



Introducing Time Series & Warp 10

Horacio Gonzalez
@LostInBrittany



Horacio Gonzalez



@LostInBrittany

Spaniard lost in Brittany, developer,
dreamer and all-around geek

 OVH
Team DevRel



Time Series

What are they?



Time Series

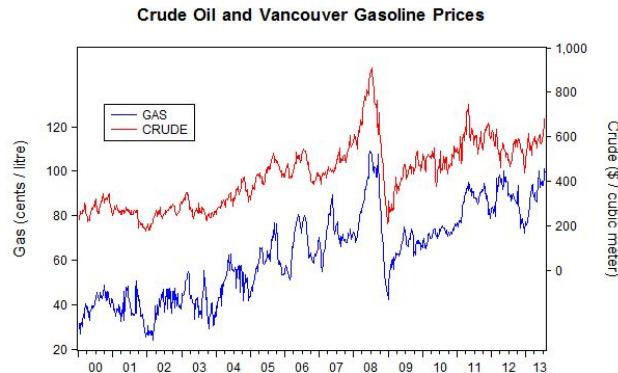
Definition of Time Series:

An ordered sequence of values of a variable at equally spaced time intervals.



Time Series

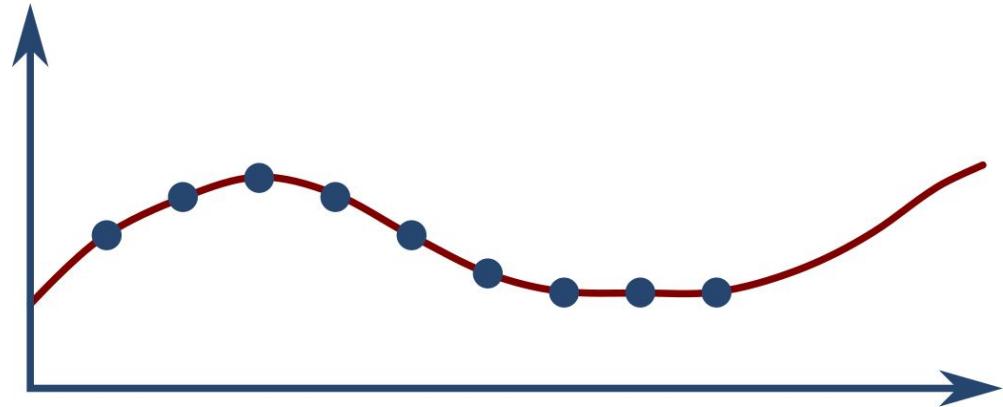
- Stock Market Analysis
- Economic Forecasting
- Budgetary Analysis
- Process and Quality Control
- Workload Projections
- Census Analysis
- ...



Time Series

Applications:

- Understanding the data
- Fit a model
 - Monitoring
 - Forecasting



Time Series



Stock market Analytics
Economic Forecasting



\$\$\$



Study & Research



Time Series

Many specific analytical tools:

- Moving average
- ARMA (AutoRegressive Moving Average)
- Multivariate ARMA models
- ARCH (AutoRegressive Conditional Heteroscedasticity)
- Dynamic time warping
- ...



Time Series



Specific application of general tools

- Artificial neural networks
- Hidden Markov model
- Fourier & Wavelets transforms
- Entropy encoding
- ...



Time Series Databases

What tools do I use?



Time Series Databases



General purpose data analytics tools:

- Matlab
- Python
- R
- ...



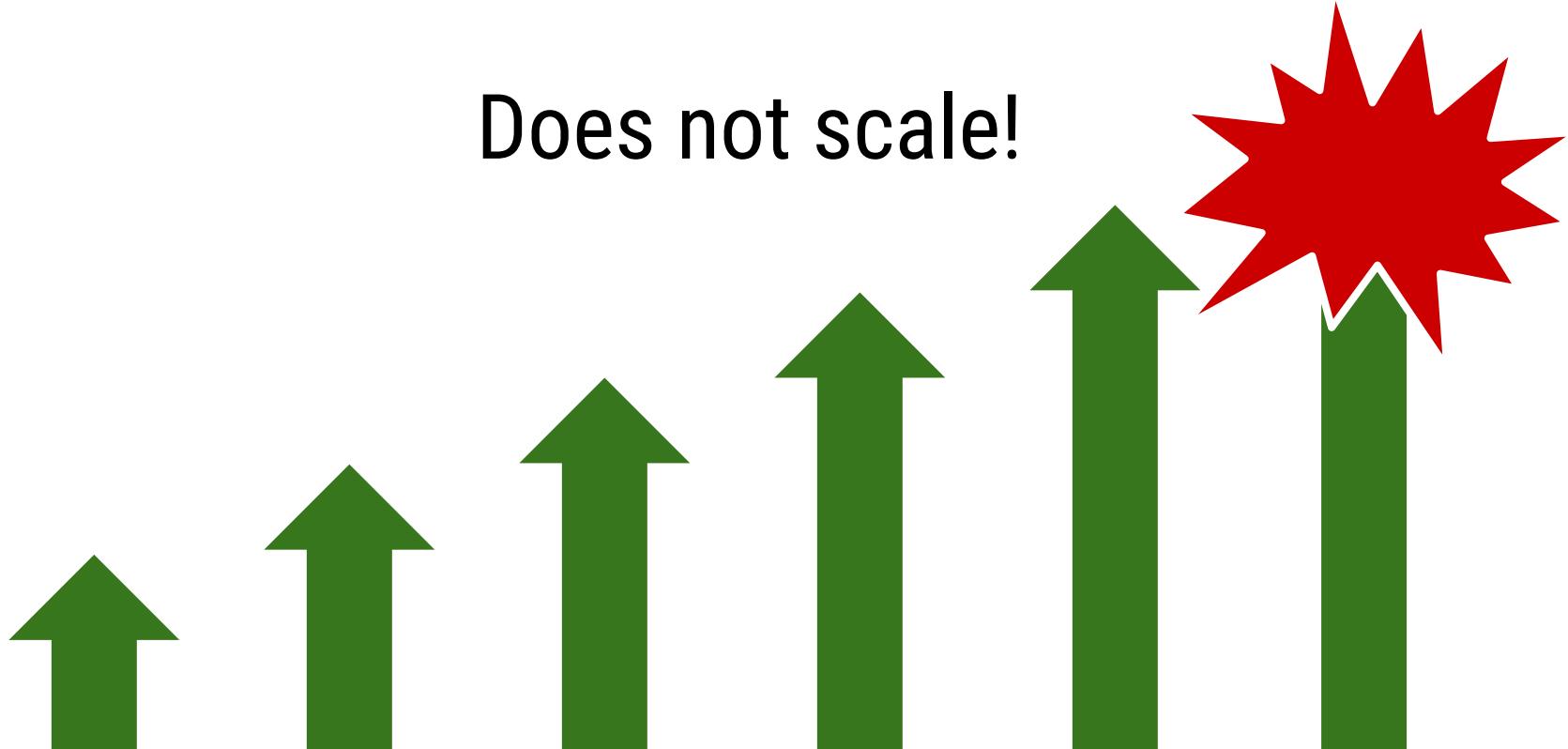
General purpose relational database engine



Time Series Databases



Does not scale!



Time Series Databases



Many type of database engine

- Relational databases
- Key-value databases
- Document databases
- Graph databases
- ...



Time Series Databases



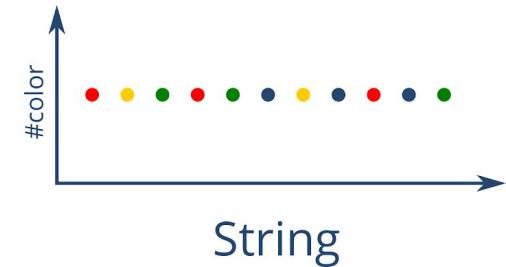
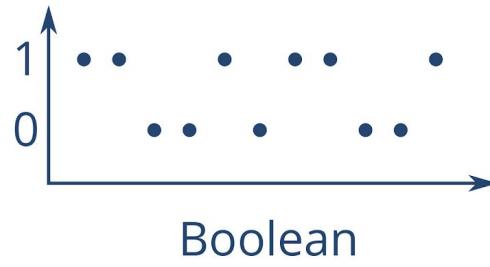
What about Time Series?

Time Series databases!



Time Series Databases

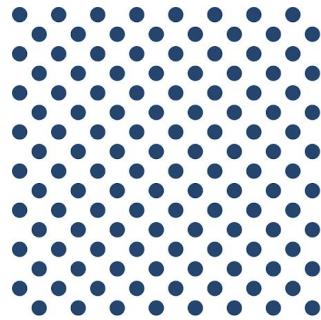
Data model: time series



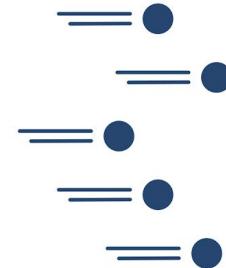
Time Series Databases



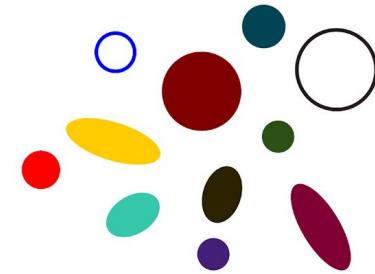
The 3 'v'



Volume



Velocity



Variety

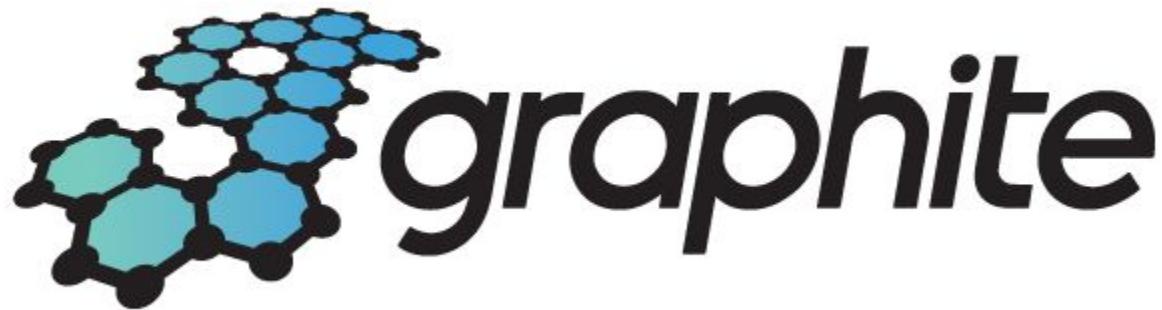


Time Series Databases

Many options



Time Series Databases



Time Series Databases



OPEN TSDB



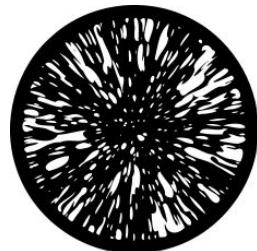
Time Series Databases



Time Series Databases



Time Series Databases



WARP 10



OVH Metrics

What did we choose?



What's OVH Metrics



Managed Cloud Platform for Geo Time Series®



What's a metric?



[me-trik] : the science of measuring



What is a metric?



Metrics are Time Series!



How do we deal with metrics?



