In [1]:
```
import numpy as np
import pandas as pd
import math
import matplotlib.pyplot as plt
from datetime import datetime
measures = {}
```

In [2]:
```
dataset = pd.read_csv(r"C:\Users\Dee1\PycharmProjects\Sklearn\data.csv")
hrw = 0.75
fs = 100
```

In [3]:
```
dataset.describe()
```

Out[3]:

	hart
count	2483.000000
mean	514.823198
std	102.945017
min	359.000000
25%	446.000000
50%	492.000000
75%	543.000000
max	854.000000

In [4]:
```
dataset.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2483 entries, 0 to 2482
Data columns (total 1 columns):
hart    2483 non-null int64
dtypes: int64(1)
memory usage: 19.5 KB
```

In [5]:
```
dataset.head()
```

Out[5]:

	hart
0	530
1	518
2	506
3	494
4	483

In [6]:
```
dataset.cumsum
plt.figure()
plt.show()
```

```
<Figure size 432x288 with 0 Axes>
```

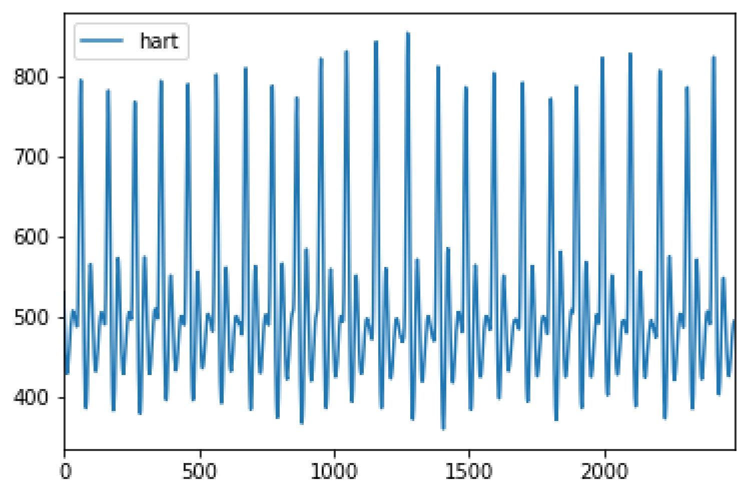
In [7]:
```
dataset.tail()
```

Out[7]:

	hart
2478	489
2479	491
2480	492
2481	493
2482	494

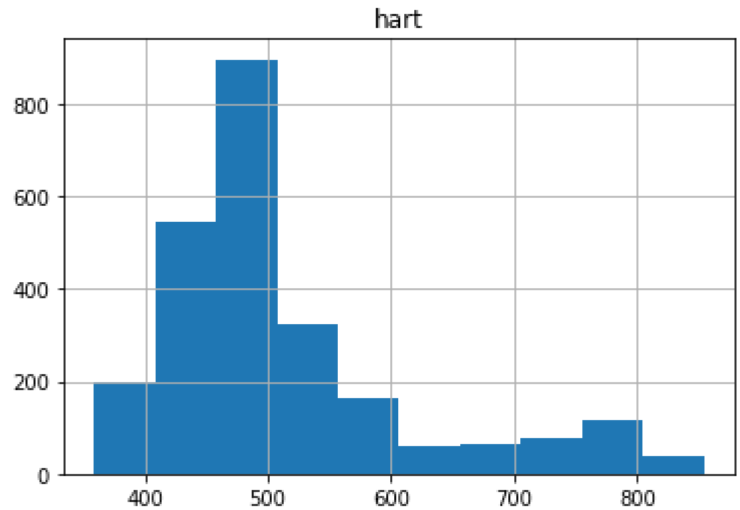
In [8]:
```
dataset.plot()
```

Out[8]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c55cda7f98>
```



In [9]:
```
dataset.hist()
```

Out[9]:
```
array([[<matplotlib.axes._subplots.AxesSubplot object at 0x000001C55EE70668
>]],
      dtype=object)
```



In [10]:
```
mov_avg = dataset['hart'].rolling(int(hrw*fs)).mean()
avg_hr = (np.mean(dataset.hart))
mov_avg = [avg_hr if math.isnan(x) else x for x in mov_avg]
# mov_avg = [x*1.2 for x in mov_avg] #For now we raise the average by 20% to p
revent the secondary heart contraction from interfering, in part 2 we will do
 this dynamically
dataset['hart_rollingmean'] = mov_avg #Append the moving average to the datafr
ame
#Mark regions of interest
window = []
peaklist = []
listpos = 0 #We use a counter to move over the different data columns
for datapoint in dataset.hart:
    rollingmean = dataset.hart_rollingmean[listpos] #Get local mean
    if (datapoint <= rollingmean) and (len(window) <= 1): #If no detectable R-
complex activity -> do nothing
        listpos += 1
    elif (datapoint > rollingmean): #If signal comes above local mean, mark RO
I
        window.append(datapoint)
        print("datapoints are :", datapoint)
        listpos += 1
    else: #If signal drops below local mean -> determine highest point
        maximum = max(window)
        beatposition = listpos - len(window) + (window.index(max(window))) #No
tate the position of the point on the X-axis
        peaklist.append(beatposition)#Add detected peak to list
        print("beat position is : ", beatposition)
        window = [] #Clear marked ROI
        listpos += 1
```

```
datapoints are : 530
datapoints are : 518
beat position is :  0
datapoints are : 515
datapoints are : 538
datapoints are : 567
datapoints are : 603
datapoints are : 640
datapoints are : 677
datapoints are : 714
datapoints are : 745
datapoints are : 772
datapoints are : 788
datapoints are : 795
datapoints are : 795
datapoints are : 783
datapoints are : 765
datapoints are : 740
datapoints are : 712
datapoints are : 677
datapoints are : 641
datapoints are : 605
datapoints are : 568
datapoints are : 535
beat position is :  63
datapoints are : 537
datapoints are : 549
datapoints are : 558
datapoints are : 564
datapoints are : 565
datapoints are : 565
datapoints are : 561
datapoints are : 556
datapoints are : 548
datapoints are : 540
beat position is :  99
datapoints are : 502
datapoints are : 504
datapoints are : 505
datapoints are : 504
datapoints are : 503
datapoints are : 502
datapoints are : 501
datapoints are : 499
datapoints are : 498
datapoints are : 496
datapoints are : 495
datapoints are : 492
datapoints are : 492
datapoints are : 490
datapoints are : 490
datapoints are : 490
datapoints are : 497
datapoints are : 510
datapoints are : 530
datapoints are : 559
datapoints are : 593
```

```
datapoints are : 630
datapoints are : 667
datapoints are : 703
datapoints are : 735
datapoints are : 759
datapoints are : 774
datapoints are : 782
datapoints are : 781
datapoints are : 771
datapoints are : 753
datapoints are : 728
datapoints are : 700
datapoints are : 668
datapoints are : 632
datapoints are : 597
datapoints are : 562
beat position is :  165
datapoints are : 521
datapoints are : 537
datapoints are : 550
datapoints are : 560
datapoints are : 569
datapoints are : 573
datapoints are : 571
datapoints are : 569
datapoints are : 563
datapoints are : 556
datapoints are : 544
beat position is :  201
datapoints are : 501
datapoints are : 503
datapoints are : 504
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datapoints are : 500
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datapoints are : 496
datapoints are : 498
datapoints are : 502
datapoints are : 512
datapoints are : 530
datapoints are : 554
datapoints are : 585
datapoints are : 618
datapoints are : 651
datapoints are : 684
datapoints are : 715
datapoints are : 739
datapoints are : 756
datapoints are : 767
datapoints are : 768
datapoints are : 762
datapoints are : 749
```

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datapoints are : 728
datapoints are : 704
datapoints are : 673
datapoints are : 641
datapoints are : 608
datapoints are : 574
datapoints are : 540
beat position is :  264
datapoints are : 521
datapoints are : 537
datapoints are : 550
datapoints are : 562
datapoints are : 569
datapoints are : 574
datapoints are : 574
datapoints are : 572
datapoints are : 567
datapoints are : 559
datapoints are : 548
datapoints are : 537
beat position is :  299
datapoints are : 506
datapoints are : 508
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datapoints are : 642
datapoints are : 679
datapoints are : 714
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datapoints are : 768
datapoints are : 785
datapoints are : 794
datapoints are : 793
datapoints are : 783
datapoints are : 766
datapoints are : 744
datapoints are : 715
datapoints are : 683
datapoints are : 647
datapoints are : 613
datapoints are : 578
datapoints are : 544
beat position is :  360
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datapoints are : 527
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datapoints are : 544
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datapoints are : 550
datapoints are : 551
datapoints are : 548
datapoints are : 543
datapoints are : 537
beat position is :  397
datapoints are : 500
datapoints are : 500
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datapoints are : 500
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datapoints are : 492
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datapoints are : 515
datapoints are : 538
datapoints are : 569
datapoints are : 604
datapoints are : 643
datapoints are : 681
datapoints are : 716
datapoints are : 747
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datapoints are : 785
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datapoints are : 758
datapoints are : 734
datapoints are : 704
datapoints are : 671
datapoints are : 636
datapoints are : 601
datapoints are : 567
beat position is :  460
datapoints are : 532
datapoints are : 543
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datapoints are : 554
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datapoints are : 553
datapoints are : 550
datapoints are : 544
datapoints are : 537
beat position is :  496
datapoints are : 503
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datapoints are : 565
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datapoints are : 641
datapoints are : 682
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datapoints are : 753
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datapoints are : 770
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datapoints are : 714
datapoints are : 680
datapoints are : 643
datapoints are : 607
datapoints are : 572
datapoints are : 537
beat position is :  565
datapoints are : 536
datapoints are : 545
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datapoints are : 561
datapoints are : 560
datapoints are : 556
datapoints are : 549
datapoints are : 541
beat position is :  601
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datapoints are : 500
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datapoints are : 497
datapoints are : 496
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datapoints are : 482
datapoints are : 480
beat position is :  640
datapoints are : 491
datapoints are : 506
datapoints are : 532
datapoints are : 565
datapoints are : 605
datapoints are : 645
datapoints are : 687
datapoints are : 726
datapoints are : 759
datapoints are : 786
datapoints are : 803
datapoints are : 810
datapoints are : 809
datapoints are : 797
datapoints are : 777
datapoints are : 751
datapoints are : 720
datapoints are : 682
datapoints are : 645
datapoints are : 605
datapoints are : 567
beat position is :  674
datapoints are : 539
datapoints are : 550
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datapoints are : 563
datapoints are : 560
datapoints are : 556
datapoints are : 550
datapoints are : 542
beat position is :  710
datapoints are : 502
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datapoints are : 492
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datapoints are : 555
datapoints are : 589
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datapoints are : 764
datapoints are : 743
datapoints are : 713
datapoints are : 679
datapoints are : 644
datapoints are : 607
datapoints are : 570
beat position is :  773
datapoints are : 532
datapoints are : 544
datapoints are : 555
datapoints are : 562
datapoints are : 565
datapoints are : 566
datapoints are : 565
datapoints are : 562
datapoints are : 554
datapoints are : 544
datapoints are : 533
beat position is :  809
datapoints are : 503
datapoints are : 503
datapoints are : 505
datapoints are : 506
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datapoints are : 509
datapoints are : 515
datapoints are : 526
datapoints are : 543
datapoints are : 568
datapoints are : 597
datapoints are : 631
datapoints are : 665
datapoints are : 698
datapoints are : 727
datapoints are : 750
datapoints are : 767
datapoints are : 773
datapoints are : 773
datapoints are : 764
datapoints are : 747
datapoints are : 724
```

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datapoints are : 695
datapoints are : 662
datapoints are : 627
datapoints are : 591
datapoints are : 556
beat position is :  863
datapoints are : 513
datapoints are : 533
datapoints are : 550
datapoints are : 564
datapoints are : 574
datapoints are : 581
datapoints are : 584
datapoints are : 583
datapoints are : 579
datapoints are : 572
datapoints are : 561
datapoints are : 548
datapoints are : 535
beat position is :  899
datapoints are : 502
datapoints are : 503
datapoints are : 506
datapoints are : 507
datapoints are : 508
datapoints are : 516
datapoints are : 529
datapoints are : 551
datapoints are : 578
datapoints are : 612
datapoints are : 650
datapoints are : 688
datapoints are : 725
datapoints are : 760
datapoints are : 789
datapoints are : 809
datapoints are : 819
datapoints are : 822
datapoints are : 815
datapoints are : 799
datapoints are : 776
datapoints are : 748
datapoints are : 714
datapoints are : 677
datapoints are : 637
datapoints are : 599
datapoints are : 562
beat position is :  953
datapoints are : 524
datapoints are : 537
datapoints are : 547
datapoints are : 552
datapoints are : 558
datapoints are : 559
datapoints are : 557
datapoints are : 553
datapoints are : 547
```

```
datapoints are : 539
beat position is :  989
datapoints are : 500
datapoints are : 498
datapoints are : 497
datapoints are : 496
datapoints are : 496
datapoints are : 493
datapoints are : 494
datapoints are : 495
datapoints are : 499
datapoints are : 511
datapoints are : 532
datapoints are : 560
datapoints are : 597
datapoints are : 637
datapoints are : 679
datapoints are : 719
datapoints are : 756
datapoints are : 788
datapoints are : 811
datapoints are : 827
datapoints are : 831
datapoints are : 826
datapoints are : 810
datapoints are : 789
datapoints are : 759
datapoints are : 725
datapoints are : 687
datapoints are : 648
datapoints are : 607
datapoints are : 570
beat position is :  1048
datapoints are : 533
datapoints are : 543
datapoints are : 549
datapoints are : 551
datapoints are : 550
datapoints are : 547
datapoints are : 542
beat position is :  1083
datapoints are : 496
datapoints are : 497
datapoints are : 494
datapoints are : 493
datapoints are : 492
datapoints are : 490
datapoints are : 488
datapoints are : 488
datapoints are : 486
datapoints are : 484
datapoints are : 483
datapoints are : 480
datapoints are : 478
datapoints are : 477
datapoints are : 476
datapoints are : 474
```

```
datapoints are : 473
beat position is :  1125
datapoints are : 479
datapoints are : 489
datapoints are : 507
datapoints are : 535
datapoints are : 570
datapoints are : 613
datapoints are : 656
datapoints are : 702
datapoints are : 745
datapoints are : 783
datapoints are : 813
datapoints are : 833
datapoints are : 843
datapoints are : 843
datapoints are : 831
datapoints are : 812
datapoints are : 784
datapoints are : 750
datapoints are : 711
datapoints are : 671
datapoints are : 629
datapoints are : 586
datapoints are : 549
beat position is :  1156
datapoints are : 538
datapoints are : 548
datapoints are : 556
datapoints are : 559
datapoints are : 560
datapoints are : 556
datapoints are : 552
datapoints are : 543
beat position is :  1192
datapoints are : 497
datapoints are : 496
datapoints are : 496
datapoints are : 495
datapoints are : 493
datapoints are : 492
datapoints are : 490
datapoints are : 486
datapoints are : 485
datapoints are : 484
datapoints are : 482
datapoints are : 480
datapoints are : 478
datapoints are : 476
datapoints are : 475
datapoints are : 473
datapoints are : 473
beat position is :  1232
datapoints are : 486
datapoints are : 496
datapoints are : 514
datapoints are : 542
```

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datapoints are : 577
datapoints are : 619
datapoints are : 664
datapoints are : 711
datapoints are : 754
datapoints are : 793
datapoints are : 822
datapoints are : 844
datapoints are : 854
datapoints are : 851
datapoints are : 839
datapoints are : 817
datapoints are : 789
datapoints are : 753
datapoints are : 712
datapoints are : 668
datapoints are : 626
datapoints are : 583
datapoints are : 541
beat position is :  1272
datapoints are : 545
datapoints are : 556
datapoints are : 565
datapoints are : 569
datapoints are : 571
datapoints are : 567
datapoints are : 562
datapoints are : 555
datapoints are : 546
beat position is :  1308
datapoints are : 500
datapoints are : 500
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datapoints are : 500
datapoints are : 499
datapoints are : 496
datapoints are : 495
datapoints are : 493
datapoints are : 491
datapoints are : 488
datapoints are : 486
datapoints are : 485
datapoints are : 483
datapoints are : 481
datapoints are : 479
datapoints are : 478
datapoints are : 476
datapoints are : 475
beat position is :  1347
datapoints are : 491
datapoints are : 511
datapoints are : 538
datapoints are : 574
datapoints are : 614
datapoints are : 656
datapoints are : 697
datapoints are : 736
```

