Re-examining Marginal use of Curiosity Rover

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Agenda

- Who am I
- What is the Curiosity rover
- How I used Marginal Data Analysis to improve efficiency of the rover

Intro

- University of Southern California - B.S in Computer Science/Physics
- Expected graduation: May of 2022

Things I do

LEADERSHIP EXCELLENCE

ARMY ROTC

Google DSC Leader

- Developer Student Club founder/leader at USC.
- Working together to build solutions for local problems in the community.
- Access to Google Developer resources.

Google

Developer Student Clubs

COUNTY OF LOS ANGELES
CALIFORNIA

Curiosity Rover

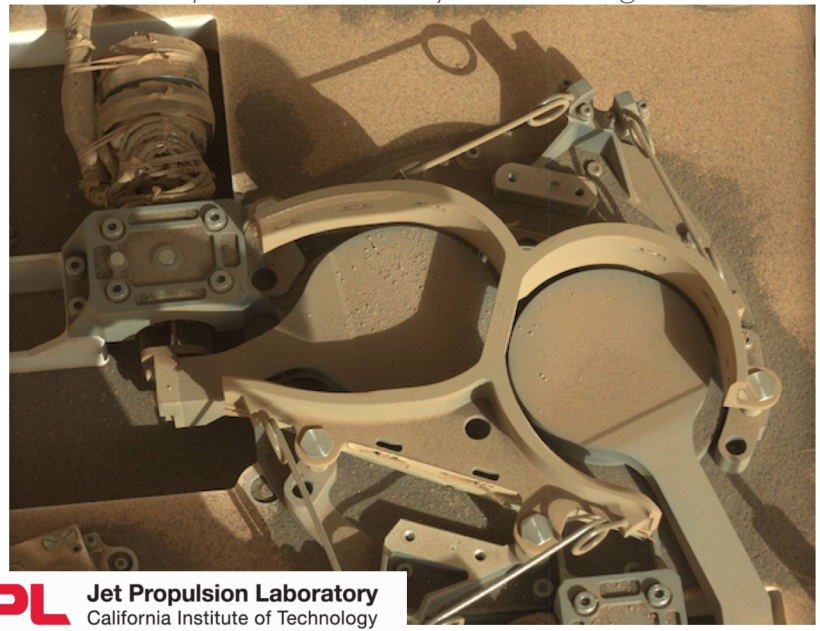
- 8 years old (launched 2011)
- 2586 Sols on Mars
- 13.42 miles traveled
- Over 600k photos taken

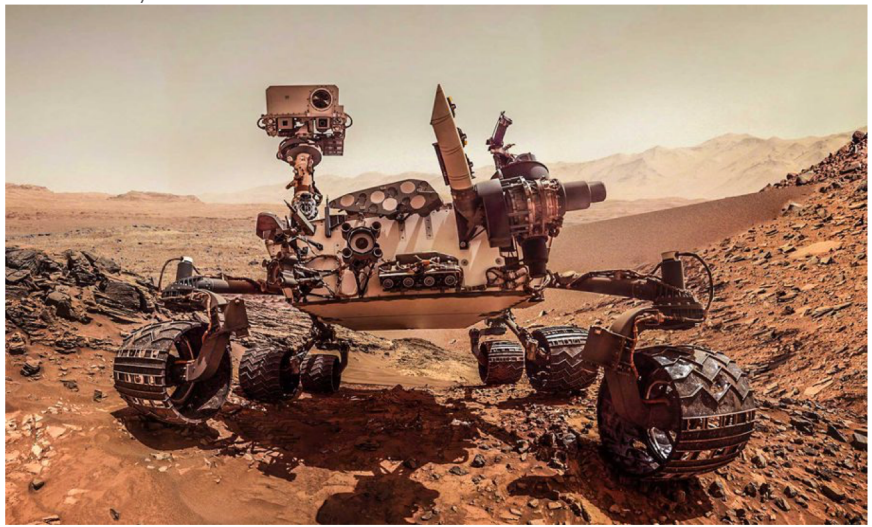
Discoveries

- Persistent evidence of liquid water
- Suitable home for Life (organic molecules, nitrogen, sulfur, oxygen, carbon)
- Methane discovery (2019)
    - Methane can be produced by living organisms or by chemical reactions between rock and water
- And much more….

Goal

- Develop a tool that analyzes the marginal use of the Curiosity rover actual vs. estimated from EVR files.

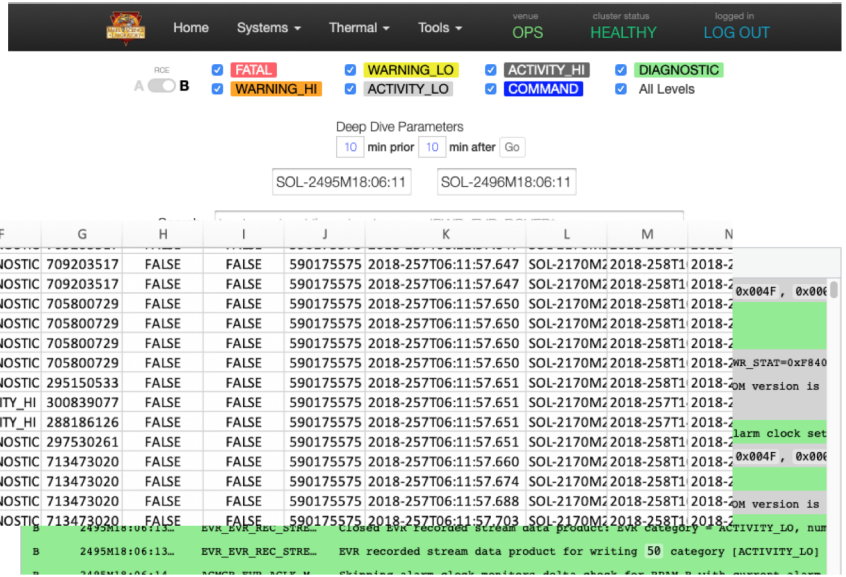




Sol 2490 left Mastcam image of SAM inlet covers.

Where things started

- EVR (Event Reports)
  - Chill_get (chill_get_evrs -t LST -b Sol-2452M00:00:00 -e Sol-2453M00:00:00 -m)
    - Spazz/Elasticsearch used



```
import os, sys, json, re
from math import floor
import elasticsearch1, urllib3
from elasticsearch1 import helpers
pwd = os.getcwd()
sys.path.insert(0, '{}/msl-datalytics/src/'.format(pwd))
from spazz import *
import timeit
start = time.time()
# from msldatalytics.src.spazz import *
#from spazz import *


es = elasticsearch1.Elasticsearch('https[redacted].nasa.gov', sniff_on_start=False)
```

Grabbing EVR files

```
numMarginDatabaseErrors = 0
numMissingActualsErrors = 0
numMultipleActualsErrors = 0
# initialize Spazz for a future query
spazzObj = spazz({'beginTime' : "Sol-" + str(starting_Sol) + "M00:00:00",'timeType': "LST"})
#initialize the query
# the "not" line should remove all instances of sub_00000
# This query is essensially a frame work for the elasticsearch to base off from. It continuosly
# match tihs query.
query = {
```

Output

	D	E	F	G	H	I	J	K	L	M	N	O	P
55609	REUMGR_EVR_USER1_WA	reumgr	ACTIVITY_LO	1.844E+09	FALSE	FALSE	590174098	2018-257T05:47:20.557	SOL-2170M2	2018-257T1	2018-257T1	A USER1 (aka	[{CategorySe [{2
55610	CBM_EVR_RECEIVED_HAIL	cbm	ACTIVITY_LO	299177405	FALSE	FALSE	590174098	2018-257T05:47:20.557	SOL-2170M2	2018-257T1	2018-257T1	Received hail	[{CategorySe [{2
55611	CBM_EVR_IGNORING_HAIL	cbm	DIAGNOSTIC	295248521	FALSE	FALSE	590174098	2018-257T05:47:20.560	SOL-2170M2	2018-257T1	2018-258T1	CBM ignorin	[{CategorySe [{1
55612	REUMGR_EVR_STATE_DEA	reumgr	ACTIVITY_LO	1.836E+09	FALSE	FALSE	590174098	2018-257T05:47:20.605	SOL-2170M2	2018-257T1	2018-257T1	The state of t	[{CategorySe [{2
55613	REUMGR_EVR_STATE_AW	reumgr	ACTIVITY_LO	1.845E+09	FALSE	FALSE	590174098	2018-257T05:47:20.980	SOL-2170M2	2018-257T1	2018-257T1	The state of t	[{CategorySe [{2
55614	REUMGR_EVR_USER1_WA	reumgr	ACTIVITY_LO	1.844E+09	FALSE	FALSE	590174098	2018-257T05:47:20.981	SOL-2170M2	2018-257T1	2018-257T1	A USER1 (aka	[{CategorySe [{2
55615	REUMGR_EVR_STATE_DEA	reumgr	ACTIVITY_LO	1.836E+09	FALSE	FALSE	590174099	2018-257T05:47:21.980	SOL-2170M2	2018-257T1	2018-257T1	The state of t	[{CategorySe [{2
55616	UPL_EVR_CHANGE_INPUT_	upl	ACTIVITY_HI	2.351E+09	FALSE	FALSE	590174102	2018-257T05:47:25.080	SOL-2170M2	2018-257T1	2018-257T1	Detected a ch	[{CategorySe [{3
55617	UPL_EVR_CTRL_CLIENT_DA	upl	DIAGNOSTIC	2.353E+09	FALSE	FALSE	590174102	2018-257T05:47:25.082	SOL-2170M2	2018-257T1	2018-258T1	Delivering 2	[{CategorySe [{1
55618	CMD_EVR_VC1_CMD_DISP	cmd	COMMAND	368067947	FALSE	FALSE	590174102	2018-257T05:47:25.083	SOL-2170M2	2018-257T1	2018-257T1	Dispatching i	[{CategorySe [{7
55619	CMD_EVR_VC1_CMD_DISP	cmd	DIAGNOSTIC	363755906	FALSE	FALSE	590174102	2018-257T05:47:25.083	SOL-2170M2	2018-257T1	2018-258T1	Successfully	[{CategorySe [{1
55620	CMD_EVR_IMM_NO_OP	cmd	ACTIVITY_LO	352867173	FALSE	FALSE	590174102	2018-257T05:47:25.083	SOL-2170M2	2018-257T1	2018-257T1	Execute imm	[{CategorySe [{2
55621	CMD_EVR_CMD_COMPLET	cmd	COMMAND	357588092	FALSE	FALSE	590174102	2018-257T05:47:25.084	SOL-2170M2	2018-257T1	2018-257T1	Successfully	[{CategorySe [{7
55622	DWN_EVR_FRAME_BUFFE	dwn	DIAGNOSTIC	622195199	FALSE	FALSE	590174122	2018-257T05:47:44.835	SOL-2170M2	2018-258T1	2018-258T1	Downlink fra	[{CategorySe [{1
55623	DWN_EVR_FRAME_BUFFE	dwn	DIAGNOSTIC	622195199	FALSE	FALSE	590174122	2018-257T05:47:44.859	SOL-2170M2	2018-258T1	2018-258T1	Downlink fra	[{CategorySe [{1
55624	ML_EVR_INST_DISCRETE_	iml	DIAGNOSTIC	1.027E+09	FALSE	FALSE	590174846	2018-257T05:59:48.552	SOL-2170M2	2018-258T1	2018-258T1	Discrete RAD	[{CategorySe [{1
55625	RAD_EVR_SLEEPING	rad	ACTIVITY_LO	1.784E+09	FALSE	FALSE	590174846	2018-257T05:59:48.552	SOL-2170M2	2018-257T1	2018-257T1	RAD went to	[{CategorySe [{2
55626	ML_EVR_INST_DISCRETE_	iml	DIAGNOSTIC	1.027E+09	FALSE	FALSE	590174874	2018-257T06:00:16.552	SOL-2170M2	2018-258T1	2018-258T1	Discrete RAD	[{CategorySe [{1
55627	RAD_EVR_WOKE_UP	rad	ACTIVITY_LO	1.789E+09	FALSE	FALSE	590174874	2018-257T06:00:16.552	SOL-2170M2	2018-257T1	2018-257T1	RAD woke up	[{CategorySe [{2
55628	ML_EVR_ICMD_SUMMAR	iml	DIAGNOSTIC	1.039E+09	FALSE	FALSE	590174950	2018-257T06:01:32.723	SOL-2170M2	2018-258T1	2018-258T1	IML (RAD-CC	[{CategorySe [{1
55629	ML_EVR_ICMD_SUMMAR	iml	DIAGNOSTIC	1.039E+09	FALSE	FALSE	590174951	2018-257T06:01:33.910	SOL-2170M2	2018-258T1	2018-258T1	IML (RAD-CC	[{CategorySe [{1
55630	CBM_EVR_SENDING_DMS_	cbm	DIAGNOSTIC	287958560	FALSE	FALSE	590175112	2018-257T06:04:14.763	SOL-2170M2	2018-258T1	2018-258T1	Requesting D	[{CategorySe [{1
55631	CBM_EVR_SENDING_PDP_	cbm	DIAGNOSTIC	293241834	FALSE	FALSE	590175112	2018-257T06:04:14.765	SOL-2170M2	2018-258T1	2018-258T1	Requesting P	[{CategorySe [{1
55632	CBM_EVR_SENDING_DWN	cbm	DIAGNOSTIC	290503239	FALSE	FALSE	590175112	2018-257T06:04:14.765	SOL-2170M2	2018-258T1	2018-258T1	Requesting D	[{CategorySe [{1
55633	DWN_EVR_CLEAR_PACKET	dwn	DIAGNOSTIC	622470062	FALSE	FALSE	590175112	2018-257T06:04:14.774	SOL-2170M2	2018-258T1	2018-258T1	Downlink pa	[{CategorySe [{1
55634	CBM_EVR_WINDOW_STAF	cbm	ACTIVITY_LO	296166838	FALSE	FALSE	590175112	2018-257T06:04:14.774	SOL-2170M2	2018-257T1	2018-257T1	Starting durs	[{CategorySe [{2
55635	PDP_EVR_FAILING_REQUE	pdp	DIAGNOSTIC	1.705E+09	FALSE	FALSE	590175112	2018-257T06:04:14.788	SOL-2170M2	2018-258T1	2018-258T1	Failing packe	[{CategorySe [{1
55636	DMS_EVR_STARTED_REPE	dms	DIAGNOSTIC	2.553E+09	FALSE	FALSE	590175112	2018-257T06:04:14.808	SOL-2170M2	2018-258T1	2018-258T1	Started proc	[{CategorySe [{1
55637	DMS_EVR_REPEAT_LOG_P	dms	DIAGNOSTIC	2.555E+09	FALSE	FALSE	590175112	2018-257T06:04:14.821	SOL-2170M2	2018-258T1	2018-258T1	Finished pro	[{CategorySe [{1
55638	DMS_EVR_REXMITS_DONE	dms	DIAGNOSTIC	2.563E+09	FALSE	FALSE	590175112	2018-257T06:04:15.059	SOL-2170M2	2018-258T1	2018-258T1	Finished pro	[{CategorySe [{1
55639	DMS_EVR_FINISHED_REPE	dms	DIAGNOSTIC	2.551E+09	FALSE	FALSE	590175112	2018-257T06:04:15.059	SOL-2170M2	2018-258T1	2018-258T1	Finished pro	[{CategorySe [{1
55640	CBM_EVR_WINDOW_FINIS	cbm	ACTIVITY_HI	295102867	FALSE	FALSE	590175117	2018-257T06:04:19.772	SOL-2170M2	2018-257T1	2018-257T1	Starting clear	[{CategorySe [{3
55641	CBM_EVR_OPENING_DWN	cbm	DIAGNOSTIC	287898568	FALSE	FALSE	590175117	2018-257T06:04:19.773	SOL-2170M2	2018-258T1	2018-258T1	Opening rec	[{CategorySe [{1
55642	CBM_EVR_UHF_CLEANUP_	cbm	DIAGNOSTIC	301417901	FALSE	FALSE	590175117	2018-257T06:04:19.773	SOL-2170M2	2018-258T1	2018-258T1	UHF Cleanup	[{CategorySe [{1
55643	CBM_EVR_UHF_CLEANUP_	cbm	DIAGNOSTIC	290873514	FALSE	FALSE	590175118	2018-257T06:04:20.390	SOL-2170M2	2018-258T1	2018-258T1	UHF Cleanup	[{CategorySe [{1
55644	CBM_EVR_UHF_STARTING_	cbm	DIAGNOSTIC	293325756	FALSE	FALSE	590175122	2018-257T06:04:24.386	SOL-2170M2	2018-258T1	2018-258T1	UHF Cleanup	[{CategorySe [{1
55645	UHFT_EVR_STARTING_MEI	uhft	ACTIVITY_LO	2.339E+09	FALSE	FALSE	590175129	2018-257T06:04:32.165	SOL-2170M2	2018-257T1	2018-257T1	Starting ELT /	[{CategorySe [{2
55646	UHFT_EVR_END_EXTENDE	uhft	ACTIVITY_LO	2.344E+09	FALSE	FALSE	590175138	2018-257T06:04:40.392	SOL-2170M2	2018-257T1	2018-257T1	Completed d	[{CategorySe [{2
55647	BTP_EVR_BEGIN_ID	btp	DIAGNOSTIC	254041532	FALSE	FALSE	590175138	2018-257T06:04:40.406	SOL-2170M2	2018-258T1	2018-258T1	About to per	[{CategorySe [{1
55648	DMS_EVR_FINISHED_COM	dms	DIAGNOSTIC	2.558E+09	FALSE	FALSE	590175138	2018-257T06:04:40.459	SOL-2170M2	2018-258T1	2018-258T1	Finished com	[{CategorySe [{1
55649	BTP_EVR_END_ID	btp	DIAGNOSTIC	259906455	FALSE	FALSE	590175138	2018-257T06:04:40.543	SOL-2170M2	2018-258T1	2018-258T1	Processing c	[{CategorySe [{1
55650	CBM_EVR_UHF_STARTING_	cbm	DIAGNOSTIC	288017747	FALSE	FALSE	590175139	2018-257T06:04:41.396	SOL-2170M2	2018-258T1	2018-258T1	UHF Cleanup	[{CategorySe [{1
55651	UHFT_EVR_STARTING_MEI	uhft	ACTIVITY_LO	2.339E+09	FALSE	FALSE	590175139	2018-257T06:04:41.404	SOL-2170M2	2018-257T1	2018-257T1	Starting ELT /	[{CategorySe [{2
55652	UHFT_EVR_END_EXTENDE	uhft	ACTIVITY_LO	2.344E+09	FALSE	FALSE	590175539	2018-257T06:11:21.894	SOL-2170M2	2018-257T1	2018-257T1	Completed d	[{CategorySe [{2
55653	CBM_EVR_REMOVED_WIN	cbm	ACTIVITY_LO	288865335	FALSE	FALSE	590175539	2018-257T06:11:21.895	SOL-2170M2	2018-257T1	2018-257T1	Removed wi	[{CategorySe [{2
55654	CBM_EVR_NEXT_FIVE_WIN	cbm	ACTIVITY_HI	288186126	FALSE	FALSE	590175539	2018-257T06:11:21.895	SOL-2170M2	2018-257T1	2018-257T1	Next 5 windc	[{CategorySe [{3
55655	CBM_EVR_ESTABLISHING_	cbm	DIAGNOSTIC	295247872	FALSE	FALSE	590175539	2018-257T06:11:21.895	SOL-2170M2	2018-258T1	2018-258T1	Starting estal	[{CategorySe [{1
55656	CBM_EVR_SENDING_DMS_	cbm	DIAGNOSTIC	295150533	FALSE	FALSE	590175539	2018-257T06:11:21.895	SOL-2170M2	2018-258T1	2018-258T1	Requesting D	[{CategorySe [{1
55657	CBM_EVR_UHF_SEQ_STAR	cbm	DIAGNOSTIC	290023849	FALSE	FALSE	590175539	2018-257T06:11:21.895	SOL-2170M2	2018-258T1	2018-258T1	Starting UHF	[{CategorySe [{1
55658	CBM_EVR_UHF_OFF_1	cbm	DIAGNOSTIC	287834614	FALSE	FALSE	590175539	2018-257T06:11:21.895	SOL-2170M2	2018-258T1	2018-258T1	UHF Off 1: h	[{CategorySe [{1
55659	BTP_EVR_BEGIN_ID	btp	DIAGNOSTIC	254041532	FALSE	FALSE	590175539	2018-257T06:11:21.923	SOL-2170M2	2018-258T1	2018-258T1	About to per	[{CategorySe [{1
55660	REUMGR_EVR_USER1_MA	reumgr	ACTIVITY_LO	1.839E+09	FALSE	FALSE	590175539	2018-257T06:11:21.946	SOL-2170M2	2018-257T1	2018-257T1	The USER1 (a	[{CategorySe [{2
55661	REUMGR_EVR_USER1_MA	reumgr	ACTIVITY_LO	1.839E+09	FALSE	FALSE	590175539	2018-257T06:11:21.994	SOL-2170M2	2018-257T1	2018-257T1	The USER1 (a	[{CategorySe [{2
55662	DMS_EVR_FINISHED_COM	dms	DIAGNOSTIC	2.558E+09	FALSE	FALSE	590175539	2018-257T06:11:22.051	SOL-2170M2	2018-258T1	2018-258T1	Finished com	[{CategorySe [{1

sol2170

Lots of useless info

55740	Evr	24967	mslsmsampc	EVR_EV
55741	Evr	24967	mslsmsampc	EVR_EV
55742	Evr	24967	mslsmsampc	EVR_EV
55743	Evr	24967	mslsmsampc	CBM_EV
55744	Evr	24954	mslsmsampc	CBM_EV
55745	Evr	24954	mslsmsampc	CBM_EV
55746	Evr	24967	mslsmsampc	CBM_EV
55747	Evr	24967	mslsmsampc	EVR_EV
55748	Evr	24967	mslsmsampc	EVR_EV
55749	Evr	24967	mslsmsampc	EVR_EV
55750	Evr	24967	mslsmsampc	EVR_EV
55751				
55752				
55753				
55754				
55755				
55756				
55757				
55758				


```
    "seqId": "sub_00171",
    "uniqueID": "sol2171_sub_00171"
  }
```

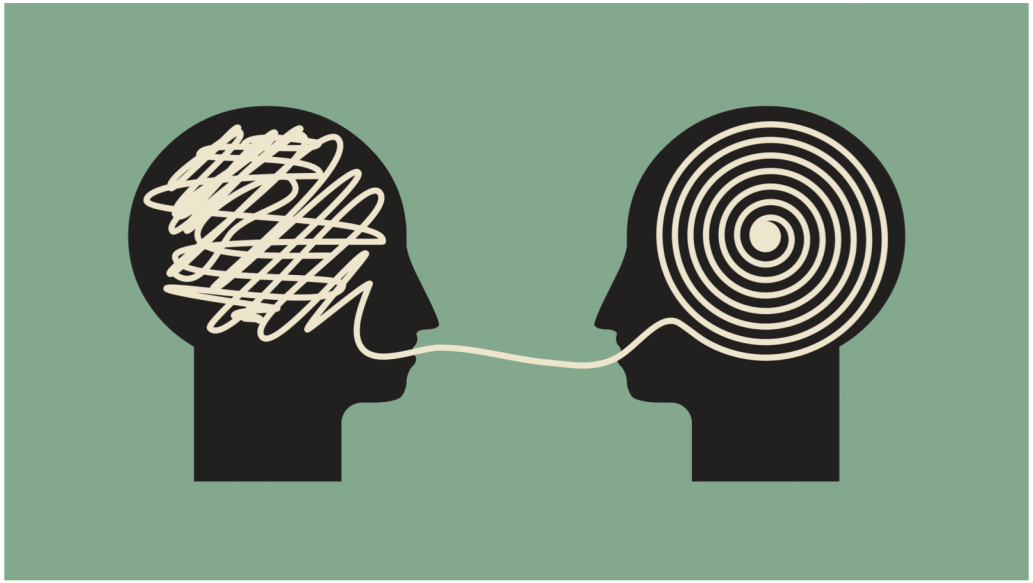
Level of priorities

1) Complexity
2) Reliability
3) Maintainability

1. Complexity

Key Factor

- Efficiency
- Ease to read/understand
- Ability to pick up fairly easily



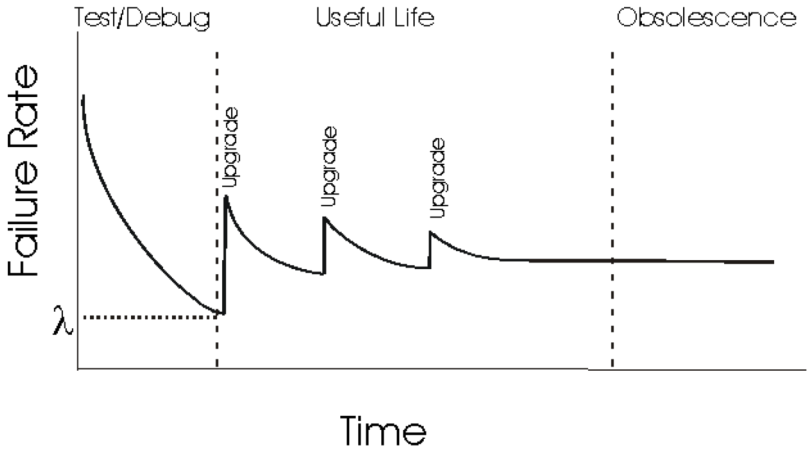
Result

```python
def hist_fixedBinsWidth (fig, arr, width = 1, subplotNum = [], binOverrides = None):
    #Inputs:
    #   fig = matplotlib figure number as integer; defined from instantiation of figure
    #   arr = array to be plotted on a histogram
    #   width = custom Width of bins as an integer.
    # Outputs:
    #   returns the figure with updated entries
    binLow = None
    binHigh = None
    if binOverrides:
        if binOverrides[0] != None:
            binLow = binOverrides[0]
        if binOverrides[1] != None:
            binHigh = binOverrides[1]
    if not binLow:
        binLow = int(floor(min(arr)/width)*width)
    if not binHigh:
        binHigh = int(ceil(max(arr)/width)*width)
    binsDist = range(binLow, binHigh+width, width)
    plt.figure(fig)
    if subplotNum:
        plt.subplot(subplotNum[0], subplotNum[1],subplotNum[2])
    plt.hist(arr, rwidth=.95, bins = binsDist)
    return fig

def makeQuadPlot (figNum, title, xLabel, yLabel, dataArr , binOverrides = None):
    fig = plt.figure(figNum)
    fig.suptitle(title)
    plot_titleAndLabels (figNum, 'All Activities', xLabel, yLabel, [2,2,1])
    if binOverrides:
        hist_fixedBinsWidth (figNum,dataArr['all'],5, [2,2,1], binOverrides)
    else:
        hist_fixedBinsWidth (figNum,dataArr['all'],5, [2,2,1])
    plt.figure(figNum)
    plot_titleAndLabels (figNum, 'Science Blocks', xLabel, yLabel, [2,2,2])
    if binOverrides:
        hist_fixedBinsWidth (figNum,dataArr['sb'],5, [2,2,2], binOverrides)
    else:
        hist_fixedBinsWidth (figNum,dataArr['sb'],5, [2,2,2])
    plt.figure(figNum)
    plot_titleAndLabels (figNum, 'Arm Backbones', xLabel, yLabel, [2,2,3])
    if binOverrides:
        hist_fixedBinsWidth (figNum,dataArr['arm'],5, [2,2,3], binOverrides)
    else:
        hist_fixedBinsWidth (figNum,dataArr['arm'],5, [2,2,3])
    plt.figure(figNum)
    plot_titleAndLabels (figNum, 'Drives', xLabel, yLabel,[2,2,4])
    if binOverrides:
        hist_fixedBinsWidth (figNum,dataArr['drive'],5, [2,2,4], binOverrides)
    else:
        ],5, [2,2,4], binOverrides)
```

```python
df_amountMarginUsed = pd.DataFrame(columns = ['all', 'sb', 'arm', 'drive'])
for column in df_amountMarginUsed.keys():
    df_amountMarginUsed[column] = pd.Series(amountMarginUsedArr[column])

df_percentMarginUsed = pd.DataFrame(columns = ['all', 'sb', 'arm', 'drive'])
for column in df_percentMarginUsed.keys():
    df_percentMarginUsed[column] = pd.Series(percentMarginUsedArr[column])

df_percentMarginUsed = pd.DataFrame(columns = ['all', 'sb', 'arm', 'drive'])
for column in df_percentMarginUsed.keys():
    df_percentMarginUsed[column] = pd.Series(percentMarginUsedArr[column])

df_IdleTime = pd.DataFrame(columns = ['all', 'sb', 'arm', 'drive'])
for column in df_IdleTime.keys():
    df_IdleTime[column] = pd.Series(amountUnusedTimeArr[column])
```

2. Reliability

- Probability of failure-free software
- TDD (Test Driven Development)



The *probability of failure* is given as

$$F(t) = 1 - R(t) = \int_0^t f(s)\, ds \tag{3}$$

and the *failure rate (FR)* indicating the conditional probability that a failure per unit time occurs in an interval $[t, t + \Delta t]$ given that a failure has not occurred before time t is given by

$$FR = \frac{F(t+\Delta t) - F(t)}{\Delta t R(t)}. \tag{4}$$

3. Maintainability

- Important because it is approx. 75% of the cost related to project.

Marginal Analysis Tool

The task is to develop a tool that analyzes the marginal use of the Curiosity rover actual vs. estimated from EVR files. If possible, James wants to look deeper into the individual sub-master processes that happens within each block for better efficiency. Eventually, make it simple enough to be a command to feed in intervals and generate
maintainable and document thoroughly for someone else to pick up.

Getting Started

1. Copy the repository in a desired location.

```
git clone https://github.jpl.nasa.gov/kevinl/MWG
```

Prerequisites

Python 2 is required to run this program. Have internet access to download packages if necessary.

I am running Python 2.7.10

Run this to find out what python version you are running

SOFTWARE MAINTENANCE

"A software system must be continuously adapted during its overall life cycle or it progressively becomes less satisfactory"

DOCUMENTATION!

Running the tests

To run

```
python analyzeMarginUse.py
```

This should create different graphs you can view. Additionally, it will give you the statistics of the percentile idle time in minutes of each activity. (sb, all, arm, drive)

- To retrieve statistics of the graph that was created using the data run:

use.

Most of the erros I encountered running this program were the different versions of packages that were installed in individual computers. It is **ABSOLUTELY VITAL** that you are running the same version of packages as I am or else your program will fail and spend a lot of time trying to figure out what is happening.

Ex. Error in `hits, _ = spazzObj.get_as_run_sequences(seqids=[seqId])` (line 245) raised an eror saying: `raise HTTP_EXCEPTIONS.get(status_code, TransportError)(status_code, error_message, additional_info)` `elasticsearch.exceptions.RequestError.`

This problem was resoluted by installing a previous python ***elasticsearch*** package.

```
python -m pip install "elasticsearch-dsl<2.0.0" --user
```

Required packages:

```
https://github.jpl.nasa.gov/MSLEO/msl-datalytics
scipy==1.2.2
elasticsearch1==1.10.0
spazz
```

Spazz is built from msl-datalytics repository that contains shared resources that utilize the Analytics cloud infrastructure to query,index, and analyze MSL Data.

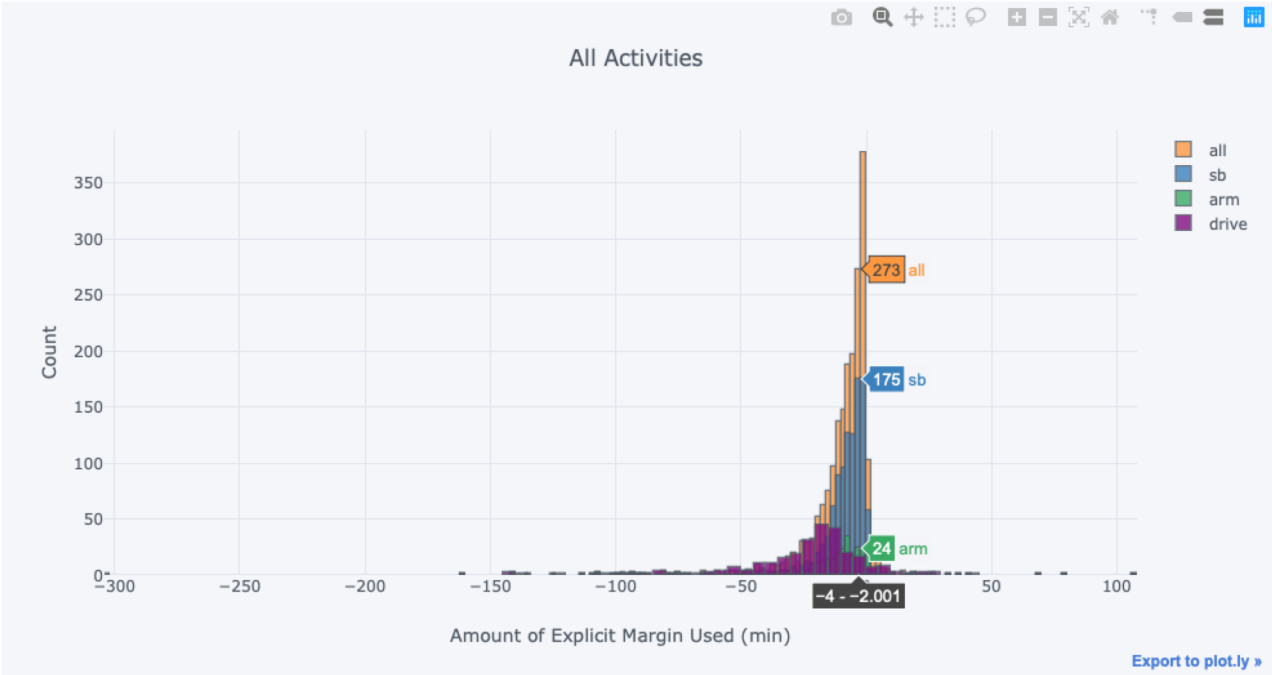
```
# Using plotly + cufflinks in offline mode
import cufflinks
cufflinks.go_offline(connected=True)
init_notebook_mode(connected=True)

# ==============================INITIALIZING ARRAYS ==================================
planSubDurArr = []
actSubDurArr = []
amountMarginUsedArr = {"all":[], "sb":[],"arm": [],"drive": []}
percentMarginUsedArr = {"all":[], "sb":[],"arm": [],"drive": []}
percentPlannedMarginArr = {"all":[], "sb":[],"arm": [],"drive": []}
amountUnusedTimeArr = {"all":[], "sb":[],"arm": [],"drive": []}
subsUsingMarginArr = []
over50PerMarginUseSBArr = []

#==============================================================================
#==============================================================================
#================================ ADDING DATA ==================================
#==============================================================================
#==============================================================================
for uniqueId in data.keys():
    #==========================amountMarginUsed=====================================
    #Iterating through Unique ID column and calculating the amountMargin actually used by
    #subtracting plannedMarginDuration -
    # Divide 60 to get in minutes and round nearest 3rd decimal place.
    amountMarginUsed = round((data[uniqueId]['planMarginDur'] - data[uniqueId]['actMarginDur'])/6
    amountMarginUsedArr["all"].append(amountMarginUsed) #appending all of the marginal data
    if ('SB' in data[uniqueId]['backboneType']):
            amountMarginUsedArr['sb'].append(amountMarginUsed)
    elif ('arm' in data[uniqueId]['backboneType']):
        amountMarginUsedArr['arm'].append(amountMarginUsed)
    elif ('drive' in data[uniqueId]['backboneType']):
        amountMarginUsedArr['drive'].append(amountMarginUsed)
    #==========================percentMarginUsed====================================
    # percent margin used is the amountMarginUsed / planMarginDur in minutes
    percentMarginUsed = round(amountMarginUsed/(data[uniqueId]['planMarginDur']/60),5)*100
    percentMarginUsedArr["all"].append(percentMarginUsed)
```

Complications

An error has occurred

The application failed to start (exited with code 1).

```
DEPRECATION: Python 2.7 will reach the end of its life on January 1st, 2020. Please upgrade your Python as Pyth
Error in value[[3L]](cond) :
  SyntaxError: invalid syntax (classes.py, line 26)

Detailed traceback:
  File "<string>", line 1, in <module>
Calls: local ... tryCatch -> tryCatchList -> tryCatchOne -> <Anonymous>
Execution halted
```


All Activities
Count
350
300
250
200
150
100
50
0
−300
−250
−200
−150
−100
−50
50
100
Amount of Explicit Margin Used (min)
all
sb
arm
drive
273 all
175 sb
24 arm
−4 - −2.001
Export to plot.ly »

Making it in a Web-Dashboard style

- Graphs created using javascript.
- Learning D3.js
  - Document Object Model (DOM)
  - Scalable Vector Graphics (SVG)
  - JavaScript
  - Geometry
  - Color Spaces
  - Data Structures
  - Standard Model

```
d3.csv("https://raw.githubusercontent.com/alohia/basket_shots/master/static/2013-14_shot
// d3.csv("data/data.txt", function(data){
    var shots = d3.select("svg")
        .selectAll("g")
        .data(data)
        .enter()
        .append("g")
            .attr("class", "shots")
            .attr("transform", function(d){
                return "translate(" + 10* d.converted_y+ "," + 10 * d.converted_x +")";
            })
        .on("mouseover", function(d){
            d3.select(this).raise()
                .append("text")
                .attr("class", "playername")
                .text(d.player)
            })
        .on("mouseout", function(d){
            d3.selectAll("text.playername").remove();
            })
```

Example graph made

Achievements

- Hands on experience
  - Reading Code
  - Proper Documentation
- Skills acquired
  - JavaScript
  - HTML
  - D3.js
    - DOM
    - SVG
- Understanding of software process

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Questions

USC '22

Computer Science Candidate