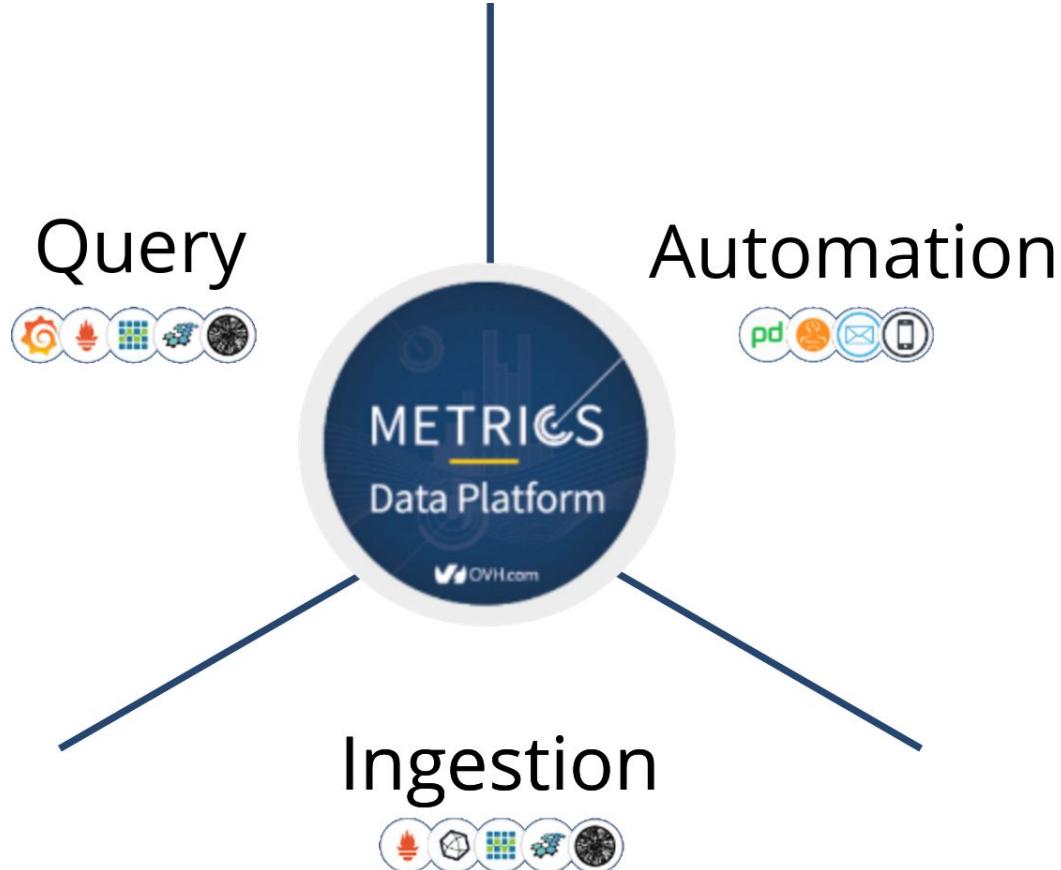
Using a Time Series Database!

But... which one?

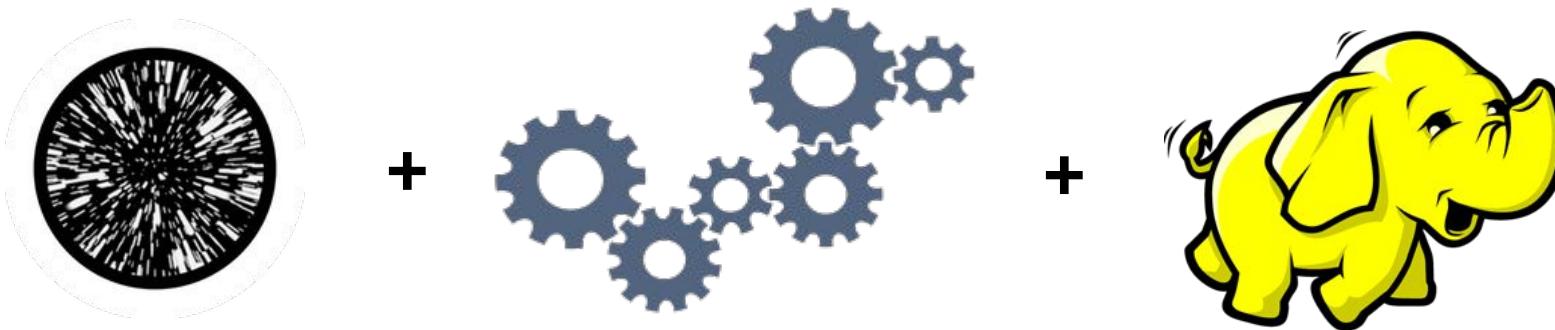
Why choose? Let's support all of them!



Metrics Data Platform



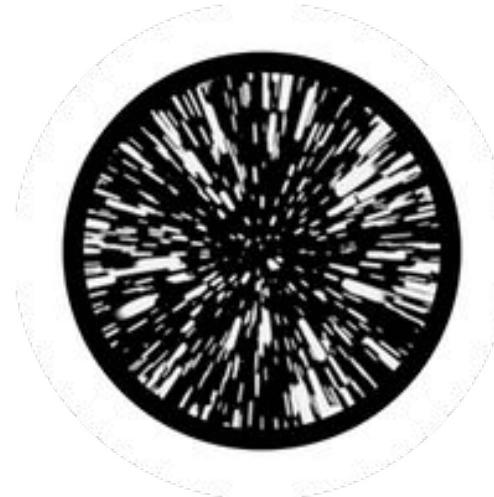
Metrics Data Platform



Metrics Data Platform



And why Warp 10?



Monitoring OVH



Metrics Data Platform



Some Metrics's metrics:

- 1.5M datapoints/s, 24h/7
- Peaks at ~10M datapoints/s
- 500M unique series



Warp 10

Open-source Time Series Database



More than a Time Series DB



Warp 10 is a software platform that

- Ingests and stores time series
- Manipulates and analyzes time series

The Warp 10 Platform

The Warp 10 Platform is designed to collect, store and manipulate sensor data. Sensor data are ingested as sequences of measurements (also called time series). The Warp 10 Platform offers the possibility for each measurement to also have spatial metadata specifying the geographic coordinates and/or the elevation of the sensor at the time of the reading. Those augmented measurements form what we call Geo Time Series® (GTS).

Geo Time Series®

The first differentiating factor of Warp 10 is that both space (location) and time are considered first class citizens. Working with Geo Time Series® (GTS) allows you to have geo-located readings without having to use four separate series and having to keep track of the reading context.

Complex searches like "find all the sensors active during last Monday in the perimeter delimited by this geo-fencing polygon" can be done without involving expensive joins between separate time series for the same source.

Platform components

Readings are pushed into the Warp 10 platform via an HTTP call to a component called Ingress. In the distributed version of the platform, the Ingress component can be instantiated multiple times to support very high ingestion rates.

Once data is dealt with by Ingress it is considered persisted by the Warp 10 storage layer called Continuum (for the spacetime continuum).

Warp 10 also offers streaming endpoints to push data using a WebSocket or to consume data as it enters the platform to build dynamic dashboards and integrate Warp 10 into a more elaborate stream processing workflow.

Security and privacy have also been addressed by Warp 10 since its very inception, this includes fine grain access control mechanisms, encryption capabilities and throttling management to enable full multi-tenancy of the platform.



Many time-series solutions



TSAR



OpenTSDB



Tempo IQ

Predix

But they are only stores...



Fetching data is only the tip of the iceberg

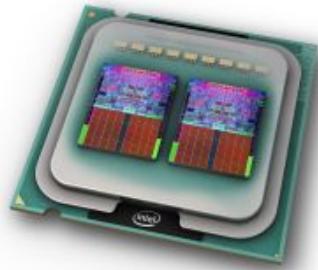


Analysing the data



High level analysis must be done elsewhere

Algorithms are resource hungry



Your computer is not a datacenter



Manipulating Time Series



To be scalable, analysis must be done in the
TSDB engine, not in user's computer



Manipulating Time Series with Warp 10



A true Time Series analysis toolbox

- Hundreds of functions
- Manipulation frameworks
- Analysis workflow



Manipulating Time Series with Warp 10



Why not a simple REST API?

- One endpoint by function?
- How to chain a workflow analysis?



REST API not suitable for
complex manipulations



Manipulating Time Series with Warp 10



Why not a SQL dialect?

- How do you do a simple moving average in SQL?
- How do you geo-time fencing in SQL?



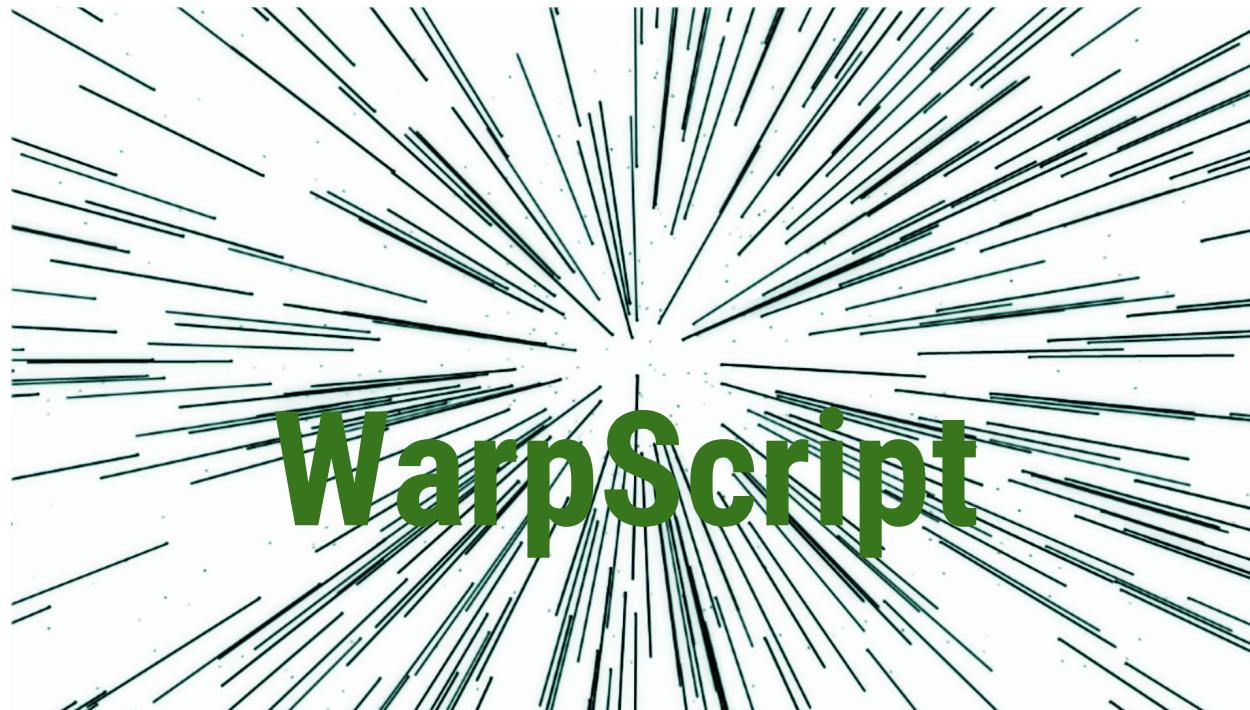
SQL is not adapted to TS analysis!



Manipulating Time Series with Warp 10

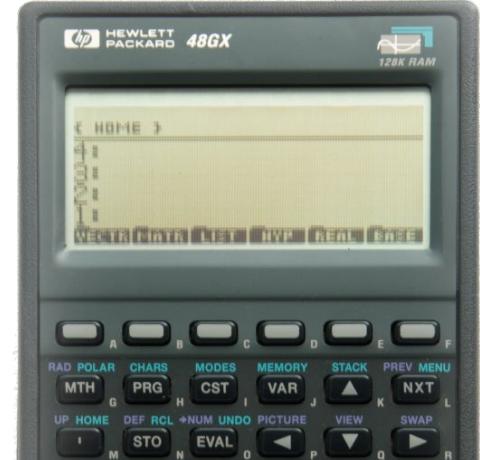


Solution: a Time Series manipulation language



WarpScript

Time Series manipulation language

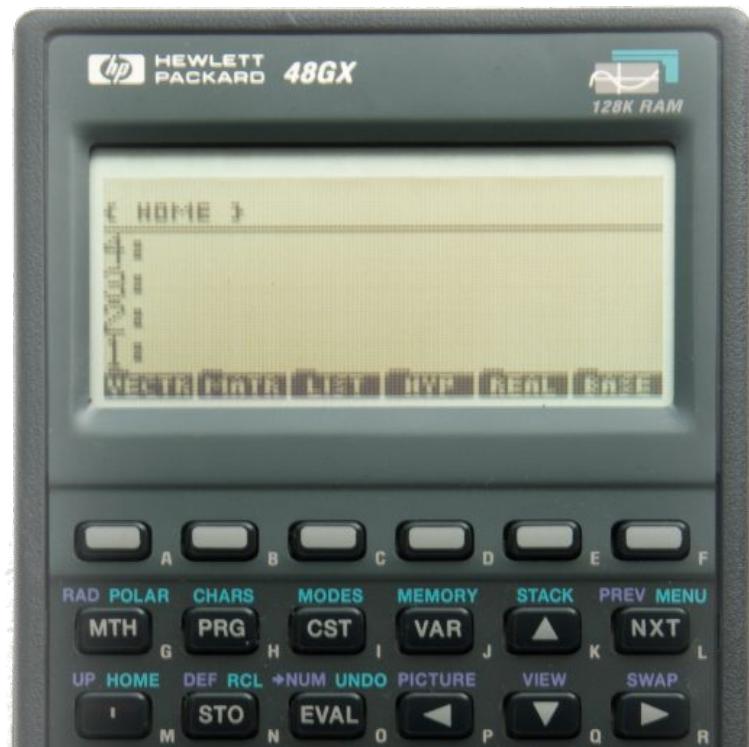


A stack based language

Input	2	3	add	11	mul	1	add
Stack	2	3		11		1	

2 3 add 11 mul 1 add

2 2 5 5 55 55 56



Basic operations

```
// This is a commentary
'a' // string value
true // boolean value
42 // long value
3.14159 // double value
+ // operations

20 22 + // several items in one line
```



Five frameworks

- BUCKETIZE
- MAP
- REDUCE
- FILTER
- APPLY



More than 800 functions

Trigonometry

Macros

Data & Time

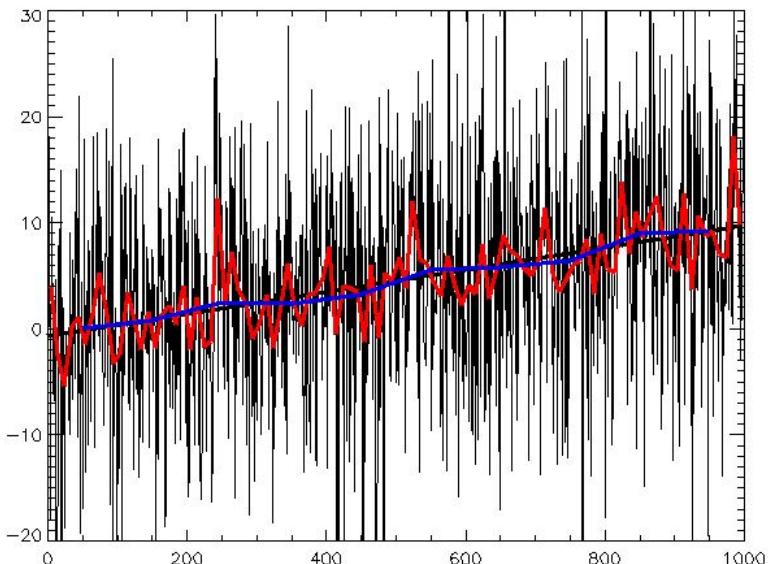
List & Maps

Logic
Structures

Strings

Maths &
statistics

Loop
Structures



Time series functions



TIMECLIP

TIMESPLIT

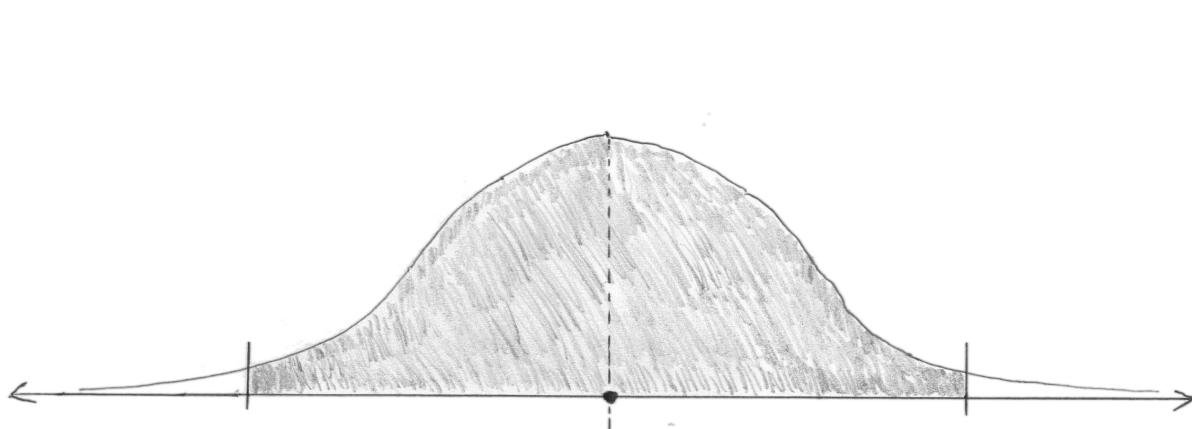
SHRINK

MERGE

...



Time series functions



MUSIGMA

NORMALIZE

NSUMSUMQ

STANDARDISE

ZSCORE

Geo-Time Series functions



Geo mapping (WKT)

Horizontal & vertical speed

Horizontal & vertical distance

Haversine

...



Quantum IDE



The screenshot shows the Quantum IDE interface. At the top is a navigation bar with the Quantum logo and a menu icon. Below the bar is a sidebar with three items: "WarpScript" (selected), "Ingress", and "Delete". The main area contains a configuration section titled "Choose your backend:" with two radio buttons: "Distributed Warp" (selected) and "Choose another backend". Below this is a code editor titled "WarpScript" containing the following code:

```
1 // This is a commentary
2 'a'      // string value
3 true     // boolean value
4 42       // long value
5 3.14159 // double value
6 +        // operations
7
8 20 22 +  // several items in one line
9
10 |
```

Permalink:

[Ci8v1froaXmgaxMgYSBjb21tZW50YXJ5CidhJyAgCS8vIHN0cmliZyB2YWx1ZQp0cnVlAkvLyBib29s...](https://ci8v1froaXmgaxMgYSBjb21tZW50YXJ5CidhJyAgCS8vIHN0cmliZyB2YWx1ZQp0cnVlAkvLyBib29s...)

Execute!



Warp 10 platform and tools

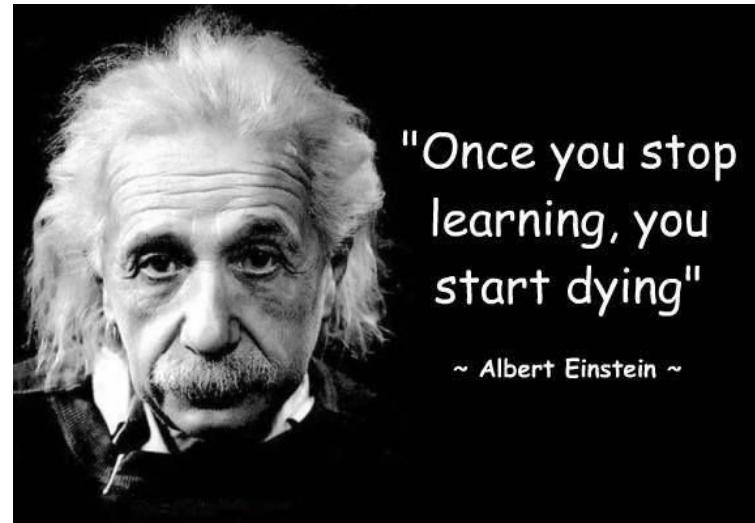


WarpScript

```
1: 15 // WAT: ADDING A POINT STORE
2: 16 // END RECORDS
3: 17
4: 18
5: 19
6: 20
7: 21
8: 22
9: 23
10: 24
11: 25
12: 26
13: 27
14: 28
15: 29
16: 30
17: 31
18: 32
19: 33
20: 34
21: 35
22: 36
23: 37
24: 38
25: 39
26: 40
27: 41
28: 42
29: 43
30: 44
31: 45
32: 46
33: 47
34: 48
35: 49
36: 50
37: 51
38: 52
39: 53
40: 54
41: 55
42: 56
43: 57
44: 58
45: 59
46: 60
47: 61
48: 62
49: 63
50: 64
51: 65
52: 66
53: 67
54: 68
55: 69
56: 70
57: 71
58: 72
59: 73
60: 74
61: 75
62: 76
63: 77
64: 78
65: 79
66: 80
67: 81
68: 82
69: 83
70: 84
71: 85
72: 86
73: 87
74: 88
75: 89
76: 90
77: 91
78: 92
79: 93
80: 94
81: 95
82: 96
83: 97
84: 98
85: 99
86: 100
87: 101
88: 102
89: 103
90: 104
91: 105
92: 106
93: 107
94: 108
95: 109
96: 110
97: 111
98: 112
99: 113
100: 114
101: 115
102: 116
103: 117
104: 118
105: 119
106: 120
107: 121
108: 122
109: 123
110: 124
111: 125
112: 126
113: 127
114: 128
115: 129
116: 130
117: 131
118: 132
119: 133
120: 134
121: 135
122: 136
123: 137
124: 138
125: 139
126: 140
127: 141
128: 142
129: 143
130: 144
131: 145
132: 146
133: 147
134: 148
135: 149
136: 150
137: 151
138: 152
139: 153
140: 154
141: 155
142: 156
143: 157
144: 158
145: 159
146: 160
147: 161
148: 162
149: 163
150: 164
151: 165
152: 166
153: 167
154: 168
155: 169
156: 170
157: 171
158: 172
159: 173
160: 174
161: 175
162: 176
163: 177
164: 178
165: 179
166: 180
167: 181
168: 182
169: 183
170: 184
171: 185
172: 186
173: 187
174: 188
175: 189
176: 190
177: 191
178: 192
179: 193
180: 194
181: 195
182: 196
183: 197
184: 198
185: 199
186: 200
187: 201
188: 202
189: 203
190: 204
191: 205
192: 206
193: 207
194: 208
195: 209
196: 210
197: 211
198: 212
199: 213
200: 214
201: 215
202: 216
203: 217
204: 218
205: 219
206: 220
207: 221
208: 222
209: 223
210: 224
211: 225
212: 226
213: 227
214: 228
215: 229
216: 230
217: 231
218: 232
219: 233
220: 234
221: 235
222: 236
223: 237
224: 238
225: 239
226: 240
227: 241
228: 242
229: 243
230: 244
231: 245
232: 246
233: 247
234: 248
235: 249
236: 250
237: 251
238: 252
239: 253
240: 254
241: 255
242: 256
243: 257
244: 258
245: 259
246: 260
247: 261
248: 262
249: 263
250: 264
251: 265
252: 266
253: 267
254: 268
255: 269
256: 270
257: 271
258: 272
259: 273
260: 274
261: 275
262: 276
263: 277
264: 278
265: 279
266: 280
267: 281
268: 282
269: 283
270: 284
271: 285
272: 286
273: 287
274: 288
275: 289
276: 290
277: 291
278: 292
279: 293
280: 294
281: 295
282: 296
283: 297
284: 298
285: 299
286: 300
287: 301
288: 302
289: 303
290: 304
291: 305
292: 306
293: 307
294: 308
295: 309
296: 310
297: 311
298: 312
299: 313
300: 314
301: 315
302: 316
303: 317
304: 318
305: 319
306: 320
307: 321
308: 322
309: 323
310: 324
311: 325
312: 326
313: 327
314: 328
315: 329
316: 330
317: 331
318: 332
319: 333
320: 334
321: 335
322: 336
323: 337
324: 338
325: 339
326: 340
327: 341
328: 342
329: 343
330: 344
331: 345
332: 346
333: 347
334: 348
335: 349
336: 350
337: 351
338: 352
339: 353
340: 354
341: 355
342: 356
343: 357
344: 358
345: 359
346: 360
347: 361
348: 362
349: 363
350: 364
351: 365
352: 366
353: 367
354: 368
355: 369
356: 370
357: 371
358: 372
359: 373
360: 374
361: 375
362: 376
363: 377
364: 378
365: 379
366: 380
367: 381
368: 382
369: 383
370: 384
371: 385
372: 386
373: 387
374: 388
375: 389
376: 390
377: 391
378: 392
379: 393
380: 394
381: 395
382: 396
383: 397
384: 398
385: 399
386: 400
387: 401
388: 402
389: 403
390: 404
391: 405
392: 406
393: 407
394: 408
395: 409
396: 410
397: 411
398: 412
399: 413
390: 414
391: 415
392: 416
393: 417
394: 418
395: 419
396: 420
397: 421
398: 422
399: 423
390: 424
391: 425
392: 426
393: 427
394: 428
395: 429
396: 430
397: 431
398: 432
399: 433
390: 434
391: 435
392: 436
393: 437
394: 438
395: 439
396: 440
397: 441
398: 442
399: 443
390: 444
391: 445
392: 446
393: 447
394: 448
395: 449
396: 450
397: 451
398: 452
399: 453
390: 454
391: 455
392: 456
393: 457
394: 458
395: 459
396: 460
397: 461
398: 462
399: 463
390: 464
391: 465
392: 466
393: 467
394: 468
395: 469
396: 470
397: 471
398: 472
399: 473
390: 474
391: 475
392: 476
393: 477
394: 478
395: 479
396: 480
397: 481
398: 482
399: 483
390: 484
391: 485
392: 486
393: 487
394: 488
395: 489
396: 490
397: 491
398: 492
399: 493
390: 494
391: 495
392: 496
393: 497
394: 498
395: 499
396: 500
397: 501
398: 502
399: 503
390: 504
391: 505
392: 506
393: 507
394: 508
395: 509
396: 510
397: 511
398: 512
399: 513
390: 514
391: 515
392: 516
393: 517
394: 518
395: 519
396: 520
397: 521
398: 522
399: 523
390: 524
391: 525
392: 526
393: 527
394: 528
395: 529
396: 530
397: 531
398: 532
399: 533
390: 534
391: 535
392: 536
393: 537
394: 538
395: 539
396: 540
397: 541
398: 542
399: 543
390: 544
391: 545
392: 546
393: 547
394: 548
395: 549
396: 550
397: 551
398: 552
399: 553
390: 554
391: 555
392: 556
393: 557
394: 558
395: 559
396: 560
397: 561
398: 562
399: 563
390: 564
391: 565
392: 566
393: 567
394: 568
395: 569
396: 570
397: 571
398: 572
399: 573
390: 574
391: 575
392: 576
393: 577
394: 578
395: 579
396: 580
397: 581
398: 582
399: 583
390: 584
391: 585
392: 586
393: 587
394: 588
395: 589
396: 590
397: 591
398: 592
399: 593
390: 594
391: 595
392: 596
393: 597
394: 598
395: 599
396: 600
397: 601
398: 602
399: 603
390: 604
391: 605
392: 606
393: 607
394: 608
395: 609
396: 610
397: 611
398: 612
399: 613
390: 614
391: 615
392: 616
393: 617
394: 618
395: 619
396: 620
397: 621
398: 622
399: 623
390: 624
391: 625
392: 626
393: 627
394: 628
395: 629
396: 630
397: 631
398: 632
399: 633
390: 634
391: 635
392: 636
393: 637
394: 638
395: 639
396: 640
397: 641
398: 642
399: 643
390: 644
391: 645
392: 646
393: 647
394: 648
395: 649
396: 650
397: 651
398: 652
399: 653
390: 654
391: 655
392: 656
393: 657
394: 658
395: 659
396: 660
397: 661
398: 662
399: 663
390: 664
391: 665
392: 666
393: 667
394: 668
395: 669
396: 670
397: 671
398: 672
399: 673
390: 674
391: 675
392: 676
393: 677
394: 678
395: 679
396: 680
397: 681
398: 682
399: 683
390: 684
391: 685
392: 686
393: 687
394: 688
395: 689
396: 690
397: 691
398: 692
399: 693
390: 694
391: 695
392: 696
393: 697
394: 698
395: 699
396: 700
397: 701
398: 702
399: 703
390: 704
391: 705
392: 706
393: 707
394: 708
395: 709
396: 710
397: 711
398: 712
399: 713
390: 714
391: 715
392: 716
393: 717
394: 718
395: 719
396: 720
397: 721
398: 722
399: 723
390: 724
391: 725
392: 726
393: 727
394: 728
395: 729
396: 730
397: 731
398: 732
399: 733
390: 734
391: 735
392: 736
393: 737
394: 738
395: 739
396: 740
397: 741
398: 742
399: 743
390: 744
391: 745
392: 746
393: 747
394: 748
395: 749
396: 750
397: 751
398: 752
399: 753
390: 754
391: 755
392: 756
393: 757
394: 758
395: 759
396: 760
397: 761
398: 762
399: 763
390: 764
391: 765
392: 766
393: 767
394: 768
395: 769
396: 770
397: 771
398: 772
399: 773
390: 774
391: 775
392: 776
393: 777
394: 778
395: 779
396: 780
397: 781
398: 782
399: 783
390: 784
391: 785
392: 786
393: 787
394: 788
395: 789
396: 790
397: 791
398: 792
399: 793
390: 794
391: 795
392: 796
393: 797
394: 798
395: 799
396: 800
397: 801
398: 802
399: 803
390: 804
391: 805
392: 806
393: 807
394: 808
395: 809
396: 810
397: 811
398: 812
399: 813
390: 814
391: 815
392: 816
393: 817
394: 818
395: 819
396: 820
397: 821
398: 822
399: 823
390: 824
391: 825
392: 826
393: 827
394: 828
395: 829
396: 830
397: 831
398: 832
399: 833
390: 834
391: 835
392: 836
393: 837
394: 838
395: 839
396: 840
397: 841
398: 842
399: 843
390: 844
391: 845
392: 846
393: 847
394: 848
395: 849
396: 850
397: 851
398: 852
399: 853
390: 854
391: 855
392: 856
393: 857
394: 858
395: 859
396: 860
397: 861
398: 862
399: 863
390: 864
391: 865
392: 866
393: 867
394: 868
395: 869
396: 870
397: 871
398: 872
399: 873
390: 874
391: 875
392: 876
393: 877
394: 878
395: 879
396: 880
397: 881
398: 882
399: 883
390: 884
391: 885
392: 886
393: 887
394: 888
395: 889
396: 890
397: 891
398: 892
399: 893
390: 894
391: 895
392: 896
393: 897
394: 898
395: 899
396: 900
397: 901
398: 902
399: 903
390: 904
391: 905
392: 906
393: 907
394: 908
395: 909
396: 910
397: 911
398: 912
399: 913
390: 914
391: 915
392: 916
393: 917
394: 918
395: 919
396: 920
397: 921
398: 922
399: 923
390: 924
391: 925
392: 926
393: 927
394: 928
395: 929
396: 930
397: 931
398: 932
399: 933
390: 934
391: 935
392: 936
393: 937
394: 938
395: 939
396: 940
397: 941
398: 942
399: 943
390: 944
391: 945
392: 946
393: 947
394: 948
395: 949
396: 950
397: 951
398: 952
399: 953
390: 954
391: 955
392: 956
393: 957
394: 958
395: 959
396: 960
397: 961
398: 962
399: 963
390: 964
391: 965
392: 966
393: 967
394: 968
395: 969
396: 970
397: 971
398: 972
399: 973
390: 974
391: 975
392: 976
393: 977
394: 978
395: 979
396: 980
397: 981
398: 982
399: 983
390: 984
391: 985
392: 986
393: 987
394: 988
395: 989
396: 990
397: 991
398: 992
399: 993
390: 994
391: 995
392: 996
393: 997
394: 998
395: 999
396: 1000
397: 1001
398: 1002
399: 1003
390: 1004
391: 1005
392: 1006
393: 1007
394: 1008
395: 1009
396: 1010
397: 1011
398: 1012
399: 1013
390: 1014
391: 1015
392: 1016
393: 1017
394: 1018
395: 1019
396: 1020
397: 1021
398: 1022
399: 1023
390: 1024
391: 1025
392: 1026
393: 1027
394: 1028
395: 1029
396: 1030
397: 1031
398: 1032
399: 1033
390: 1034
391: 1035
392: 1036
393: 1037
394: 1038
395: 1039
396: 1040
397: 1041
398: 1042
399: 1043
390: 1044
391: 1045
392: 1046
393: 1047
394: 1048
395: 1049
396: 1050
397: 1051
398: 1052
399: 1053
390: 1054
391: 1055
392: 1056
393: 1057
394: 1058
395: 1059
396: 1060
397: 1061
398: 1062
399: 1063
390: 1064
391: 1065
392: 1066
393: 1067
394: 1068
395: 1069
396: 1070
397: 1071
398: 1072
399: 1073
390: 1074
391: 1075
392: 1076
393: 1077
394: 1078
395: 1079
396: 1080
397: 1081
398: 1082
399: 1083
390: 1084
391: 1085
392: 1086
393: 1087
394: 1088
395: 1089
396: 1090
397: 1091
398: 1092
399: 1093
390: 1094
391: 1095
392: 1096
393: 1097
394: 1098
395: 1099
396: 1100
397: 1101
398: 1102
399: 1103
390: 1104
391: 1105
392: 1106
393: 1107
394: 1108
395: 1109
396: 1110
397: 1111
398: 1112
399: 1113
390: 1114
391: 1115
392: 1116
393: 1117
394: 1118
395: 1119
396: 1120
397: 1121
398: 1122
399: 1123
390: 1124
391: 1125
392: 1126
393: 1127
394: 1128
395: 1129
396: 1130
397: 1131
398: 1132
399: 1133
390: 1134
391: 1135
392: 1136
393: 1137
394: 1138
395: 1139
396: 1140
397: 1141
398: 1142
399: 1143
390: 1144
391: 1145
392: 1146
393: 1147
394: 1148
395: 1149
396: 1150
397: 1151
398: 1152
399: 1153
390: 1154
391: 1155
392: 1156
393: 1157
394: 1158
395: 1159
396: 1160
397: 1161
398: 1162
399: 1163
390: 1164
391: 1165
392: 1166
393: 1167
394: 1168
395: 1169
396: 1170
397: 1171
398: 1172
399: 1173
390: 1174
391: 1175
392: 1176
393: 1177
394: 1178
395: 1179
396: 1180
397: 1181
398: 1182
399: 1183
390: 1184
391: 1185
392: 1186
393: 1187
394: 1188
395: 1189
396: 1190
397: 1191
398: 1192
399: 1193
390: 1194
391: 1195
392: 1196
393: 1197
394: 1198
395: 1199
396: 1200
397: 1201
398: 1202
399: 1203
390: 1204
391: 1205
392: 1206
393: 1207
394: 1208
395: 1209
396: 1210
397: 1211
398: 1212
399: 1213
390: 1214
391: 1215
392: 1216
393: 1217
394: 1218
395: 1219
396: 1220
397: 1221
398: 1222
399: 1223
390: 1224
391: 1225
392: 1226
393: 1227
394: 1228
395: 1229
396: 1230
397: 1231
398: 1232
399: 1233
390: 1234
391: 1235
392: 1236
393: 1237
394: 1238
395: 1239
396: 1240
397: 1241
398: 1242
399: 1243
390: 1244
391: 1245
392: 1246
393: 1247
394: 1248
395: 1249
396: 1250
397: 1251
398: 1252
399: 1253
390: 1254
391: 1255
392: 1256
393: 1257
394: 1258
395: 1259
396: 1260
397: 1261
398: 1262
399: 1263
390: 1264
391: 1265
392: 1266
393: 1267
394: 1268
395: 1269
396: 1270
397: 1271
398: 1272
399: 1273
390: 1274
391: 1275
392: 1276
393: 1277
394: 1278
395: 1279
396: 1280
397: 1281
398: 1282
399: 1283
390: 1284
391: 1285
392: 1286
393: 1287
394: 1288
395: 1289
396: 1290
397: 1291
398: 1292
399: 1293
390: 1294
391: 1295
392: 1296
393: 1297
394: 1298
395: 1299
396: 1300
397: 1301
398: 1302
399: 1303
390: 1304
391: 1305
392: 1306
393: 1307
394: 1308
395: 1309
396: 1310
397: 1311
398: 1312
399: 1313
390: 1314
391: 1315
392: 1316
393: 1317
394: 1318
395: 1319
396: 1320
397: 1321
398: 1322
399: 1323
390: 1324
391: 1325
392: 1326
393: 1327
394: 1328
395: 1329
396: 1330
397: 1331
398: 1332
399: 1333
390: 1334
391: 1335
392: 1336
393: 1337
394: 1338
395: 1339
396: 1340
397: 1341
398: 1342
399: 1343
390: 1344
391: 1345
392: 1346
393: 1347
394: 1348
3
```

And this is only the surface

Possibilities are endless



Think differently



Time Series are everywhere



Thank you!





Rediscover the known Universe with NASA datasets

Horacio Gonzalez
@LostInBrittany



Horacio Gonzalez



@LostInBrittany

Spaniard lost in Brittany, developer,
dreamer and all-around geek

 OVH
Team DevRel



HelloExoWorld



Looking for exoplanets in NASA datasets



HelloExoWorld

Once upon a time...



An amateur astronomer



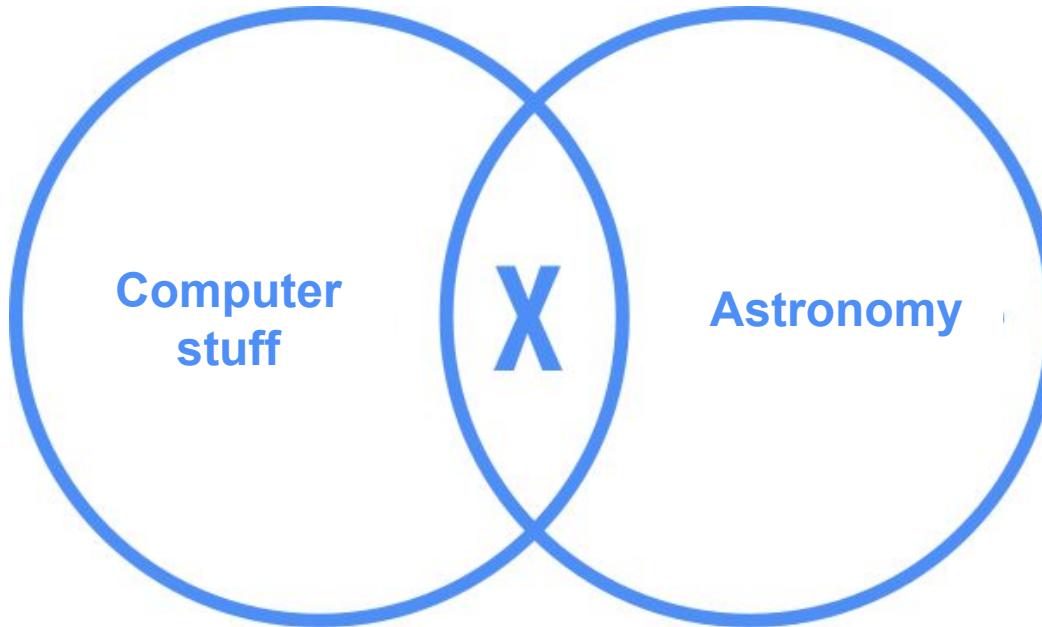
Pierre Zemb, DevOps OVH

What not to do if you love astronomy



Live in Brest

Looking for solutions



Mixing passions



Google is your friend...



time series astro

time series astronomy

time series **analysis** in astronomy limits and potentialities

astroml.time series

astronomical time series **analysis**

random time series in astronomy

astrophysical time series

[Google Search](#) [I'm Feeling Lucky](#) [Learn more](#)

Report inappropriate predictions

Let's find a project



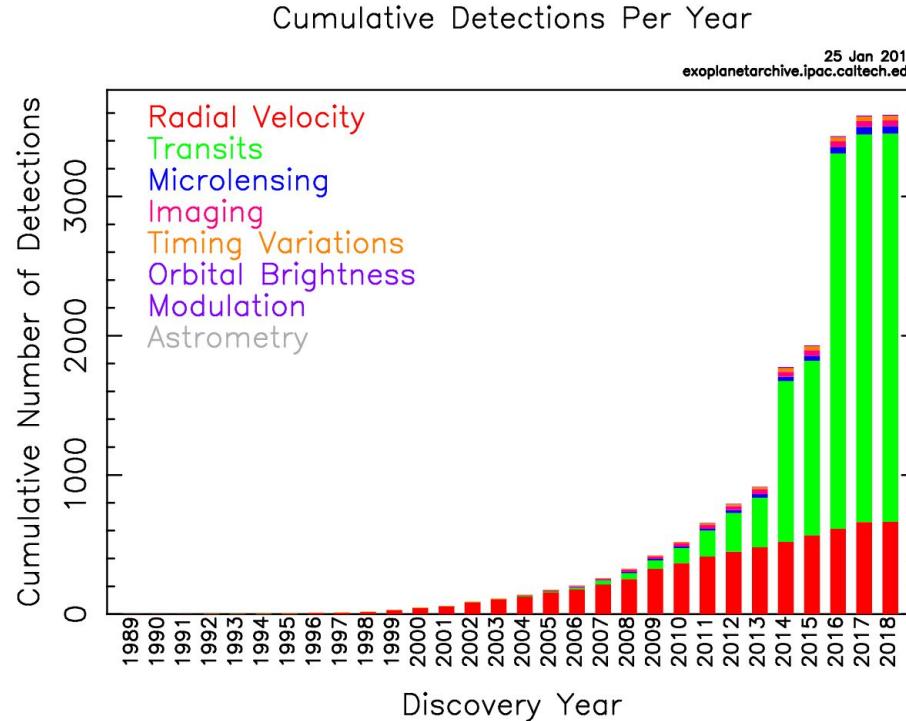
Exoplanets?



Planets orbiting stars far away



How do we find them?



The transit method seems the best



The transit method



How do we look for transits?

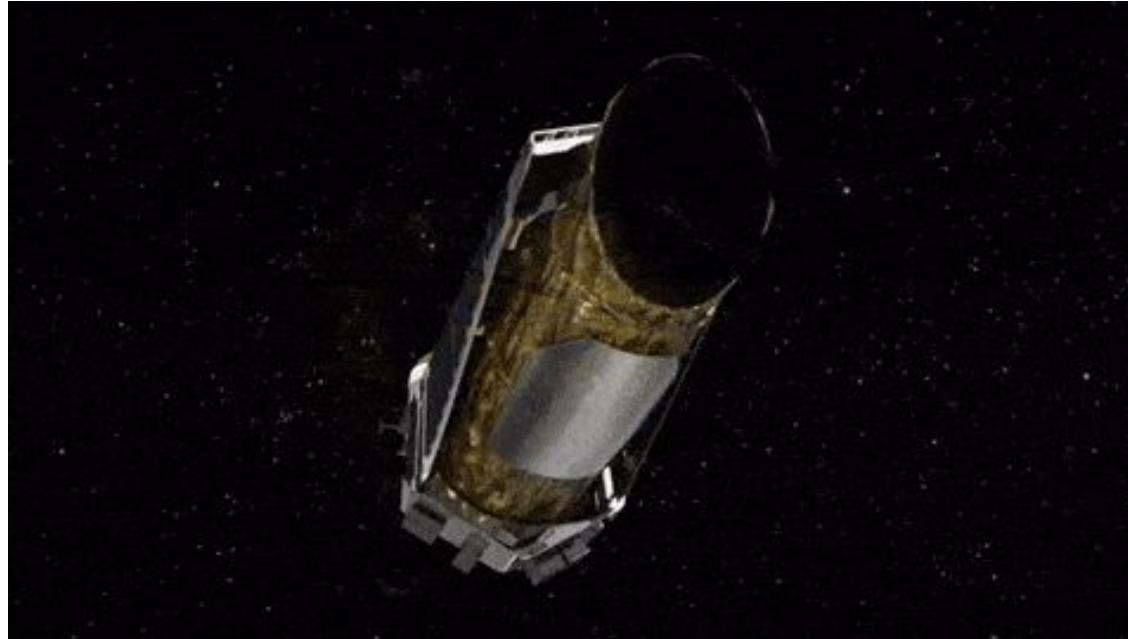
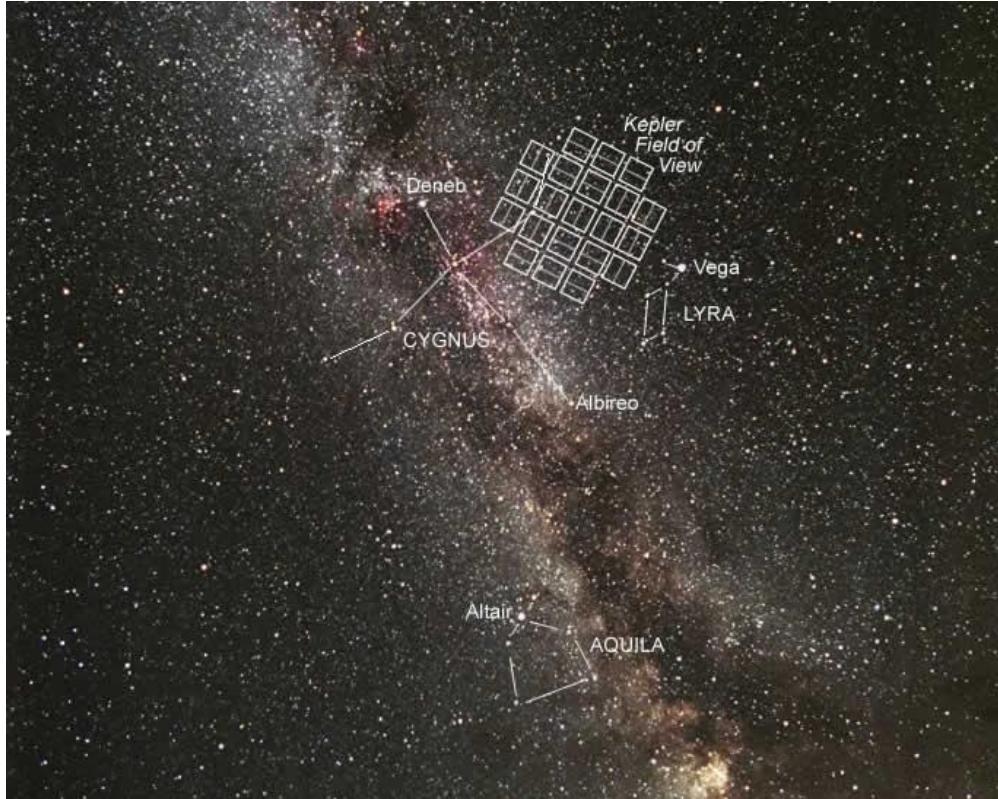


Image credits : NASA

Kepler

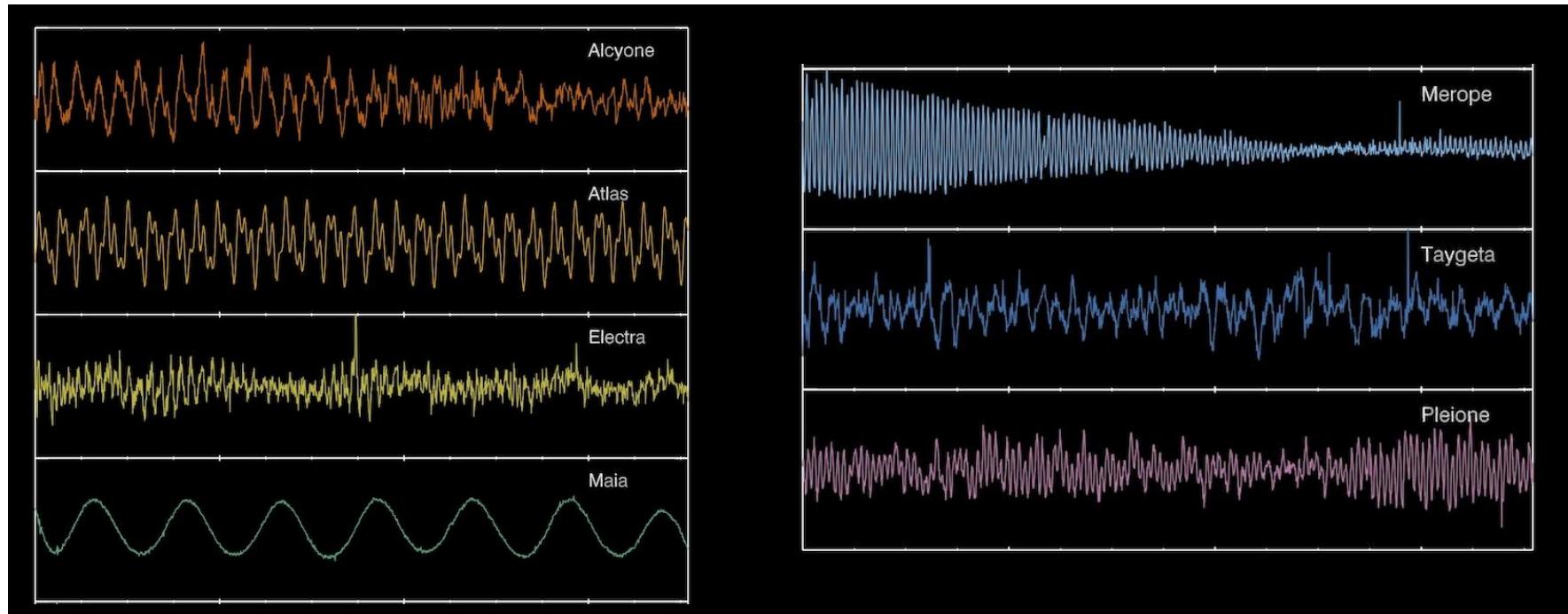
Watching the sky



And what kind of data we get?



Well, that's the problem



Seven stars, seven different profiles



Kinda big data



Ben Montet
@benmontet

Following

The full [@NASAKepler](#) dataset (Kepler + K2) is ~25 TB in size. For comparison, the entire archive of the [@librarycongress](#) is 15 TB.

7:54 PM - 3 Mar 2017

7 Retweets 15 Likes



3

7

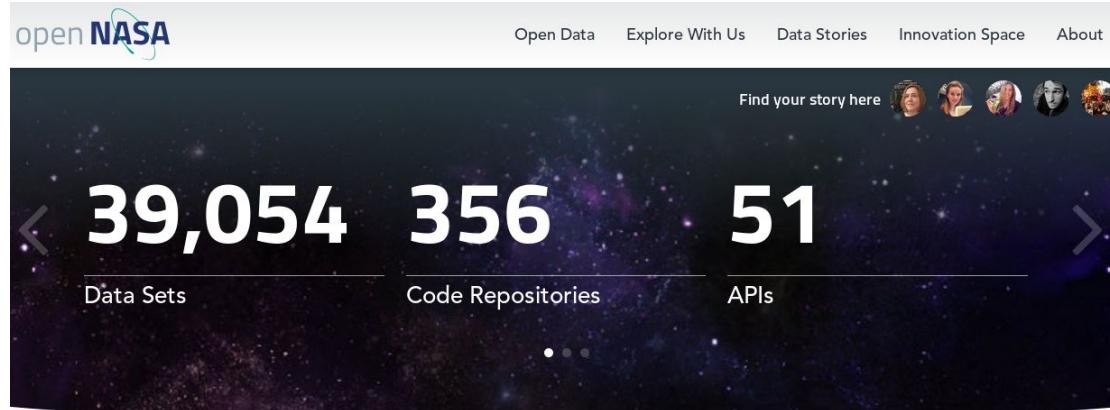
15



Over 40 million light curves



Big AND open data



Lots of datasets in #opendata



And we can help with that!



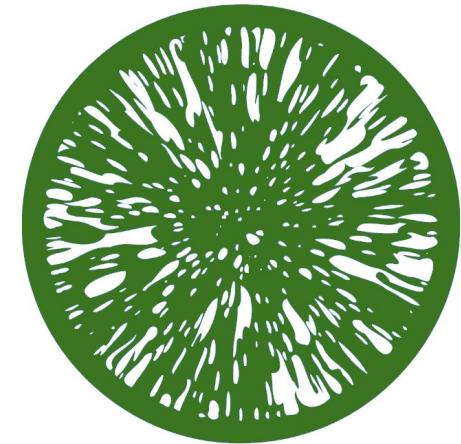
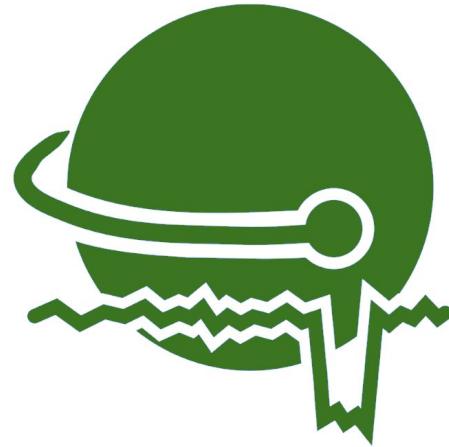
Let's use our tools to analyse the data



A match made in heaven

Warp 10, OVH Metrics and HelloExoWorld

METRICS



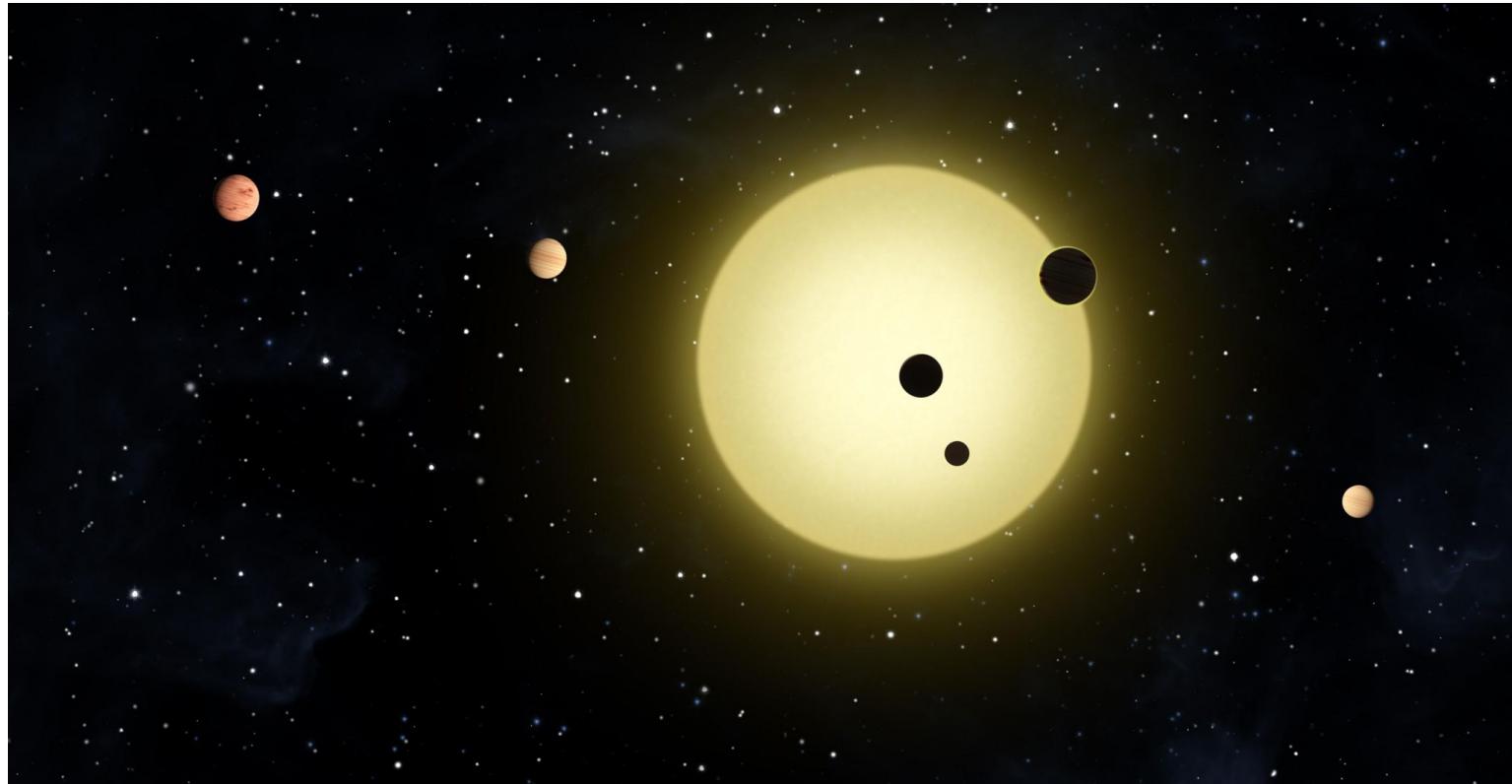
What we have done



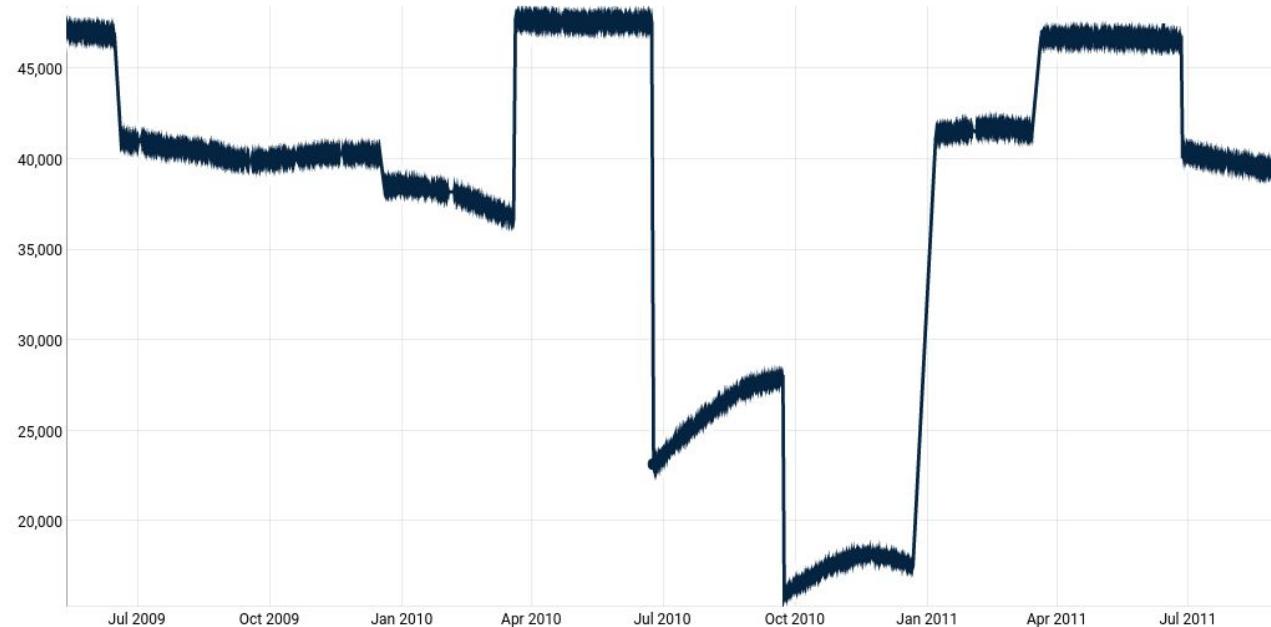
- Downloaded and parsed 40 millions of FITS files
- Pushed it to OVH Metrics
- Select a cool subset as training set
- Verified we could find the same planets as NASA



Choosing a star: Kepler 11



Looking at the raw signal...

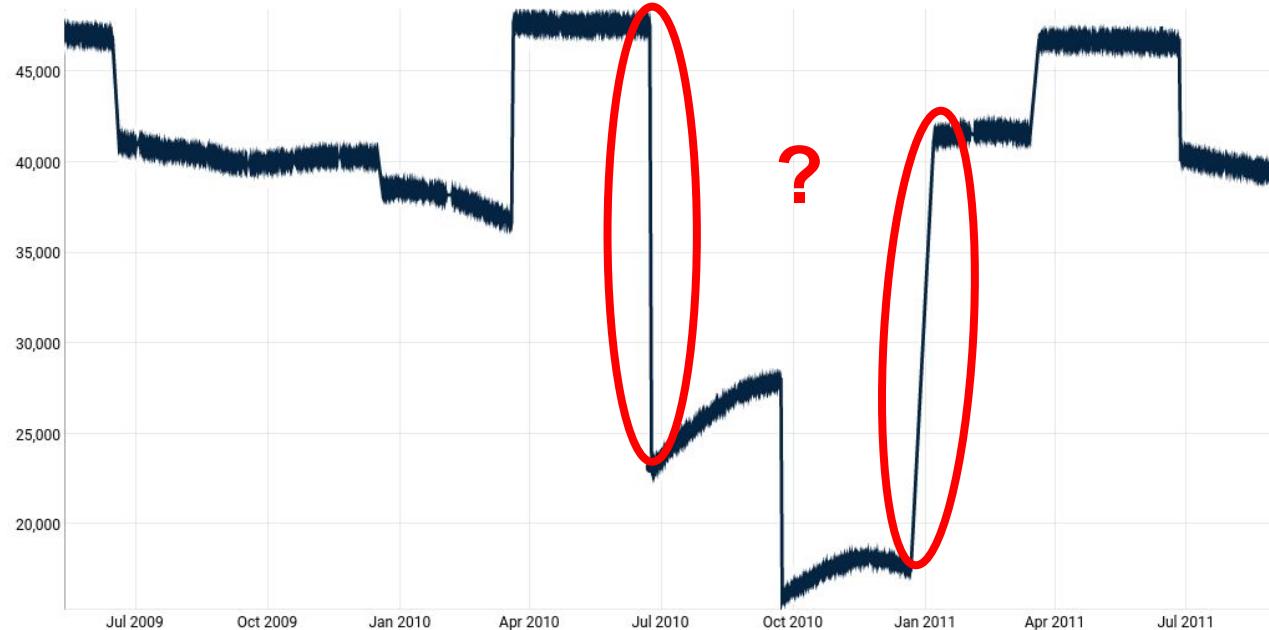


SAP_FLUX:

The flux in units of electrons per second contained in the optimal aperture pixels collected by the spacecraft.



Looking at the raw signal...

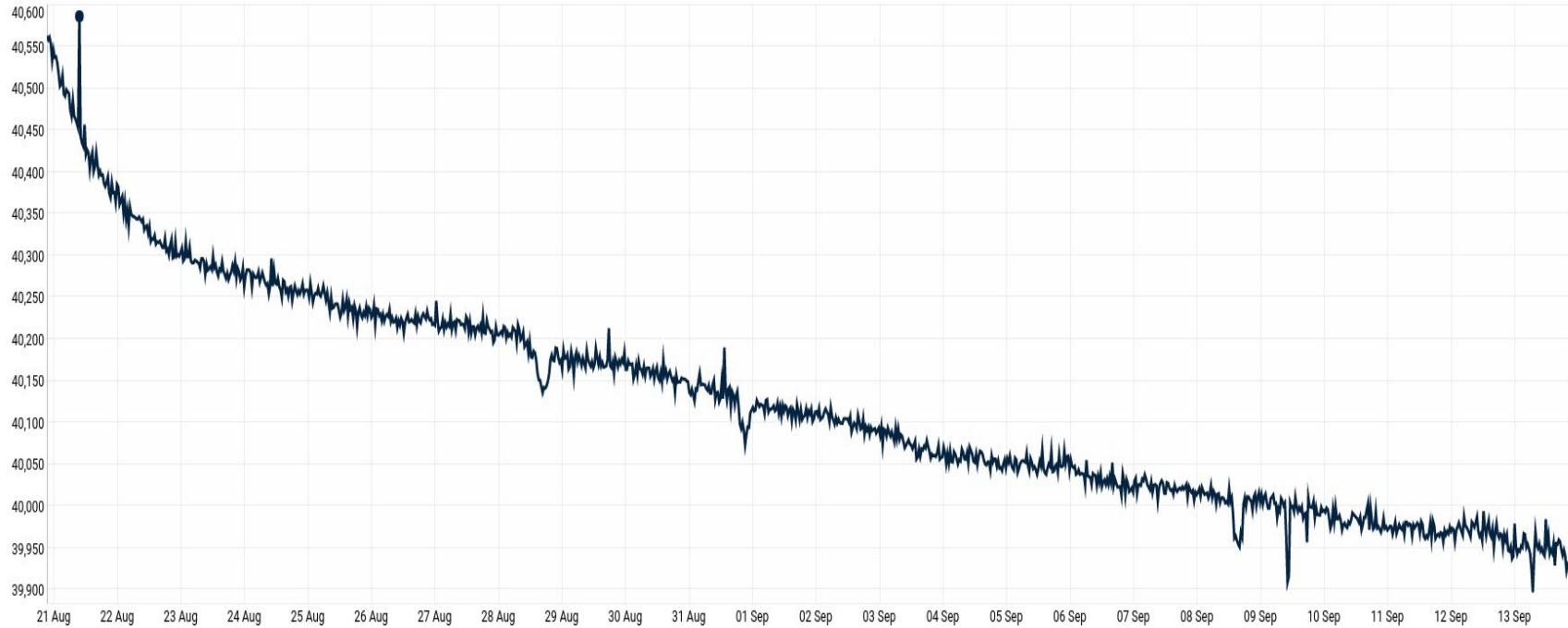


SAP_FLUX:

The flux in units of electrons per second contained in the optimal aperture pixels collected by the spacecraft.



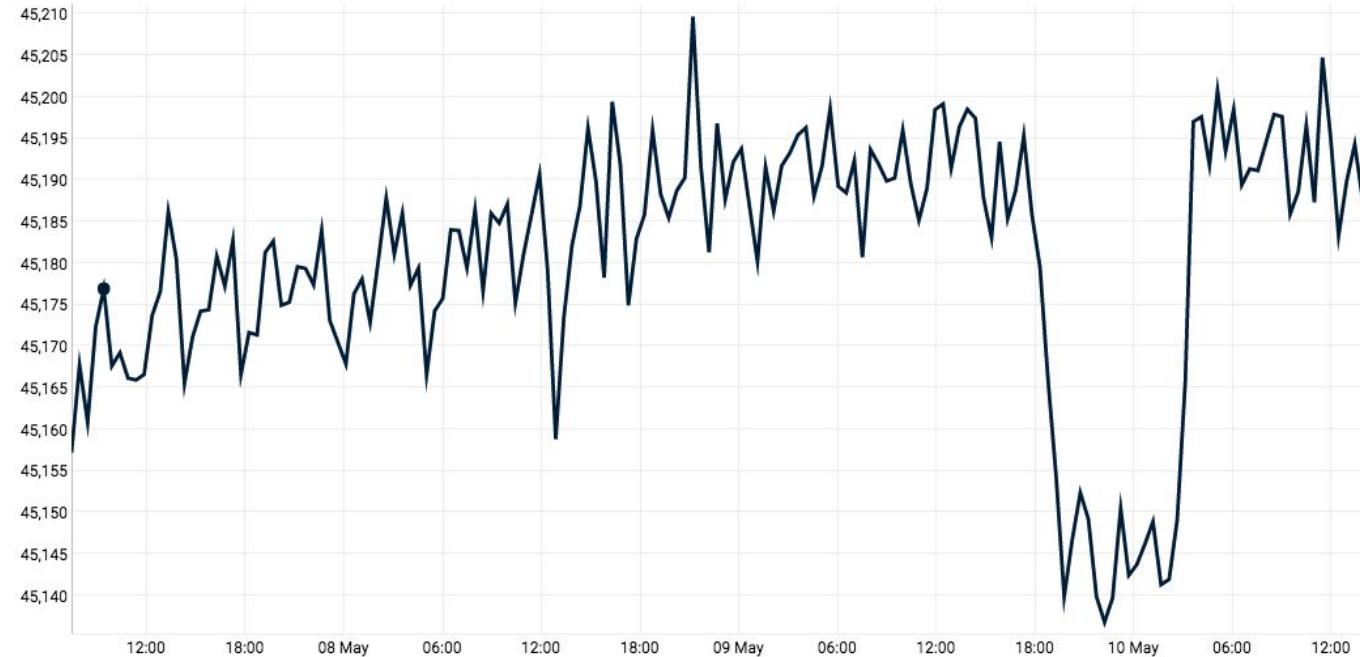
Looking at one record



Perturbations in dirty signals



Transits are tiny



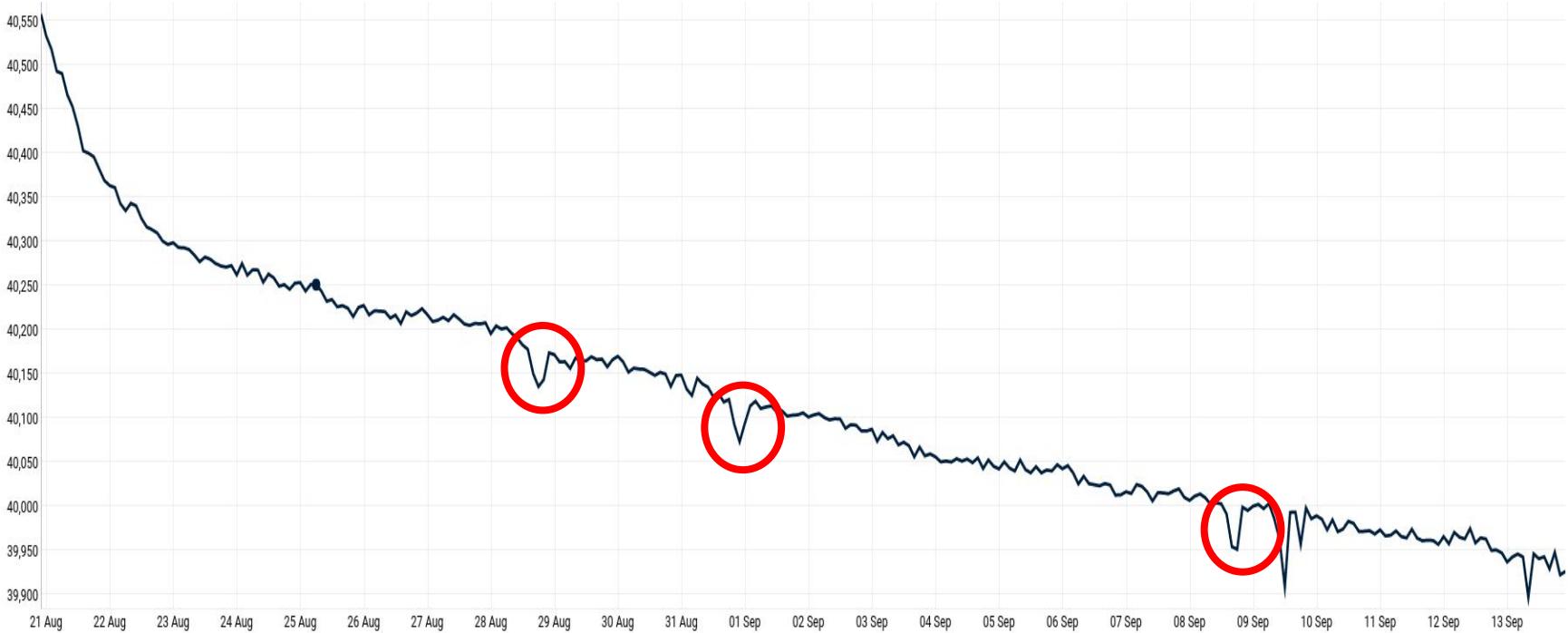
~40 electrons per second



First step: downsampling



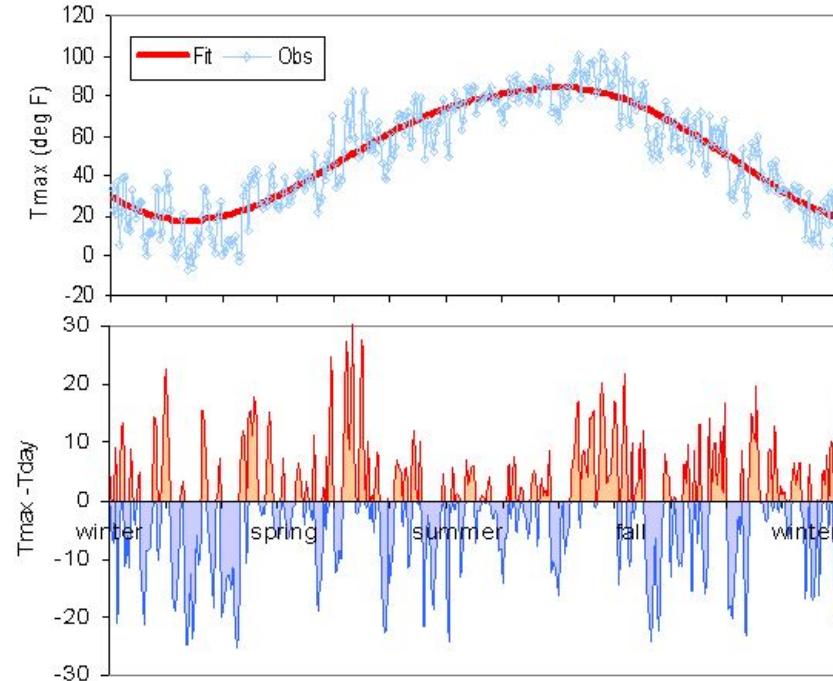
First step: downsampling



You can see the transit candidates...
but how can we teach the computer to see them?



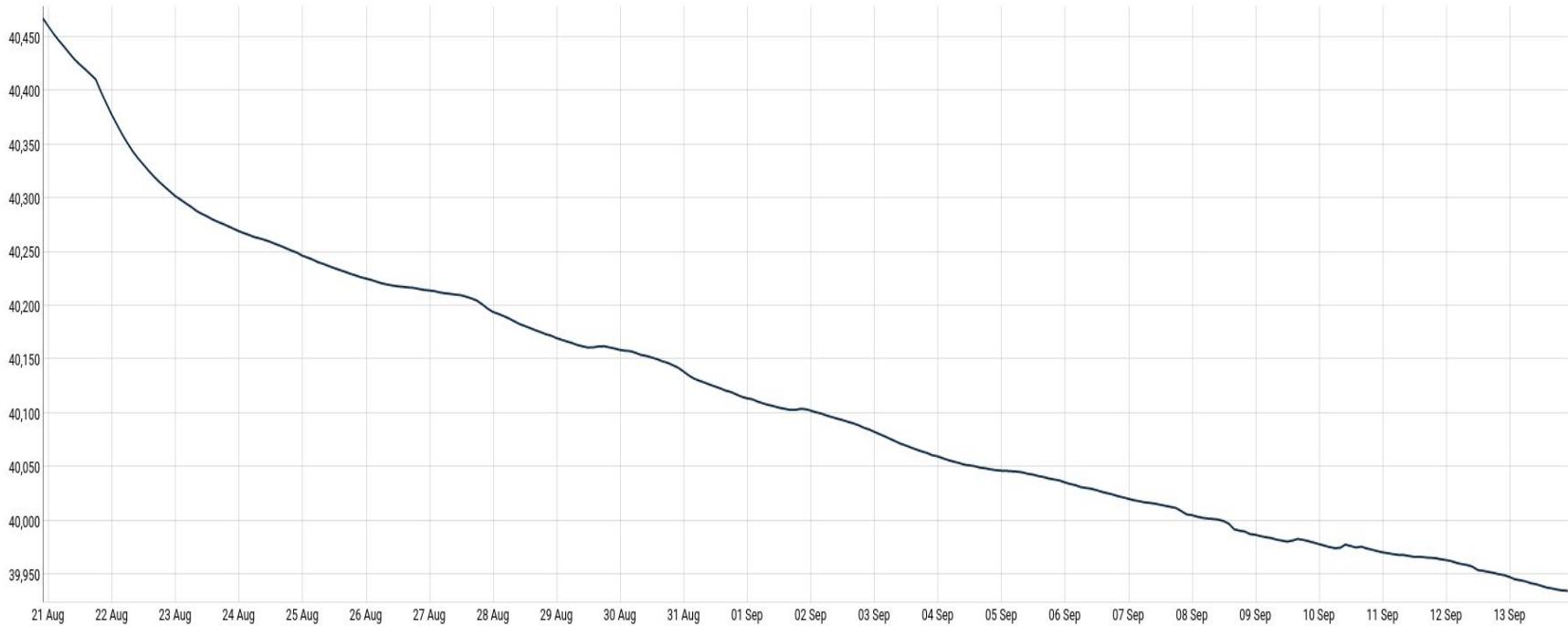
If you ❤ signal processing



High pass filter



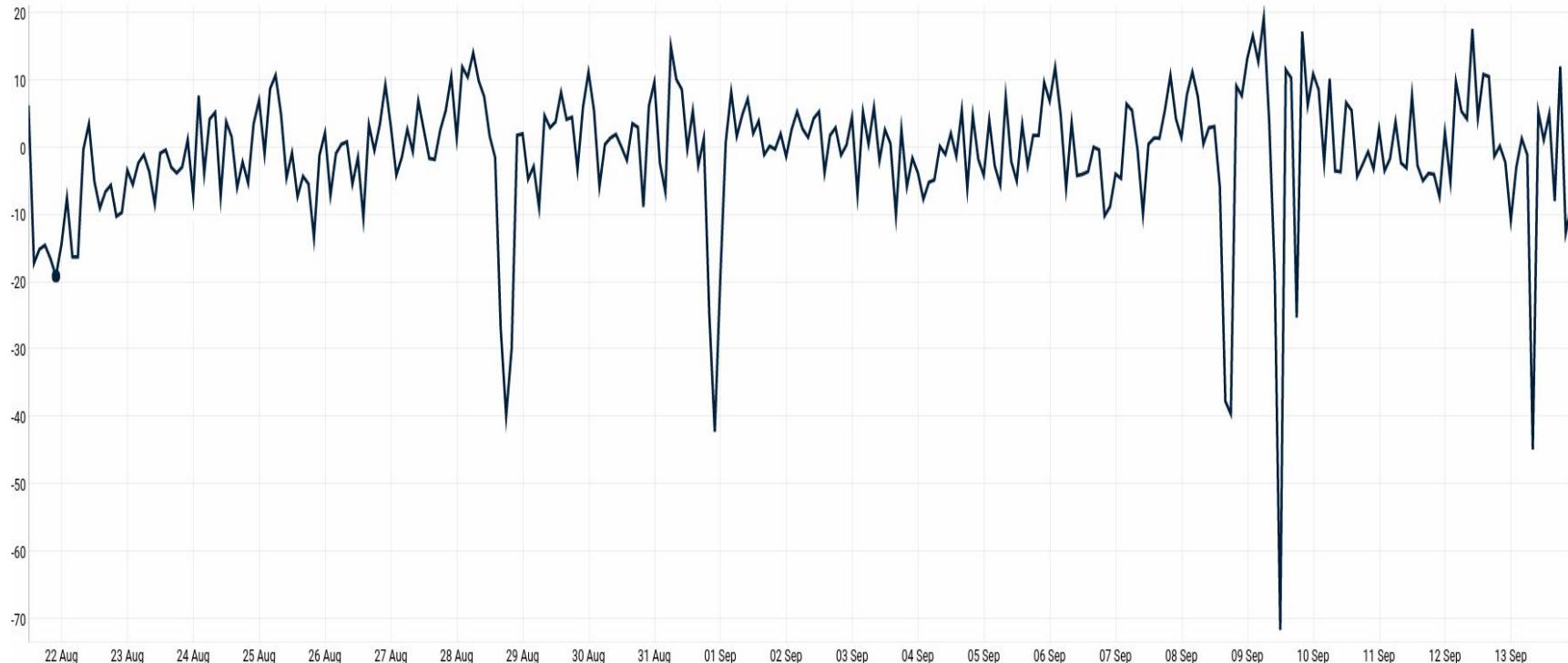
Poor person's high pass filter



Using the trend



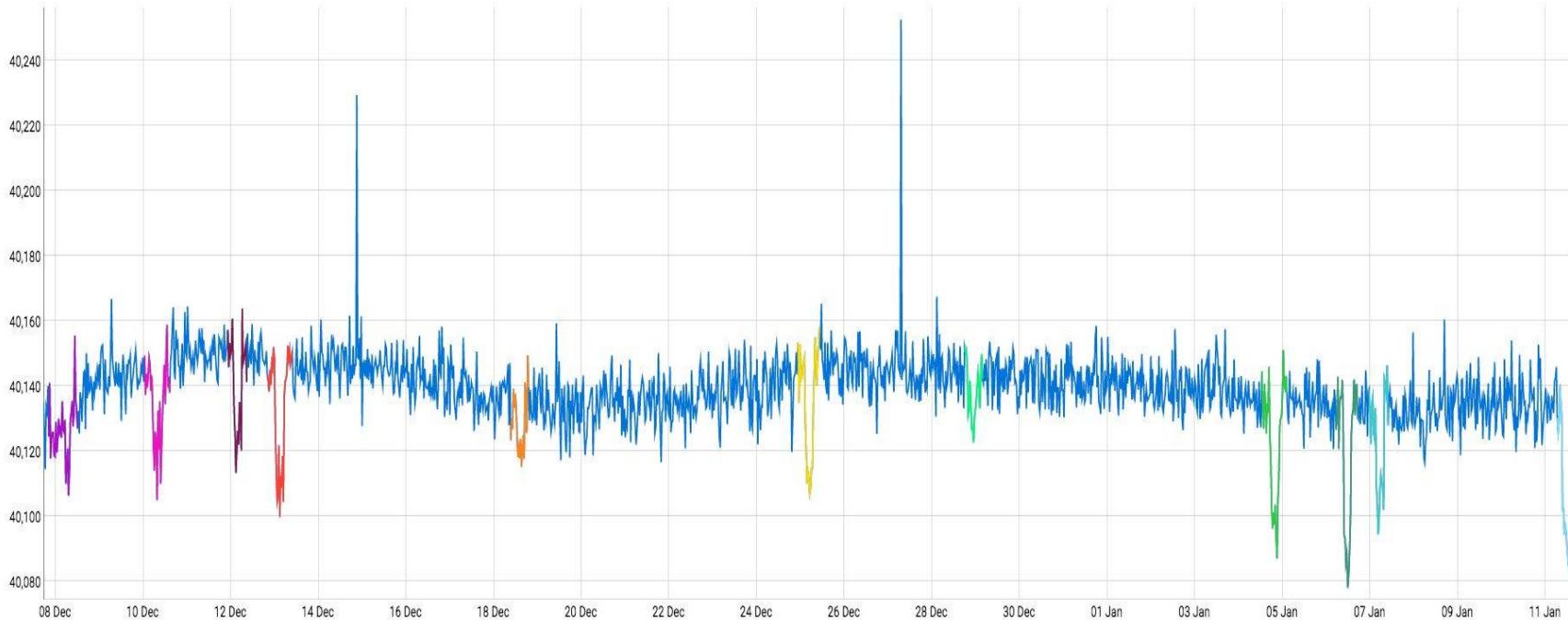
Signal - Trend



Now you can see them well



After some tuning

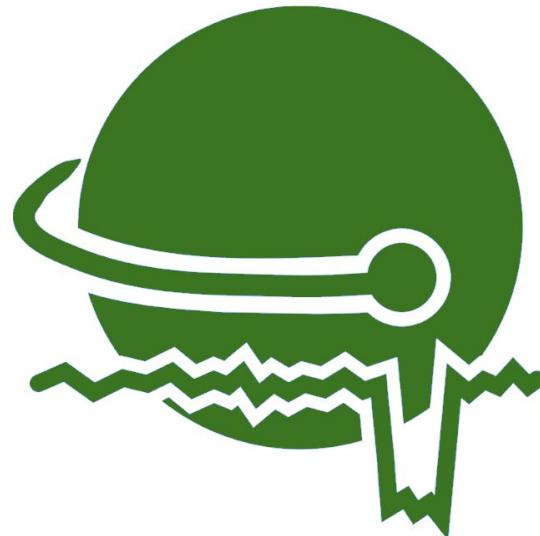


We have our transit candidates



What's next?

Where do we go from here?



Only the beginning



New import method

Better detection

Deep learning

Explorer

satellite/star location

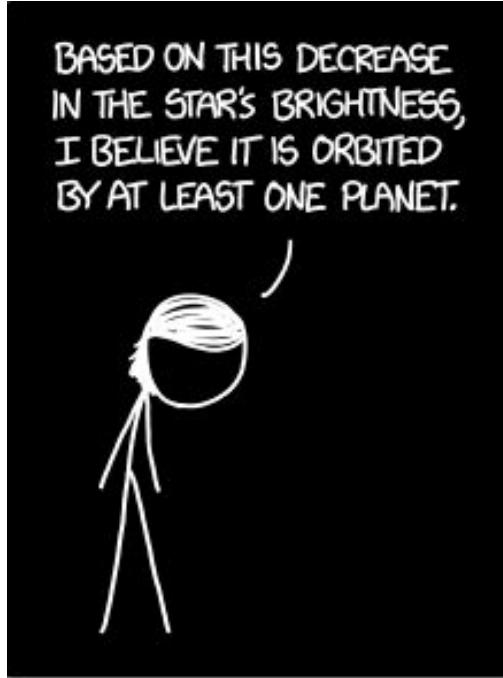
Yours?



A growing team



And you!



<https://xkcd.com/1371/>

Join us!

<https://helloexo.world>

Thank you!



A large, colorful word cloud centered around the words "thank you" in various languages. The word "thank" is in red, "you" is in yellow, and "gracias" is in green. Other words include "danke" (blue), "merci" (orange), "gracias" (green), "teşekkür ederim" (purple), "mochchakkeram" (pink), "raibh maith agat" (brown), "dakujem" (yellow), "arigatō" (pink), "grazie" (blue), "terima kasih" (yellow), "감사합니다" (pink), "xiexie" (light blue), "ngiyabonga" (red), "misaotra" (light blue), "matondo" (light blue), "paldies" (light blue), "grazzi" (light blue), "mahalo" (light blue), "lapadh leat" (light blue), "хвала" (light blue), "asante manana" (light blue), "obrigada" (light blue), "muruozze" (light blue), and "chokran" (light blue). The background is white with a subtle grid pattern.