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datapoints are : 768
datapoints are : 793
datapoints are : 806
datapoints are : 812
datapoints are : 807
datapoints are : 791
datapoints are : 770
datapoints are : 741
datapoints are : 707
datapoints are : 670
datapoints are : 631
datapoints are : 592
datapoints are : 553
beat position is :  1385
datapoints are : 541
datapoints are : 557
datapoints are : 569
datapoints are : 578
datapoints are : 583
datapoints are : 585
datapoints are : 582
datapoints are : 575
datapoints are : 566
datapoints are : 556
datapoints are : 542
beat position is :  1421
datapoints are : 504
datapoints are : 505
datapoints are : 504
datapoints are : 505
datapoints are : 505
datapoints are : 503
datapoints are : 501
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datapoints are : 497
datapoints are : 494
datapoints are : 491
datapoints are : 488
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datapoints are : 482
datapoints are : 481
datapoints are : 480
datapoints are : 483
datapoints are : 490
datapoints are : 504
datapoints are : 527
datapoints are : 556
datapoints are : 590
datapoints are : 626
datapoints are : 666
datapoints are : 702
datapoints are : 734
datapoints are : 760
datapoints are : 777
datapoints are : 786
datapoints are : 786
datapoints are : 779
```

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datapoints are : 763
datapoints are : 740
datapoints are : 711
datapoints are : 680
datapoints are : 644
datapoints are : 608
datapoints are : 572
datapoints are : 539
beat position is :  1487
datapoints are : 522
datapoints are : 536
datapoints are : 547
datapoints are : 556
datapoints are : 561
datapoints are : 564
datapoints are : 562
datapoints are : 559
datapoints are : 552
datapoints are : 543
datapoints are : 534
beat position is :  1523
datapoints are : 500
datapoints are : 500
datapoints are : 500
datapoints are : 500
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datapoints are : 498
datapoints are : 497
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datapoints are : 485
datapoints are : 483
datapoints are : 483
datapoints are : 483
datapoints are : 485
datapoints are : 493
datapoints are : 506
datapoints are : 527
datapoints are : 557
datapoints are : 591
datapoints are : 631
datapoints are : 671
datapoints are : 710
datapoints are : 746
datapoints are : 773
datapoints are : 793
datapoints are : 803
datapoints are : 804
datapoints are : 797
datapoints are : 783
datapoints are : 760
datapoints are : 731
datapoints are : 698
```

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datapoints are : 663
datapoints are : 625
datapoints are : 590
datapoints are : 554
beat position is :  1592
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beat position is :  1628
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datapoints are : 516
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datapoints are : 572
datapoints are : 607
datapoints are : 647
datapoints are : 684
datapoints are : 719
datapoints are : 750
datapoints are : 773
datapoints are : 787
datapoints are : 792
datapoints are : 790
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datapoints are : 732
datapoints are : 700
datapoints are : 666
datapoints are : 629
datapoints are : 594
datapoints are : 557
beat position is :  1698
datapoints are : 529
datapoints are : 540
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datapoints are : 549
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datapoints are : 544
beat position is :  1734
datapoints are : 499
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datapoints are : 481
datapoints are : 489
datapoints are : 505
datapoints are : 528
datapoints are : 558
datapoints are : 594
datapoints are : 630
datapoints are : 668
datapoints are : 701
datapoints are : 730
datapoints are : 752
datapoints are : 767
datapoints are : 772
datapoints are : 768
datapoints are : 757
datapoints are : 736
datapoints are : 712
datapoints are : 683
datapoints are : 650
datapoints are : 615
datapoints are : 581
datapoints are : 546
beat position is :  1803
datapoints are : 518
datapoints are : 536
datapoints are : 553
datapoints are : 565
datapoints are : 573
datapoints are : 579
datapoints are : 581
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datapoints are : 578
datapoints are : 574
datapoints are : 566
datapoints are : 557
datapoints are : 544
datapoints are : 531
beat position is :  1839
datapoints are : 505
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datapoints are : 545
datapoints are : 573
datapoints are : 604
datapoints are : 638
datapoints are : 675
datapoints are : 709
datapoints are : 739
datapoints are : 762
datapoints are : 779
datapoints are : 787
datapoints are : 785
datapoints are : 776
datapoints are : 759
datapoints are : 736
datapoints are : 707
datapoints are : 675
datapoints are : 641
datapoints are : 606
datapoints are : 572
beat position is :  1897
datapoints are : 525
datapoints are : 539
datapoints are : 552
datapoints are : 561
datapoints are : 565
datapoints are : 568
datapoints are : 567
datapoints are : 564
datapoints are : 559
datapoints are : 551
datapoints are : 541
beat position is :  1933
datapoints are : 502
datapoints are : 501
datapoints are : 501
datapoints are : 498
datapoints are : 496
datapoints are : 495
datapoints are : 494
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datapoints are : 492
datapoints are : 491
datapoints are : 494
datapoints are : 501
datapoints are : 515
datapoints are : 538
datapoints are : 569
datapoints are : 606
datapoints are : 646
datapoints are : 686
datapoints are : 725
datapoints are : 761
datapoints are : 790
datapoints are : 810
datapoints are : 822
datapoints are : 823
datapoints are : 815
datapoints are : 798
datapoints are : 774
datapoints are : 743
datapoints are : 708
datapoints are : 671
datapoints are : 631
datapoints are : 595
datapoints are : 557
beat position is :  1994
datapoints are : 537
datapoints are : 544
datapoints are : 548
datapoints are : 551
datapoints are : 551
datapoints are : 548
datapoints are : 544
beat position is :  2029
datapoints are : 494
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datapoints are : 497
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datapoints are : 542
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datapoints are : 616
datapoints are : 658
datapoints are : 699
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datapoints are : 740
datapoints are : 774
datapoints are : 801
datapoints are : 820
datapoints are : 828
datapoints are : 825
datapoints are : 815
datapoints are : 794
datapoints are : 769
datapoints are : 737
datapoints are : 702
datapoints are : 664
datapoints are : 625
datapoints are : 586
datapoints are : 548
beat position is :  2097
datapoints are : 530
datapoints are : 540
datapoints are : 549
datapoints are : 553
datapoints are : 556
datapoints are : 555
datapoints are : 552
datapoints are : 546
beat position is :  2133
datapoints are : 495
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datapoints are : 475
beat position is :  2173
datapoints are : 478
datapoints are : 488
datapoints are : 503
datapoints are : 526
datapoints are : 558
datapoints are : 596
datapoints are : 637
datapoints are : 678
datapoints are : 716
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datapoints are : 807
datapoints are : 798
datapoints are : 779
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datapoints are : 725
datapoints are : 689
datapoints are : 652
datapoints are : 614
datapoints are : 576
datapoints are : 538
beat position is :  2206
datapoints are : 532
datapoints are : 548
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datapoints are : 561
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beat position is :  2242
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datapoints are : 528
datapoints are : 555
datapoints are : 586
datapoints are : 623
datapoints are : 659
datapoints are : 693
datapoints are : 726
datapoints are : 753
datapoints are : 772
datapoints are : 784
datapoints are : 786
datapoints are : 780
datapoints are : 765
datapoints are : 744
datapoints are : 719
datapoints are : 687
datapoints are : 654
```

```
datapoints are : 619
datapoints are : 584
datapoints are : 550
beat position is :  2308
datapoints are : 524
datapoints are : 541
datapoints are : 553
datapoints are : 562
datapoints are : 568
datapoints are : 571
datapoints are : 570
datapoints are : 565
datapoints are : 560
datapoints are : 551
datapoints are : 542
beat position is :  2343
datapoints are : 504
datapoints are : 506
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datapoints are : 566
datapoints are : 603
datapoints are : 641
datapoints are : 681
datapoints are : 721
datapoints are : 758
datapoints are : 786
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datapoints are : 824
datapoints are : 815
datapoints are : 799
datapoints are : 777
datapoints are : 748
datapoints are : 715
datapoints are : 679
datapoints are : 642
datapoints are : 603
datapoints are : 566
beat position is :  2406
datapoints are : 538
datapoints are : 544
datapoints are : 547
datapoints are : 548
datapoints are : 546
```

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datapoints are : 543
beat position is :  2442
datapoints are : 494
```

In [11]:

```
# CALCULATE BPM: DISPLAY RR LIST, RR INTERVAL, AVG BPM
rr_list = []
cnt = 0
while (cnt < (len(peaklist)-1)):
    rr_interval = (peaklist[cnt+1] - peaklist[cnt]) #Calculate distance betwee
n beats in # of samples

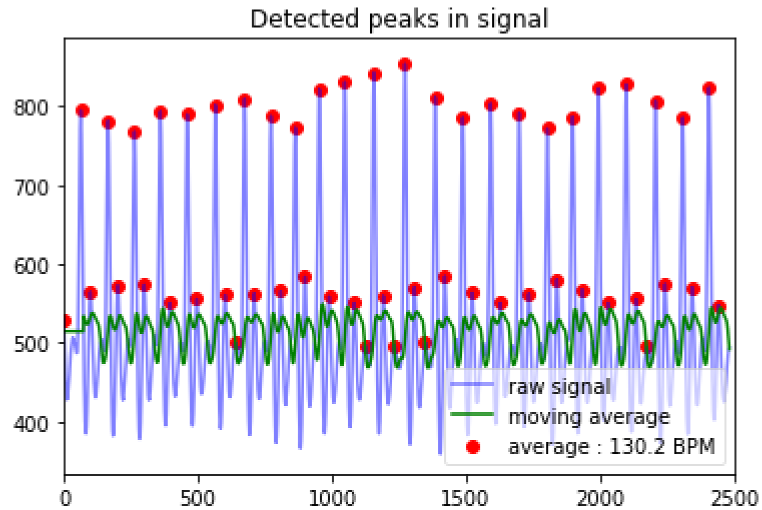
    ms_dist = ((rr_interval / fs) * 1000.0) #Convert sample distances to ms di
stances
    rr_list.append(ms_dist) #Append to list
    cnt += 1

bpm = 60000 / np.mean(rr_list) #60000 ms (1 minute) / average R-R interval of
 signal

print("rr list is : ", rr_list)
print("rr intervals are : ", rr_interval)
print("Average Heart Beat is: %.01f" %bpm)
```

```
rr list is :  [630.0, 360.0, 660.0, 360.0, 630.0, 350.0, 610.0, 370.0, 630.0,
360.0, 690.0, 360.0, 390.0, 340.0, 360.0, 630.0, 360.0, 540.0, 360.0, 540.0,
360.0, 590.0, 350.0, 420.0, 310.0, 360.0, 400.0, 400.0, 360.0, 390.0, 380.0,
360.0, 660.0, 360.0, 690.0, 360.0, 700.0, 360.0, 690.0, 360.0, 580.0, 360.0,
610.0, 350.0, 680.0, 360.0, 400.0, 330.0, 360.0, 660.0, 350.0, 630.0, 360.0]
rr intervals are :  36
Average Heart Beat is: 130.2
```

In [12]:
```
# PLOTTING :
ybeat = [dataset.hart[x] for x in peaklist] #Get the y-value of all peaks for
 plotting purposes
plt.title("Detected peaks in signal")
plt.xlim(0,2500)
plt.plot(dataset.hart, alpha=0.5, color='blue', label = "raw signal")
# PLOTTING MOVING AVERAGE:
plt.plot(mov_avg, color ='green', label = "moving average")
# PLOTTING DETECTED PEAKS:
plt.scatter(peaklist, ybeat, color='red', label = "average : %.1f BPM"%bpm)
plt.legend(loc= 4, framealpha= 0.6)
plt.show()
```



In [13]:
```
# CALCULATING THE RR DIFFERENCE AND RR SQUARE DIFFERENCE:
rr_diff = []
rr_sqdiff = []
cnt = 1 #Use counter to iterate over RR_list
while (cnt < (len(rr_list)-1)): #Keep going as long as there are R-R intervals
    rr_diff.append(abs(rr_list[cnt] - rr_list[cnt+1])) #Calculate absolute dif
ference between successive R-R interval
    rr_sqdiff.append(math.pow(rr_list[cnt] - rr_list[cnt+1], 2)) #Calculate sq
uared difference
    cnt += 1
print("rr difference is : ",rr_diff)
print("rr square difference is : ", rr_sqdiff)
```

```
rr difference is :  [300.0, 300.0, 270.0, 280.0, 260.0, 240.0, 260.0, 270.0,
330.0, 330.0, 30.0, 50.0, 20.0, 270.0, 270.0, 180.0, 180.0, 180.0, 180.0, 23
0.0, 240.0, 70.0, 110.0, 50.0, 40.0, 0.0, 40.0, 30.0, 10.0, 20.0, 300.0, 300.
0, 330.0, 330.0, 340.0, 340.0, 330.0, 330.0, 220.0, 220.0, 250.0, 260.0, 330.
0, 320.0, 40.0, 70.0, 30.0, 300.0, 310.0, 280.0, 270.0]
rr square difference is :  [90000.0, 90000.0, 72900.0, 78400.0, 67600.0, 5760
0.0, 67600.0, 72900.0, 108900.0, 108900.0, 900.0, 2500.0, 400.0, 72900.0, 729
00.0, 32400.0, 32400.0, 32400.0, 32400.0, 52900.0, 57600.0, 4900.0, 12100.0,
2500.0, 1600.0, 0.0, 1600.0, 900.0, 100.0, 400.0, 90000.0, 90000.0, 108900.0,
108900.0, 115600.0, 115600.0, 108900.0, 108900.0, 48400.0, 48400.0, 62500.0,
67600.0, 108900.0, 102400.0, 1600.0, 4900.0, 900.0, 90000.0, 96100.0, 78400.
0, 72900.0]
```

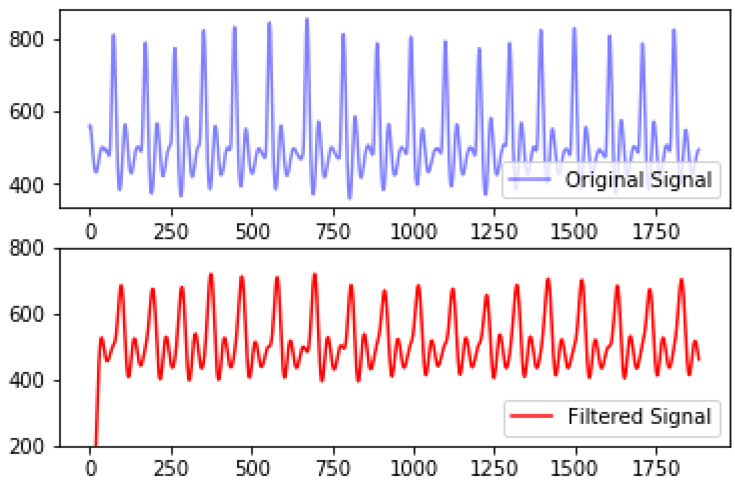
In [17]:
```
# CALCULATING ALL TIME DOMAIN MEASURES:
ibi = np.mean(rr_list) #Take the mean of RR_list to get the mean Inter Beat In
terval
print("IBI:", ibi,"ms")
sdnn = np.std(rr_list) #Take standard deviation of all R-R intervals
print("SDNN:", sdnn,"ms")
sdsd = np.std(rr_diff) #Take standard deviation of the differences between all
subsequent R-R intervals
print("SDSD:", sdsd,"ms")
rmssd = np.sqrt(np.mean(rr_sqdiff)) #Take root of the mean of the list of squa
red differences
print("RMSSD:", rmssd,"ms")
nn20 = [x for x in rr_diff if (x>20)] #First create a list of all values over
 20, 50
nn50 = [x for x in rr_diff if (x>50)]
pnn20 = float(len(nn20)) / float(len(rr_diff)) #Calculate the proportion of NN
20, NN50 intervals to all intervals
pnn50 = float(len(nn50)) / float(len(rr_diff)) #Note the use of float(), becau
se we don't want Python to think we want an int() and round the proportion to
 0 or 1
Accuracy = (100 - 7.8) #100 - (real heart beat - bpm)
print("pNN20: ", pnn20,"%")
print("pNN50: ", pnn50,"%")
print("Accuracy: ", Accuracy, "%")
```

```
IBI: 460.75471698113205 ms
SDNN: 133.68294025598757 ms
SDSD: 115.48137387656202 ms
RMSSD: 236.74260035644073 ms
pNN20:  0.9215686274509803 %
pNN50:  0.7647058823529411 %
Accuracy:  92.2 %
```

In [15]:
```
# CALCULATING
from scipy.signal import butter,lfilter

def butter_lowpass(cutoff, fs, order=5):
    nyq = 0.5 * fs #Nyquist frequeny is half the sampling frequency
    normal_cutoff = cutoff / nyq
    b,a = butter(order, normal_cutoff, btype='low', analog=False)
    return b,a
def butter_lowpass_filter(data, cutoff, fs, order):
    b, a = butter_lowpass(cutoff, fs, order=order)
    y = lfilter(b, a, data)
    return y

dataset = pd.read_csv("data.csv")
dataset = dataset[600:12000].reset_index(drop=True) #For visibility take a sub
selection of the entire signal from samples 6000 - 12000 (00:01:00 - 00:02:00)
filtered = butter_lowpass_filter(dataset.hart, 2.5, 100.0, 5)#filter the signa
l with a cutoff at 2.5Hz and a 5th order Butterworth filter
#Plot it
plt.subplot(211)
plt.plot(dataset.hart, color='Blue', alpha=0.5, label='Original Signal')
plt.legend(loc=4)
plt.subplot(212)
plt.plot(filtered, color='Red', label='Filtered Signal')
plt.ylim(200,800) #limit filtered signal to have same y-axis as original (filt
er response starts at 0 so otherwise the plot will be scaled)
plt.legend(loc=4)
plt.show()
```



In [ ]: