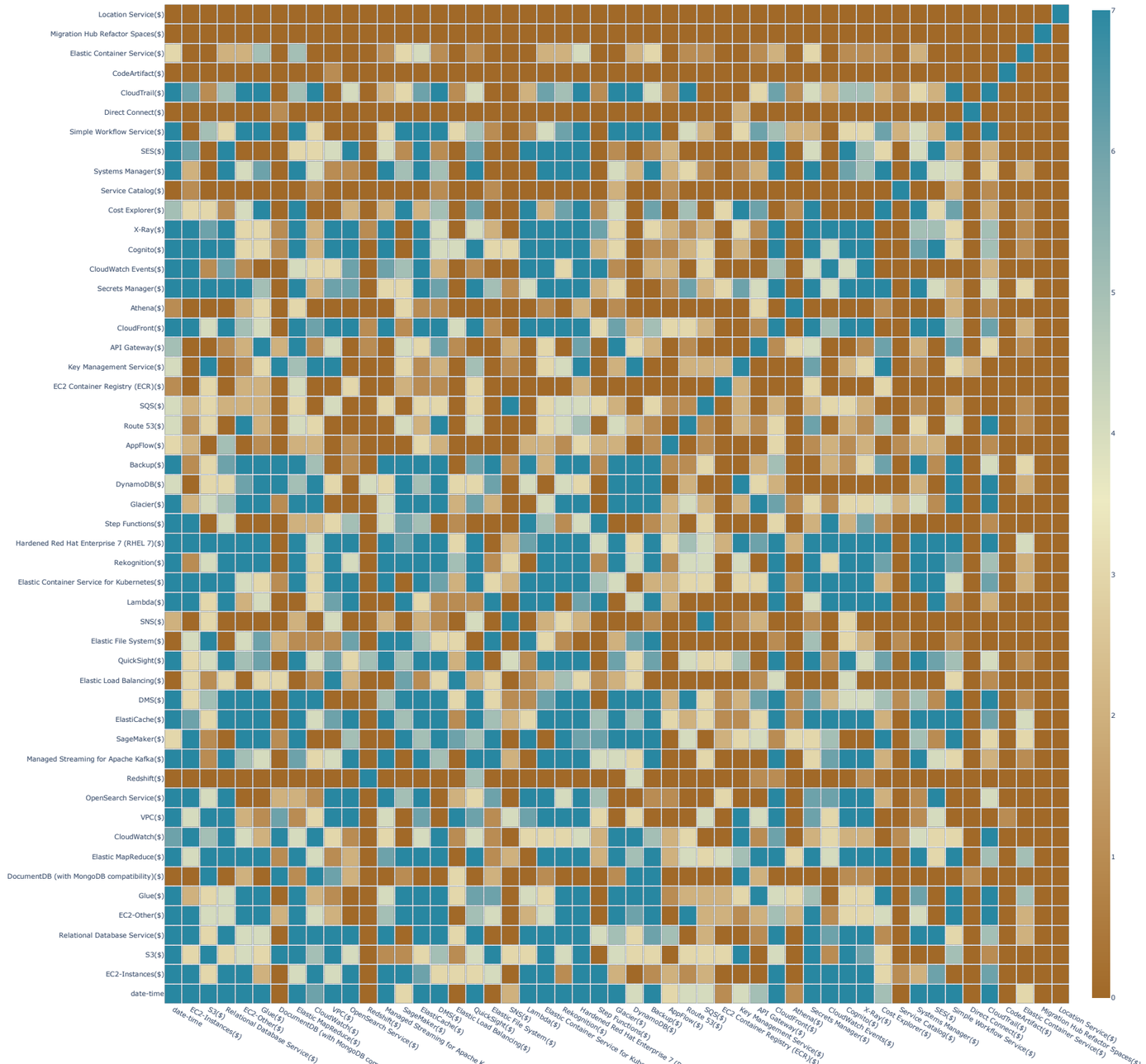
KMBL-PROD-Daily.csv

simple RANK based representation of correlations based on p-values for easier analysis

	date-time	EC2-Instances($)	S3($)	Relational Database Service($)	EC2-Other($)	Glue($)	DocumentDB (with MongoDB compatibility) ($)	Elastic MapReduce($)	CloudWatch($)	VPC($)	OpenSearch Service($)	Redshift($)	Managed Streaming for Apache Kafka($)	SageMaker($)	ElastiCache($)	DMS($)	Elastic Load Balancing($)	QuickSight($)	Elastic File System($)	SNS($)	Lambda($)	Elastic Container Service for Kubernetes($)	Rekognition($)	Hardened Red Hat Enterprise 7 (RHEL 7)($)	Step Functions($)	Glacier($)	DynamoDB($)	Backup($)	AppFlow($)	Route 53($)	SQS($)	EC2 Container Registry (ECR)($)	Key Management Service($)	API Gateway($)	CloudFront($)	Athena($)	Secrets Manager($)	CloudWatch Events($)	Cognito($)	X-Ray($)	Cost Explorer($)	Service Catalog($)	Systems Manager($)	SES($)	W Se
date-time	7	7	7	7	7	7	0	7	6	7	7	0	7	3	7	7	0	7	0	2	7	7	7	7	7	7	4	7	3	4	4	1	4	5	7	1	7	7	7	7	5	0	7	7	
EC2-Instances($)	7	7	3	7	7	2	0	4	7	4	7	0	7	7	6	3	3	3	4	0	7	7	1	7	7	2	0	1	2	1	2	0	0	0	7	0	7	7	7	7	3	1	2	6	
S3($)	7	3	7	3	4	3	7	7	5	7	4	0	1	1	3	5	1	4	7	3	3	7	4	7	0	4	3	3	0	3	3	3	7	0	4	0	7	1	7	6	3	0	0	0	
Relational Database Service($)	7	7	3	7	4	4	0	7	7	7	7	0	7	0	7	7	3	7	0	0	7	7	7	7	4	5	3	6	5	0	2	0	0	1	7	0	7	6	7	7	1	0	7	7	
EC2-Other($)	7	7	4	4	7	7	2	7	4	2	0	0	5	7	7	7	0	5	4	0	2	4	7	7	0	7	6	7	0	7	2	2	1	2	5	2	7	1	3	3	4	0	4	0	

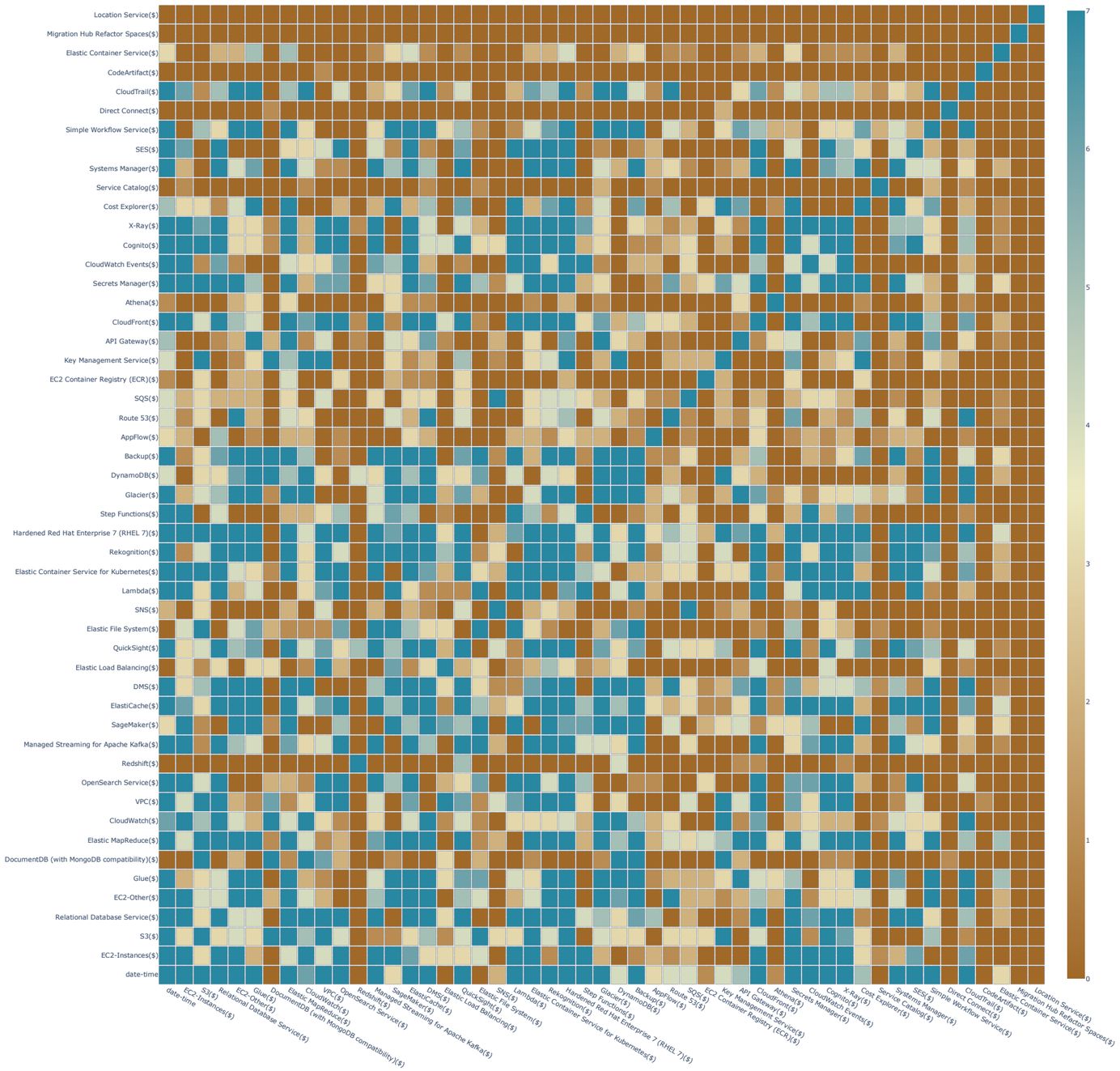
KMBL-PROD-Daily.csv

raw correlations of service usage



KMBL-PROD-Daily.csv

statistical significance of usage correlations between services:



KMBL-PROD-Daily: Forecasting usage and costs for the next 60 days...

Refresher

In [18]:
```
# list of all the datafiles
print(filelist)

# Components of each analysis:
# "cur_data_raw" - raw data from the file
# "cur_data" - clean data
# "cur_summary" - .describe() with 10 percentiles
# "volatility" - std/mean as a percentage value
# "cur_data_simple" - remove total costs as well
# "cur_rho" - correlation matrix across all services
# "curr_pval" - p-values over the correlation
# "cur_corr_p_star" - easier representation of correlations based on p-values
# "cur_corr_p_rank" - easier representation of correlations based on p-values
# "cur_heatmap_rho" - plotly graph object for plotting the heatmap based on raw correlations
```

```
# "cur_heatmap_rank" - plotly graph object for plotting the heatmap based on curr_corr_p_rank
```

```
['KIAL-PROD-Daily.csv', 'KMBL-811-PROD-Daily.csv', 'KMBL-Logs-Daily.csv', 'KMBL-MB2-PROD-Daily.csv', 'KMBL-OU-Daily.csv', 'KMBL-PROD-Daily.csv']
```

In [19]:
```
res["KMBL-PROD-Daily.csv"]["cur_data"].columns
```

Out[19]:
```
Index(['date-time', 'S3($)', 'Tax($)', 'Relational Database Service($)',
       'EC2-Other($)', 'CloudWatch($)', 'Support (Business)($)',
       'EC2-Instances($)', 'Glue($)', 'Redshift($)',
       'DocumentDB (with MongoDB compatibility)($)', 'Elastic MapReduce($)',
       'VPC($)', 'OpenSearch Service($)', 'ElastiCache($)',
       'Elastic Load Balancing($)', 'DMS($)', 'CloudTrail($)',
       'Managed Streaming for Apache Kafka($)', 'Elastic File System($)',
       'QuickSight($)', 'Rekognition($)',
       'Elastic Container Service for Kubernetes($)', 'SNS($)', 'Glacier($)',
       'Hardened Red Hat Enterprise 7 (RHEL 7)($)', 'SageMaker($)',
       'DynamoDB($)', 'Lambda($)', 'Backup($)', 'Kinesis($)', 'Route 53($)',
       'AppFlow($)', 'SQS($)', 'Step Functions($)',
       'EC2 Container Registry (ECR)($)', 'Key Management Service($)',
       'API Gateway($)', 'Managed Workflows for Apache Airflow($)',
       'CloudFront($)', 'Secrets Manager($)', 'Athena($)',
       'CIS  Linux 2 Benchmark - Level 2($)', 'Transfer Family($)',
       'Config($)', 'Cognito($)', 'CloudWatch Events($)',
       'Kinesis Firehose($)', 'Cost Explorer($)',
       'RHEL 8 with Support by Supported Images($)', 'X-Ray($)',
       'Direct Connect($)', 'Service Catalog($)', 'SES($)',
       'Systems Manager($)', 'Textract($)',
       'Red Hat Enterprise Linux (RHEL) 8.4 with support by ProComputers($)',
       'Simple Workflow Service($)', 'CloudShell($)',
       'Elastic Container Service($)', 'CodeArtifact($)', 'IoT($)',
       'CodeCommit($)', 'Migration Hub Refactor Spaces($)',
       'Location Service($)', 'Refund($)', 'Total costs($)'],
      dtype='object')
```

In [20]:
```
# time series for the next 60 days
future_periods = 60
```

In [21]:
```
# create new dataframe from a slice of cur_data
#
# carefully choose the right filename
# specify the service from the list above
# TEMPLATE: service_costs = pd.DataFrame(res["<FILENAME>"]["cur_data"][['date-time', '<AWS SERVICE>']])
#
service_costs = pd.DataFrame(
    res["KMBL-PROD-Daily.csv"]["cur_data"][
        ["date-time", "EC2-Instances($)"]
    ]
)
```

In [22]:
```
# prophet needs specific column names
#
# carefully choose the right filename
# specify the service from the list above
# TEMPLATE: service_costs.rename(columns={'date-time': 'ds', '<AWS SERVICE>': 'y'}, inplace=True)
#
service_costs.rename(
    columns={"date-time": "ds", "EC2-Instances($)": "y"}, inplace=True
)
```

Methods to make the predictions

In [23]:
```
model = Prophet()
model.fit(service_costs)
```

```
15:46:27 - cmdstanpy - INFO - Chain [1] start processing
15:46:27 - cmdstanpy - INFO - Chain [1] done processing
```

Out[23]:
```
<prophet.forecaster.Prophet at 0x2107aec1dd0>
```

In [24]:
```
future_dates = model.make_future_dataframe(periods=future_periods)
```

In [25]:
```
# only select the last future_periods of the dataframe for prediction
future_dates = future_dates.tail(future_periods)
```

In [26]:
```
# future_dates
```

In [27]:
```
forecast = model.predict(future_dates)
```

In [ ]:
```

```

Review the SERVICE this forecast has been created for

In [28]:
```
# Look at the raw forecast data
forecast.head(10)
```

Out[28]:

	ds	trend	yhat_lower	yhat_upper	trend_lower	trend_upper	additive_terms	additive_terms_lower	additive_terms_upper	weekly	weekly_lower	weekly_upper	multiplicative_terms	multiplicative_terms_lower	multiplicative_terms_upper	yhat
0	2024-05-01	785.796799	609.070200	986.798432	785.796799	785.796799	20.365058	20.365058	20.365058	20.365058	20.365058	20.365058	0.0	0.0	0.0	806.161858
1	2024-05-02	791.497902	608.513042	987.339822	791.497902	791.497902	2.048677	2.048677	2.048677	2.048677	2.048677	2.048677	0.0	0.0	0.0	793.546579
2	2024-05-03	797.199005	638.760938	991.688959	797.199005	797.199005	10.926905	10.926905	10.926905	10.926905	10.926905	10.926905	0.0	0.0	0.0	808.125910
3	2024-05-04	802.900108	593.570064	973.071120	802.871196	802.900108	-20.314472	-20.314472	-20.314472	-20.314472	-20.314472	-20.314472	0.0	0.0	0.0	782.585635
4	2024-05-05	808.601210	595.427037	953.985395	808.471026	808.646535	-31.987010	-31.987010	-31.987010	-31.987010	-31.987010	-31.987010	0.0	0.0	0.0	776.614201
5	2024-05-06	814.302313	642.860363	1007.221719	814.030923	814.435171	10.869140	10.869140	10.869140	10.869140	10.869140	10.869140	0.0	0.0	0.0	825.171453
6	2024-05-07	820.003416	632.623716	1007.460103	819.584556	820.231692	8.091701	8.091701	8.091701	8.091701	8.091701	8.091701	0.0	0.0	0.0	828.095117
7	2024-05-08	825.704518	648.000702	1024.946559	825.101589	826.070952	20.365058	20.365058	20.365058	20.365058	20.365058	20.365058	0.0	0.0	0.0	846.069577
8	2024-05-09	831.405621	660.201280	1034.568115	830.625049	831.957036	2.048677	2.048677	2.048677	2.048677	2.048677	2.048677	0.0	0.0	0.0	833.454298
9	2024-05-10	837.106724	658.649907	1044.164877	836.130873	837.839683	10.926905	10.926905	10.926905	10.926905	10.926905	10.926905	0.0	0.0	0.0	848.033629

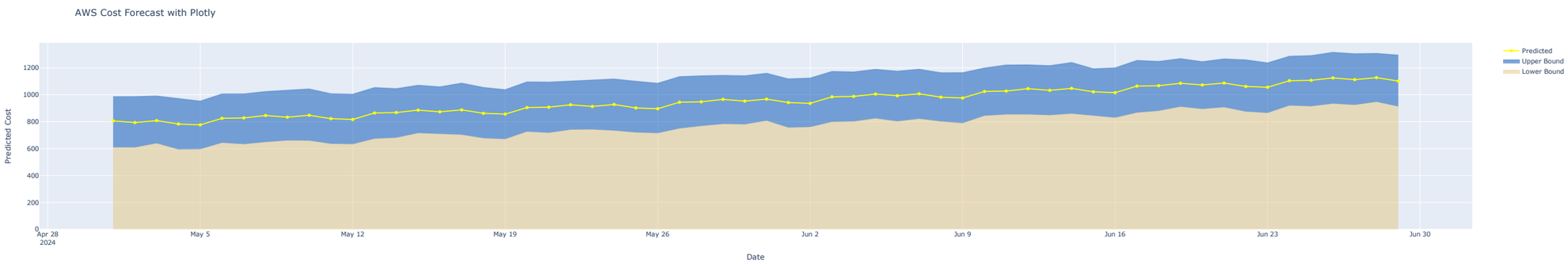
Plot the forecast data

In [29]:
```
# Create a figure for the forecast
fig = go.Figure(
    data=[
        # Lower limit
        go.Scatter(
            x=forecast["ds"],
            y=forecast["yhat_lower"],
            line=dict(color="rgba(229,198,131,0.2)"),
            mode="lines",
            fill="tonexty",
            name="Lower Bound",
        ),
        # upper limit
        go.Scatter(
            x=forecast["ds"],
            y=forecast["yhat_upper"],
            line=dict(color="rgba(0,80,180,0.2)"),
            mode="lines",
            fill="tonexty",
            name="Upper Bound",
        ),
        # predictions
        go.Scatter(
            x=forecast["ds"],
            y=forecast["yhat"],
            line=dict(color="yellow"),
            mode="lines+markers",
            name="Predicted",
        ),
    ]
)

# Modify layout
```

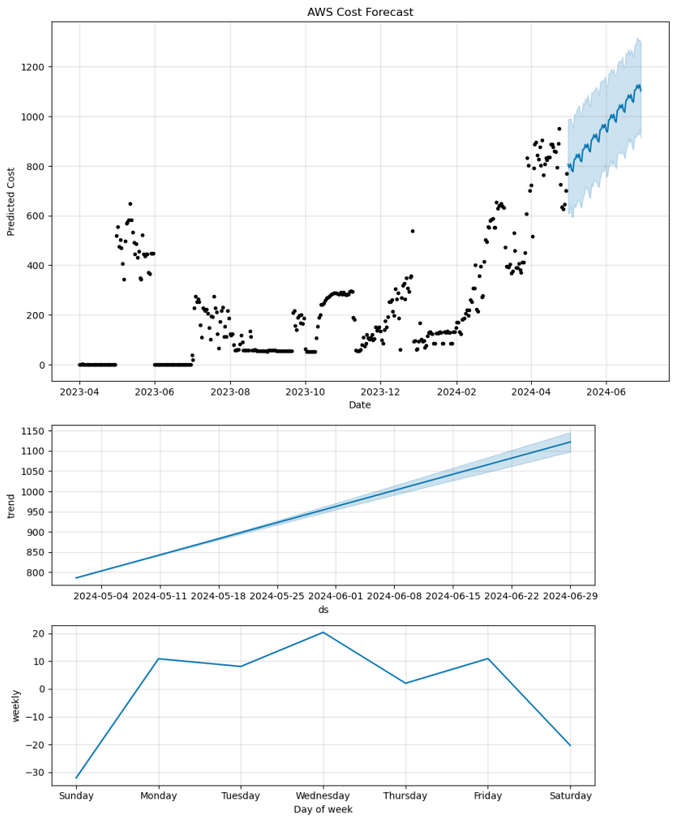
```
fig.update_layout(
    title="AWS Cost Forecast with Plotly",
    xaxis_title="Date",
    yaxis_title="Predicted Cost",
)

fig.show()
```



In [30]:
```
# # matplotlib is the simplest, but not interactive.
model.plot(forecast)
plt.xlabel("Date")
plt.ylabel("Predicted Cost")
plt.title("AWS Cost Forecast")
plt.grid(True)
plt.show()

# we'll only use MPL to plot the components
# Visualize model components (trend, seasonality, etc.)
model.plot_components(forecast)
plt.show()
```



In [31]:
```
# Plotly not very useful for components and seasonality
trends = go.Scatter(
    x=forecast["ds"],
    y=forecast["yhat"],
    mode="lines+markers",
    name="Trend",
)

# Handle weekly and yearly seasonality, if present
if "weekly" in forecast.columns:
    weekly = go.Scatter(
        x=forecast["ds"],
        y=forecast["weekly"],
        mode="lines",
        name="Weekly",
    )
```

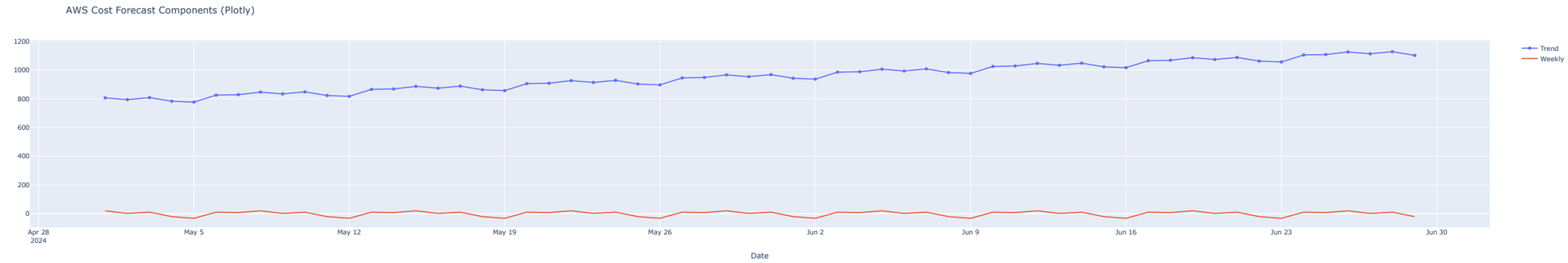
```
if "yearly" in forecast.columns:
    yearly = go.Scatter(
        x=forecast["ds"],
        y=forecast["yearly"],
        mode="lines",
        name="Yearly",
    )

# Compose the figure
data = [trends]
if "weekly" in forecast.columns:
    data.append(weekly)
if "yearly" in forecast.columns:
    data.append(yearly)

fig_components = go.Figure(data=data)

# Customize layout
fig_components.update_layout(
    title="AWS Cost Forecast Components (Plotly)", xaxis_title="Date"
)

fig_components.show()
```



done.

In [ ]: