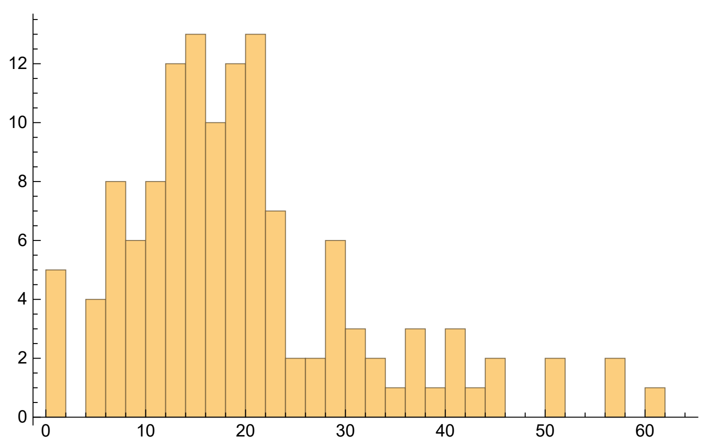
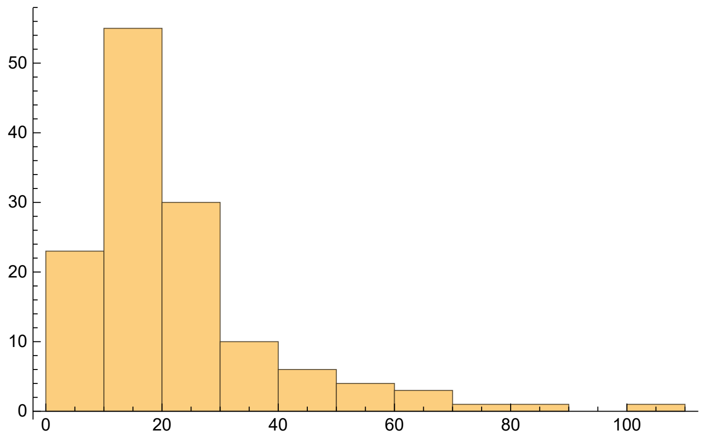
```
(* Adam Beck *)
(* Problem 1*)


(* hosp-heart.nb data *)

(* {M,V} M = one year mortality rate,
percentage of patiuents that died within one year of the
 transplant operation,
V = average annual number of transplants at that center during the same 4 years *)
heart = {{17.9, 27}, {23.1, 4}, {40, 3}, {6.5, 35}, {14.9, 17}, {12.5, 4}, {15.7, 45},
   {9.8, 28}, {24, 6}, {5.0, 10}, {15.4, 13}, {4.8, 7}, {0, 1}, {19.1, 47}, {4.5, 6},
   {15, 56}, {12.5, 4}, {33.9, 8}, {10.7, 9}, {13, 14}, {28.3, 12}, {57.1, 2}, {6.3, 4},
   {10, 3}, {8.3, 12}, {17.5, 10}, {20, 3}, {29.3, 10}, {21.4, 7}, {27.3, 8}, {13.6, 6},
   {21.8, 30}, {36.4, 3}, {18.2, 11}, {33.3, 2}, {20, 4}, {38.5, 7}, {20.8, 18}, {12.2, 19},
   {22.2, 18}, {29, 8}, {0, 9}, {5.7, 9}, {50, 2}, {21.7, 15}, {66.7, 4}, {29.4, 17},
   {12.1, 27}, {10.7, 14}, {6.3, 4}, {16.2, 9}, {21.1, 5}, {17.4, 33}, {23.9, 17},
   {42.9, 2}, {40, 2}, {6.7, 15}, {44.4, 3}, {18.7, 34}, {14.7, 24}, {7.4, 7}, {12.6, 24},
   {9.7, 26}, {44.4, 2}, {16.7, 6}, {15.8, 14}, {83.3, 2}, {10.9, 22}, {13.3, 5},
   {11.1, 5}, {75, 2}, {19, 20}, {14, 13}, {60, 1}, {21.2, 8}, {9.7, 8}, {50, 2}, {25, 14},
   {18.6, 15}, {0.0, 1}, {35.3, 9}, {23.5, 85}, {15.6, 11}, {37.5, 2}, {14.3, 28},
   {14.3, 4}, {16.7, 6}, {20.0, 15}, {13.0, 17}, {9.6, 26}, {66.7, 3}, {30.8, 3},
   {14.0, 13}, {27.5, 10}, {37.5, 8}, {18.9, 13}, {0.0, 4}, {12.2, 44}, {57.1, 4},
   {21.4, 35}, {23.4, 16}, {10.9, 12}, {15.6, 8}, {16.7, 2}, {13.9, 9}, {18.2, 11},
   {11.5, 26}, {18.4, 13}, {16.7, 3}, {20.4, 14}, {40.0, 5}, {20.7, 56}, {19.6, 13},
   {13.5, 9}, {29.9, 36}, {8.4, 21}, {28.4, 24}, {7.7, 23}, {19.3, 29}, {0.0, 1},
   {22.2, 20}, {30.0, 5}, {7.0, 11}, {23.8, 7}, {18.8, 29}, {14.5, 16}, {17.0, 16},
   {20.0, 15}, {6.7, 15}, {11.4, 20}, {100.0, 1}, {31.4, 9}, {17.6, 26}, {19.6, 14}};

(* Split this M and V data into separate
 lists via Transpose[] in order to parse through *)
heartTranspose = Transpose[heart];
MData = heartTranspose[[1]];
VData = heartTranspose[[2]];

(* Define mean, median, quantile, and variance functions *)

mean[x_] := Sum[x[[i]], {i, 1, Length[x]}] / Length[x];
(* Sum elements, divide by length *)

median[x_] := (s = Sort[x]; s[[IntegerPart[.5 * Length[s]]]]);
(* Sort list, take element at index 1/2*length *)

quantile[x_, alpha_] := (s = Sort[x]; s[[IntegerPart[alpha * Length[s]]]])
 (* Sort list, take element at index alpha*length *)

variance[x_] := (m = mean[x]; Sum[(x[[i]] - m)^2, {i, 1, Length[x]}] / Length[x]);
(* difference of every element from mean, squared, times 1/length *)

(* Find the mean, median, q1 and q3, and variance *)
hospMeanM = mean[MData]
21.9045
```

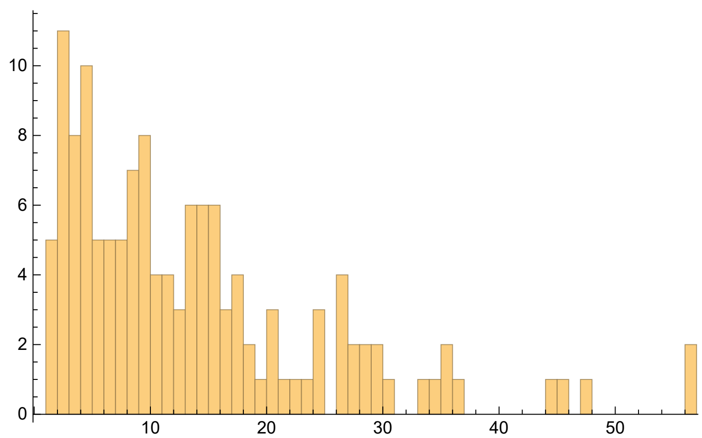
```
hospMeanV = N[mean[VData]]
13.8657

hospMedianM = median[MData]
18.2

hospMedianV = median[VData]
10

hospQ1M = quantile[MData, .25]
12.2

hospQ1V = quantile[VData, .25]
4

hospQ3M = quantile[MData, .75]
25

hospQ3V = quantile[VData, .75]
17

hospVarianceM = variance[MData]
268.634

hospVarianceV = N[variance[VData]]
166.46

(* Histograms using two difference bin sizes *)
(* I will use a bin size Length/2 for a very large bin count,
and Length/10 for a smaller bin count *)

(* MData large bin count *)
Histogram[MData, IntegerPart[Length[MData] / 2]]
```



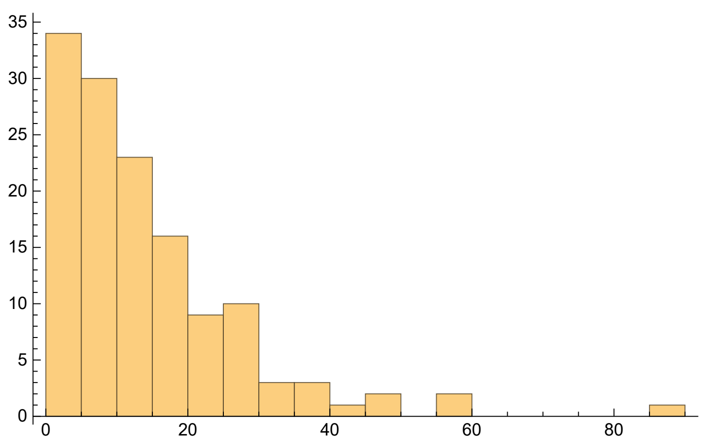
```
(* MData small bin count *)
Histogram[MData, IntegerPart[Length[MData] / 10]]
```



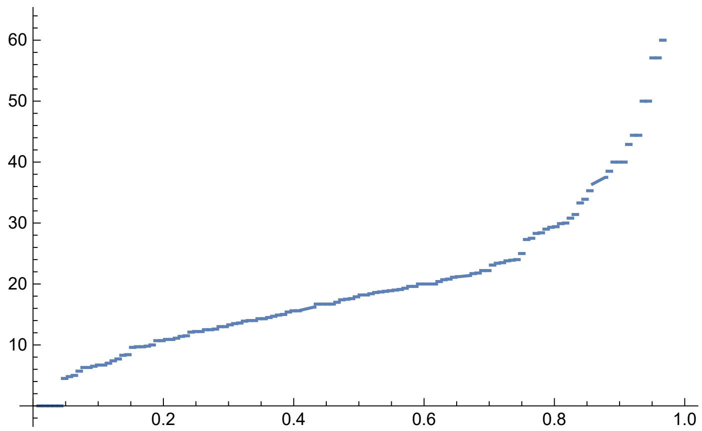

```
(* VData, large bin count *)
Histogram[VData, IntegerPart[Length[VData] / 2]]
```



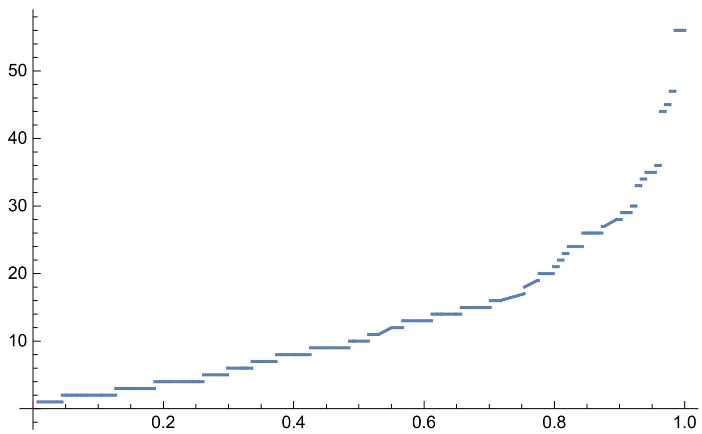

```
(* VData, small bin count*)
Histogram[VData, IntegerPart[Length[VData] / 10]]
```



```
(* Produce plots of quantile functions, moment functions, and CDFs *)

(* Define functions for moments and CDF *)

(* Sum elements raised to the kth power, divide by length *)
moment[x_, k_] := N[Sum[x[[i]]^k, {i, 1, Length[x]}] / Length[x]];

cdf[x_, xi_] := N[Sum[If[x[[i]] <= xi, 1, 0], {i, 1, Length[x]}]];
(* Count that an element is less than or equal to a given element *)

(* Plot the quantile functions *)
(* MData *)
Plot[quantile[MData, i], {i, 0, 1}]
```

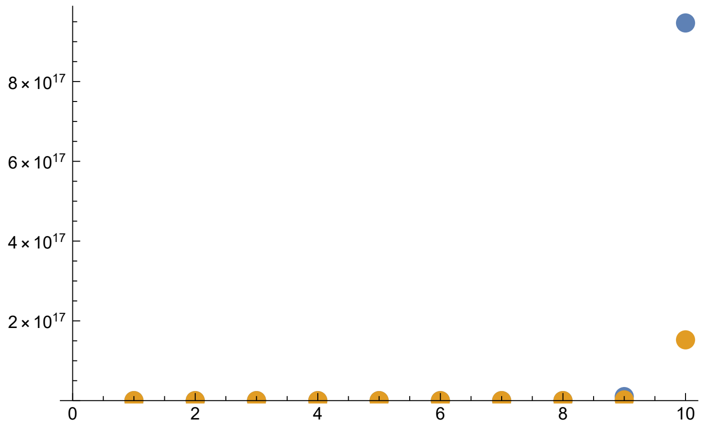


```
(* VData *)
Plot[quantile[VData, i], {i, 0, 1}]
```

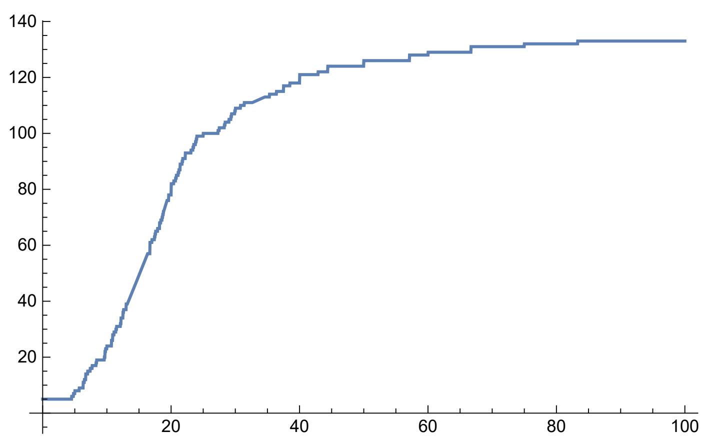


```
(* Plot moment functions *)
(* Get the first 10 moments for MData and VData in a Table *)
momMData = Table[moment[MData, i], {i, 1, 10}];

momVData = Table[moment[VData, i], {i, 1, 10}];
```

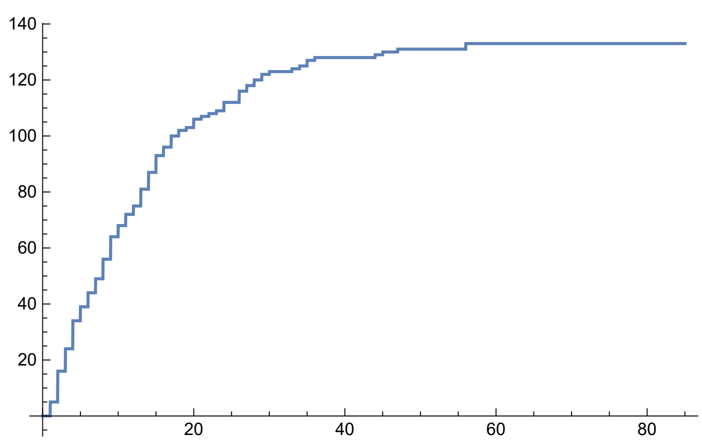
```
(* Plot the two moments *)
ListPlot[{momMData, momVData}, PlotStyle → PointSize[.03], PlotRange → {0, 9.9 * 10^17}]
(* Blue is MData, Orange is VData*)
```



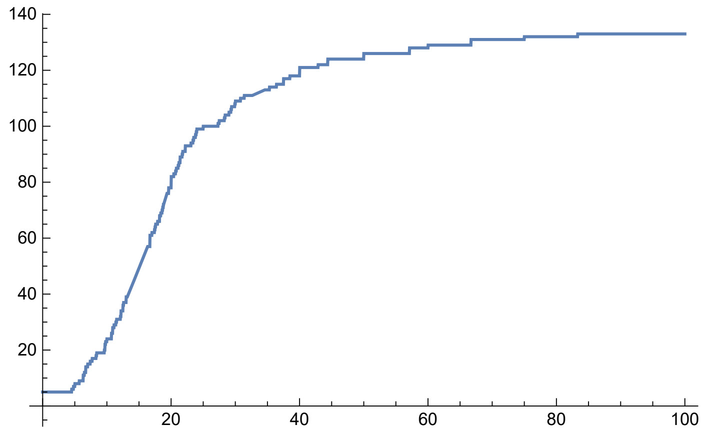
```
(* Plot CDF functions *)
(* MData from range 0 to maximum element in the data set *)
Plot[cdf[MData, i], {i, 0, Max[MData]}]
```



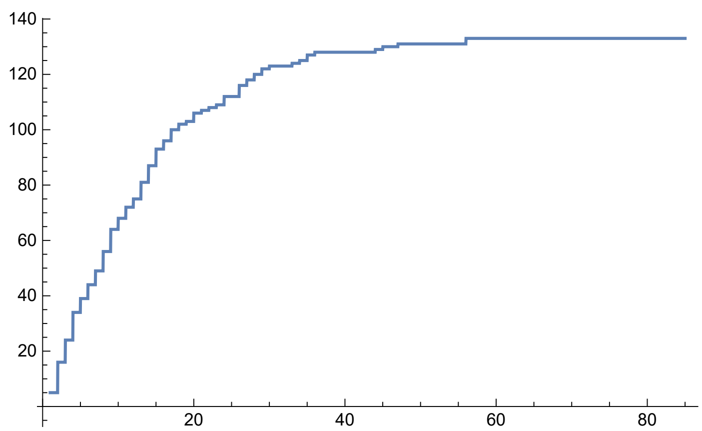
```
(* VData *)
(* VData from range 0 to maximum element in the data set *)
Plot[cdf[VData, i], {i, 0, Max[VData]}]
```



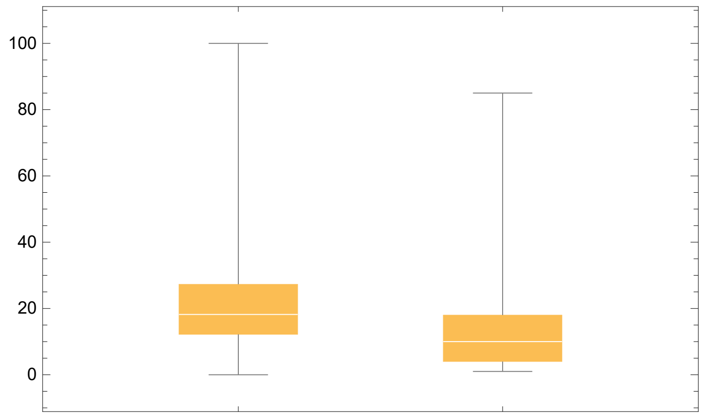
```
(* MData from range minimum element to maximum element in the data set *)

Plot[cdf[MData, i], {i, Min[MData], Max[MData]}]
```



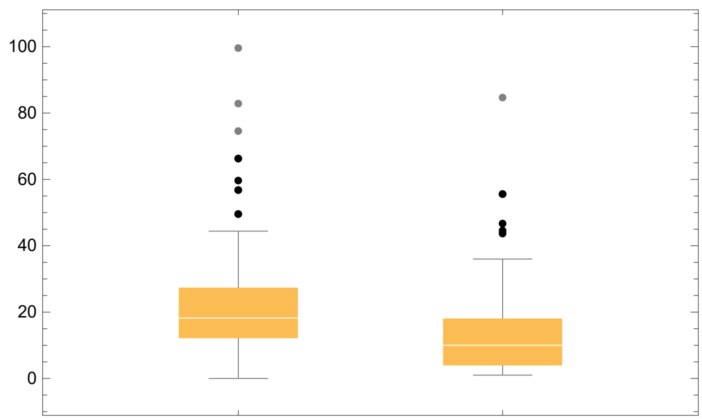

```
(* MData from range minimum element to maximum element in the data set *)
Plot[cdf[VData, i], {i, Min[VData], Max[VData]}]
```



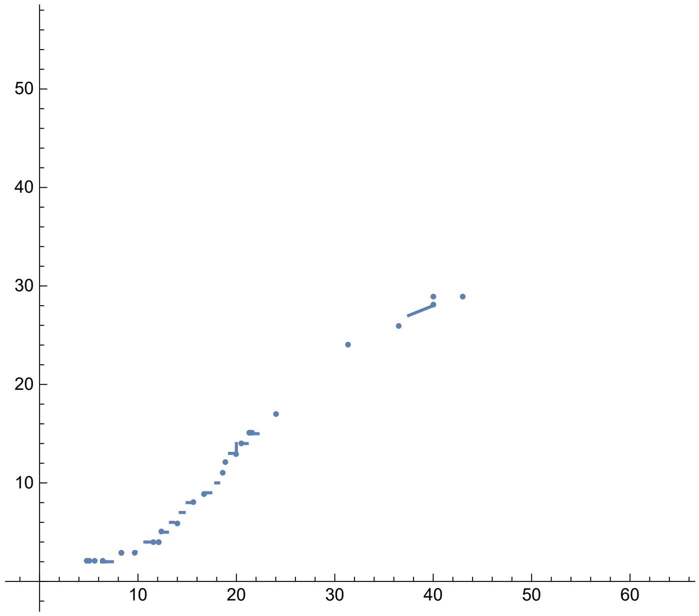
```
(* Although the instructions do not say to compare
 any box and whisker and QQ plots for this hospital data
 against other sets of data, I will product them anyways. QQ
 will be MData(x axis) against VDaya (y axis) *)

(* Box an whisker plots *)
(* A box and whisker plot takes a min, q1, q2 (median), q3, and max *)

(* Box and whisker, MData and VData, outliers not shown *)
BoxWhiskerChart[{MData, VData}]
```




```
(* Box and whisker, MData and VData, outliers shown *)
BoxWhiskerChart[{MData, VData}, "Outliers"]
```



```
(* Parametric Plots (QQ Plots), MData on x axis, VData on y axis *)
ParametricPlot[{quantile[MData, i], quantile[VData, i]}, {i, 0, 1}]
```



```
(* If the two sets come from a population with the same distribution,
the points should fall approximately
 along a 45 degree reference line. As we can see,
the 2 batches do not appear to have come from populations with
 a common distribution, as they do not fit along a straight line. However,
I would consider it closer to a straight line
 than, say, a quadratic. So it suggests that the data
 sets came from population of fairly equal distributions. *)

(* resistor.nb data *)
(* The data represents a listing of the resistances
 (in ohms) of 200 resistors which are all rated at 10 kiloohms. *)
resistors = {9.97910927, 9.833997401, 10.48797923, 9.778286587, 10.4127049, 9.729651074,
   10.34005333, 9.894176108, 10.07983211, 9.933230947, 9.977783398, 10.13141411,
   10.1266421, 9.37852757, 10.26785423, 9.907086669, 9.744503691, 9.971603949,
   9.693939764, 9.620137112, 12.28072506, 10.0580338, 10.33764317, 9.757096213,
   9.593230848, 9.713741738, 9.432574293, 9.62099431, 9.802732952, 9.971484578,
   10.22548428, 10.3352728, 9.989841592, 10.29860424, 9.52298034, 10.08499861,
   9.394148142, 9.944944954, 10.21438162, 10.36193691, 10.02987499, 9.603449021,
   9.742946181, 9.875414084, 10.05078967, 10.12314509, 10.15281111, 5.870566193,
   9.484863417, 9.973958404, 9.94911044, 9.374762262, 9.788310356, 10.06500849,
   9.77439594, 10.03864565, 10.32397119, 9.916142963, 9.967350072, 10.09860352,
   9.987682395, 10.15563395, 9.537918791, 9.945042157, 10.02686399, 9.74540807,
   10.26915708, 9.696347652, 10.13930795, 9.51572712, 9.367227099, 9.831637831,
   10.1807235, 9.88921993, 9.923452458, 9.944225885, 9.779727284, 10.26538836, 10.2298635,
   10.2461264, 9.694717951, 9.771545526, 9.679096242, 10.15118993, 10.25894345,
   9.613968464, 10.14607857, 10.3809408, 10.00425765, 10.30422606, 9.938641588,
   10.14989447, 9.62901378, 6.613345698, 10.48706974, 10.10426569, 10.15476425,
   9.839152246, 9.74229305, 9.712882265, 10.09355753, 9.655283966, 10.01073951,
   10.23032052, 9.896222755, 9.646005983, 10.22741355, 9.916736976, 9.853518852,
   9.797304974, 9.542975581, 9.582644329, 10.06420074, 10.1110437, 9.09833499,
   9.694181349, 10.0837185, 9.990310834, 9.680224016, 9.544769559, 10.12220661,
   10.35625939, 9.68922915, 9.816272486, 9.838797828, 9.787675983, 10.01512384,
   9.672549018, 9.166747182, 9.839861368, 10.0490497, 9.9589975, 9.707653239, 9.642065029,
   10.14670044, 9.704657023, 9.851454583, 9.92931813, 10.05903936, 9.749898131,
   10.12904658, 9.776733909, 9.956306817, 10.10913774, 9.25291271, 9.823820724,
   9.581313056, 9.84027462, 9.738894951, 9.923279654, 9.815685862, 9.754906605,
   10.19531748, 9.718578829, 9.830784043, 9.860661512, 9.665515781, 9.956836598,
   10.06308718, 9.401201273, 10.10992616, 9.738494773, 9.991823154, 9.877411846,
   10.23755441, 10.04556889, 9.978626954, 10.06519891, 9.774786454, 10.26202664,
   10.10298671, 9.558598995, 9.352852535, 9.611078544, 9.807194024, 9.684415081,
   10.17326848, 9.683191811, 10.03918111, 9.891267714, 9.707087079, 9.68933829,
   10.10867702, 9.770431111, 9.697278747, 10.15024178, 10.17638293, 9.676198933,
   9.765484028, 9.952918381, 10.15444308, 10.03372073, 9.607316647, 9.856609145,
   9.805244863, 9.728007162, 9.951510938, 10.03217857, 10.19504918, 10.23059564};
```

```
(* Find the mean, median, q1 and q3, and variance *)
(* functions were defined above for the hospital data *)
resistorMean = mean[resistors]
```

9.87989

```
resistorMedian = median[resistors]
```

9.91674

```
resistorQ1 = quantile[resistors, .25]
```

9.71288

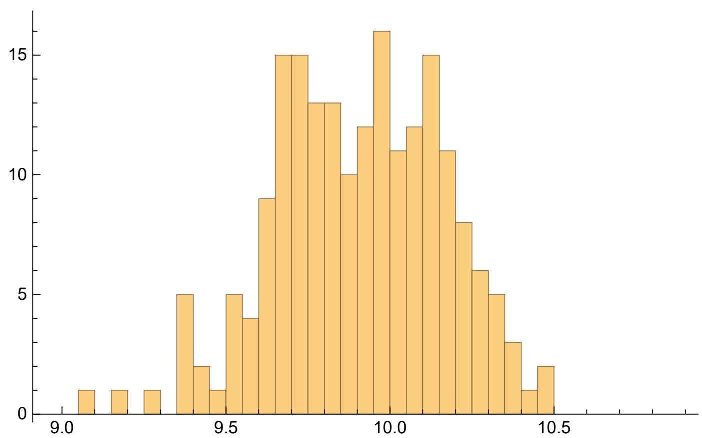
```
resistorQ3 = quantile[resistors, .75]
```

10.1043

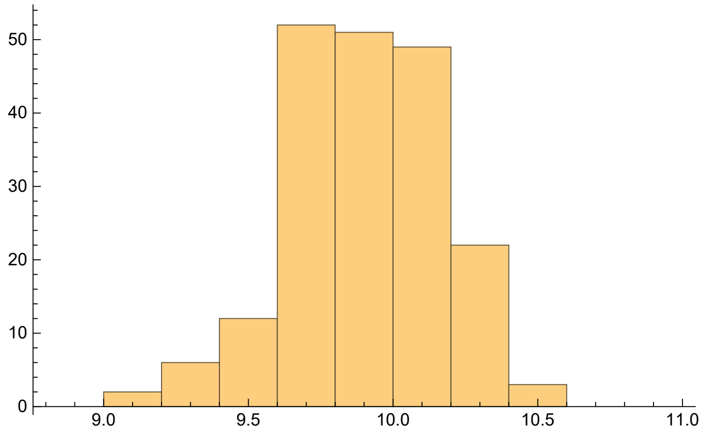
```
resistorVariance = variance[resistors]
```

0.229448

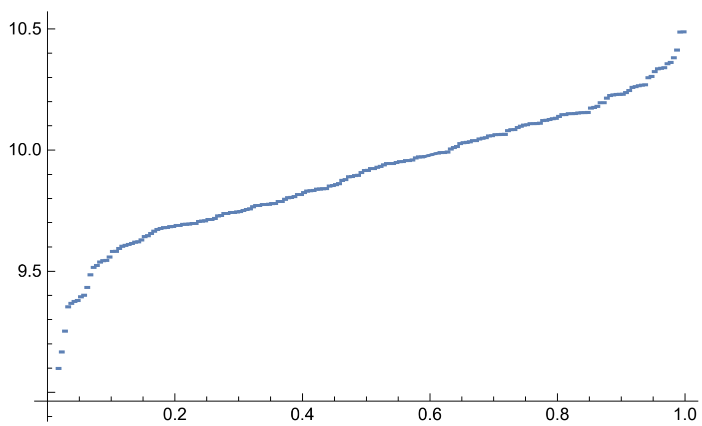
```
(* Histograms using two difference bin sizes *)
(* I will use a bin size Length/2 for a very large bin count,
and Length/10 for a smaller bin count*)

(* Large bin count*)
Histogram[resistors, IntegerPart[Length[resistors] / 2]]
```



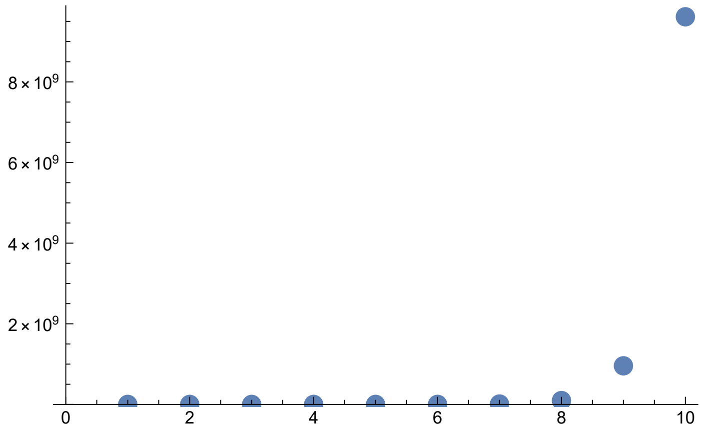
```
(* Small bin count *)
Histogram[resistors, IntegerPart[Length[resistors] / 10]]
```



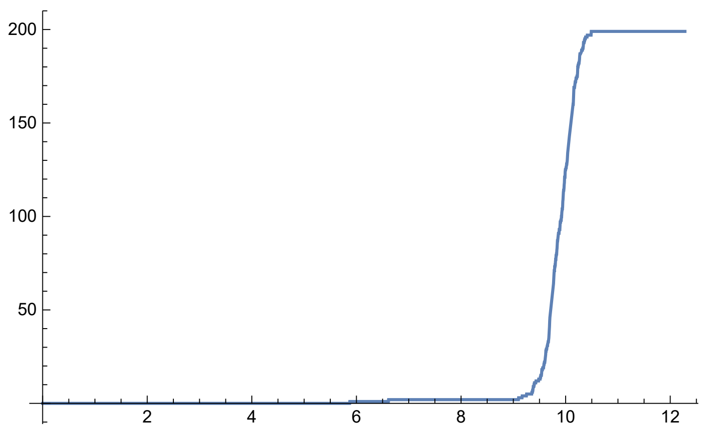

```
(* Produce plots of quantile functions, moment functions, and CDFS *)
(* functions were defined above for the hospital data *)

(* Plot the quantile functions *)
Plot[quantile[resistors, i], {i, 0, 1}]
```



```
(* Plot the moment functions *)
(* Get the first 10 moments for the resistor data in a table *)
momResistorData = Table[moment[resistors, i], {i, 1, 10}];

(* Plot the moment *)
ListPlot[momResistorData, PlotStyle → PointSize[.03], PlotRange → {0, 9.9 * 10^9}]
```

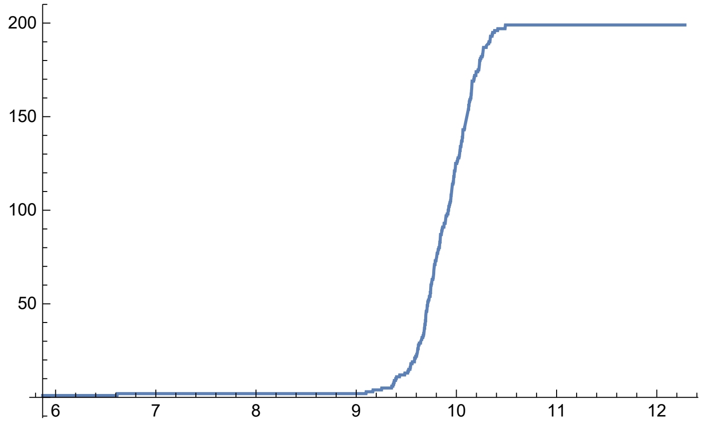


```
(* Plot the CDF functions *)
(* CDF for range 0 to the maximum element in the data set *)
Plot[cdf[resistors, i], {i, 0, Max[resistors]}]
```

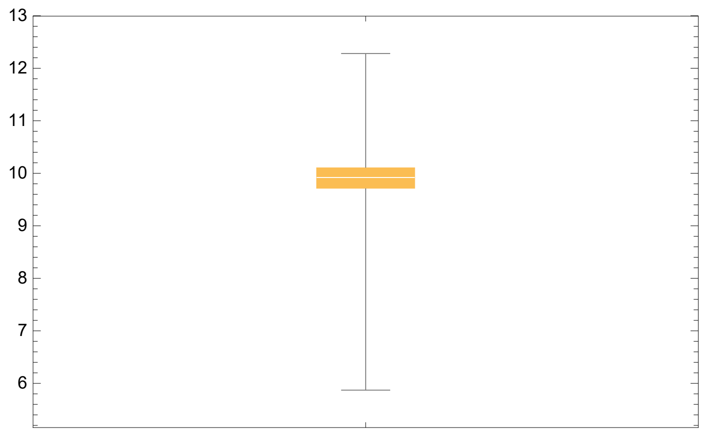


```
(* CDF for range minimum element to maximum element in the data set *)
```

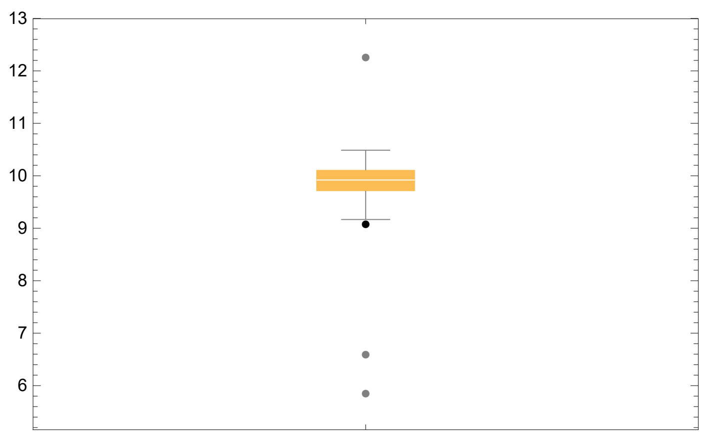
```
Plot[cdf[resistors, i], {i, Min[resistors], Max[resistors]}]
```




```
(* Box an whisker plots *)
(* A box and whisker plot takes a min, q1, q2 (median), q3, and max *)


(* Box and whisker, resistor data, outliers not shown *)
BoxWhiskerChart[resistors]
```




```
(* Box and whisker, resistor data, outliers shown *)

BoxWhiskerChart[resistors, "Outliers"]
```



```
(* Parametric plot comparison with drips and resistor data will be later *)

(* drips-pcw.nb data *)

(* The set of data provided below represents the time intervals
 (in seconds) between consecutive water drips from a nozzle. *)
Drp = {0.18228360, 0.18623970, 0.13423350, 0.10354810, 0.15513900, 0.23274050, 0.20233310,
   0.12894790, 0.18684980, 0.22657810, 0.26112470, 0.19178580, 0.13767700, 0.14837620,
   0.22277630, 0.16055710, 0.13788350, 0.09521610, 0.24578210, 0.17383130, 0.25812850,
   0.18938570, 0.25420280, 0.22464200, 0.26155470, 0.10953020, 0.22034160, 0.10145990,
   0.19693630, 0.12816710, 0.13596500, 0.10053220, 0.25587460, 0.14042210, 0.25563470,
   0.13526800, 0.25192090, 0.25315870, 0.25650260, 0.07200480, 0.22221230, 0.10651970,
   0.23083320, 0.14309380, 0.12039200, 0.07573480, 0.28357910, 0.13409110, 0.25356630,
   0.13608820, 0.15960660, 0.20411740, 0.25443260, 0.10519020, 0.22459810, 0.10852200,
   0.23142460, 0.18760390, 0.14815410, 0.13764410, 0.22559380, 0.14294190, 0.21218650,
   0.12436990, 0.17052370, 0.26370070, 0.22443330, 0.13576010, 0.22104630, 0.14850460,
   0.20739950, 0.23946950, 0.09949950, 0.13500100, 0.22572200, 0.13560920, 0.26428920,
   0.16429840, 0.13426580, 0.21094650, 0.22839840, 0.13847070, 0.22873960, 0.09668840,
   0.21728640, 0.21903800, 0.14815920, 0.13720790, 0.22385060, 0.13849930, 0.25677440,
   0.14003500, 0.13574610, 0.21009840, 0.22764460, 0.13569010, 0.23362570, 0.10627020,
   0.20359420, 0.22037170, 0.14801240, 0.14313470, 0.22738740, 0.13893190, 0.26134080,
   0.15902480, 0.13821110, 0.25994540, 0.19984440, 0.13702970, 0.25571080, 0.10017000,
   0.24149470, 0.20942150, 0.09821050, 0.17724780, 0.22568230, 0.09987190, 0.25377520,
   0.13363160, 0.14934250, 0.25567830, 0.16646210, 0.13653430, 0.26081120, 0.11141880,
   0.22362140, 0.26196300, 0.25485620, 0.15926790, 0.22449670, 0.11083920, 0.22594470,
   0.14749760, 0.09495230, 0.13961280, 0.22764470, 0.14142230, 0.24807480, 0.13791740,
   0.24859080, 0.25935050, 0.26436380, 0.14695130, 0.23698890, 0.10994630, 0.24675460,
   0.19712410, 0.10504020, 0.11948800, 0.22092570, 0.13606610, 0.22484940, 0.12570890,
   0.16141710, 0.26257510, 0.14825630, 0.13100610, 0.20236200, 0.13893380, 0.26028230,
   0.23129920, 0.09723730, 0.24600470, 0.23302040, 0.14716670, 0.18991060, 0.09395180,
   0.14256570, 0.25940860, 0.13184190, 0.14779980, 0.26544610, 0.17659160, 0.25689390,
   0.22272640, 0.10381410, 0.22347600, 0.25889310, 0.09551590, 0.21917120, 0.07637890,
   0.14582530, 0.27091080, 0.13431580, 0.11580080, 0.26142020, 0.13817780, 0.25436520,
   0.19498570, 0.09923730, 0.22391340, 0.22166680, 0.09870400, 0.22214220, 0.14858030,
   0.17792490, 0.24428880, 0.14327470, 0.15278630, 0.25635740, 0.14497800, 0.18314970,
   0.23344810, 0.11068690, 0.26540170, 0.14857800, 0.10705320, 0.22829050, 0.18691300,
   0.13606300, 0.25154320, 0.10921350, 0.22934640, 0.22450430, 0.13692630, 0.23764460,
   0.18372960, 0.10921790, 0.19986190, 0.15007520, 0.13633160, 0.22506690, 0.11534350,
   0.17324380, 0.21237050, 0.14873530, 0.21643160, 0.22657440, 0.13686960, 0.23828540,
   0.318174320, 0.14837860, 0.21115580, 0.16123000, 0.13529380, 0.24016030, 0.12552070,
   0.15950540, 0.21113940, 0.14725600, 0.21805820, 0.22875220, 0.12800870, 0.20448610,
   0.21948410, 0.14692220, 0.24746870, 0.14248680, 0.13871530, 0.23005070, 0.16313400,
   0.13891430, 0.26708190, 0.11291010, 0.25614080, 0.24051200, 0.24548400, 0.23622310,
   0.23961130, 0.09302900, 0.21150500, 0.11970740, 0.12498680, 0.11555500, 0.13855050,
   0.12045270, 0.26194240, 0.14797380, 0.16864190, 0.22269730, 0.26032830, 0.25778280,
   0.22254430, 0.10020850, 0.26106870, 0.15855650, 0.14371780, 0.11136020, 0.12119620,
   0.14110830, 0.25684420, 0.09828760, 0.23301490, 0.20504970, 0.18349520, 0.21975910,
   0.24160800, 0.10200310, 0.21208000, 0.14020810, 0.15974330, 0.18873760, 0.14236020,
   0.12082240, 0.22755640, 0.14818550, 0.22244030, 0.17957990, 0.24217980, 0.20160190,
   0.22291860, 0.14020770, 0.25848130, 0.13665170, 0.17852080, 0.11437730, 0.15921670,
   0.13596970, 0.26868740, 0.10135420, 0.22488520, 0.20168690, 0.20958320, 0.22973200,
```

```
0.22528830, 0.10985200, 0.25246890, 0.14021050, 0.17207190, 0.14624990, 0.14421290,
0.13553570, 0.19721490, 0.11316860, 0.22365350, 0.19277550, 0.22177710, 0.22281810,
0.22673220, 0.18224740, 0.22948630, 0.13615970, 0.14343280, 0.13595380, 0.13332310,
0.13758030, 0.17235540, 0.13477980, 0.22750740, 0.27205230, 0.22723570, 0.22356740,
0.26976620, 0.16408940, 0.25041400, 0.13610470, 0.09729680, 0.10675350, 0.14689520,
0.10447090, 0.19264200, 0.11169570, 0.25101950, 0.24382670, 0.25675530, 0.23134120,
0.19872520, 0.15405980, 0.26169180, 0.12361070, 0.11594210, 0.13849870, 0.12892750,
0.15996210, 0.18149290, 0.10359830, 0.20306880, 0.22509590, 0.22510400, 0.22840200,
0.24895140, 0.19837270, 0.25859040, 0.18603360, 0.13769650, 0.13587430, 0.13107450,
0.12671680, 0.17744900, 0.10807120, 0.15458710, 0.22524160, 0.22834810, 0.26317470,
0.25623170, 0.14897020, 0.25305620, 0.19255750, 0.13608600, 0.13614730, 0.11293430,
0.13007420, 0.16590880, 0.10560190, 0.19604770, 0.22842020, 0.22890840, 0.19967150,
0.17581550, 0.21840620, 0.26584180, 0.18360270, 0.13641250, 0.15187060, 0.17108980};
```

```
(* Find the mean, median, q1, q3, and variance *)
(* functions were defined above for the hospital data *)
dripMean = mean[Drp]
```

0.182304

```
dripMedian = median[Drp]
```

0.181493

```
dripQ1 = quantile[Drp, .25]
```

0.136332

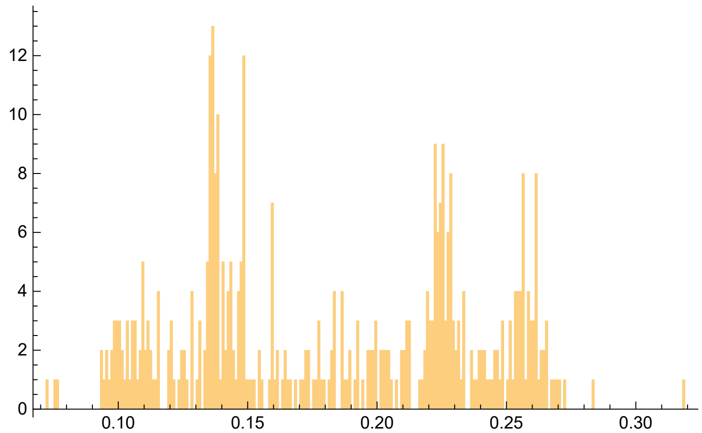
```
dripQ3 = quantile[Drp, .75]
```

0.227645

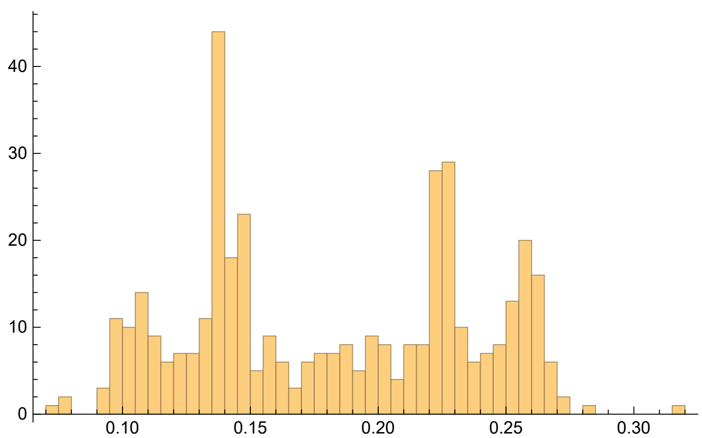
```
dripVariance = variance[Drp]
```

0.00291283

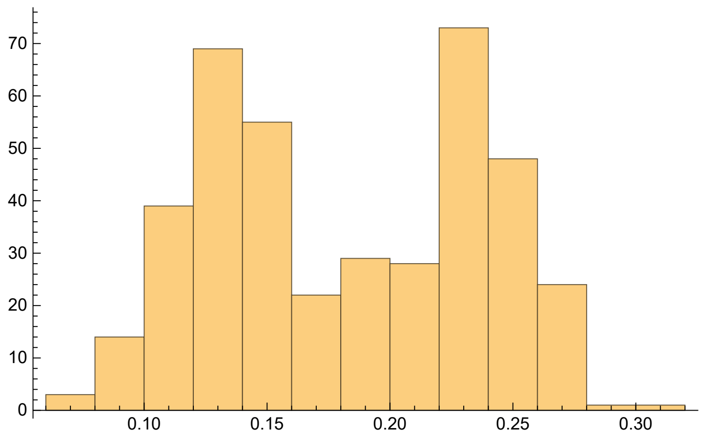
```
(* Histograms using two different bin sizes *)
(* I will use a bin size of Length/2 for a very large bin count,
and Length/10 for a smaller bin count *)

(* Large bin count *)
Histogram[Drp, IntegerPart[Length[Drp] / 2]]
```



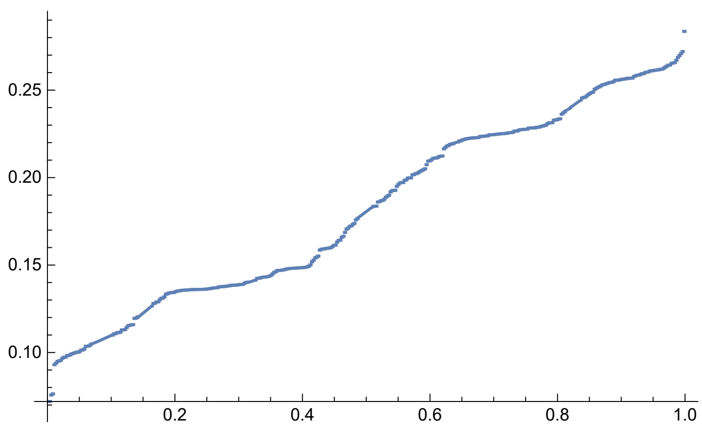

```
(* Small bin count *)
Histogram[Drp, IntegerPart[Length[Drp] / 10]]
```



```
(* As there is 200 data elements,
Igit  will use Length/30 for an even smaller bin count,
as it is appropriate for this data size, unlike the other data set sizes *)

Histogram[Drp, IntegerPart[Length[Drp] / 30]]
```

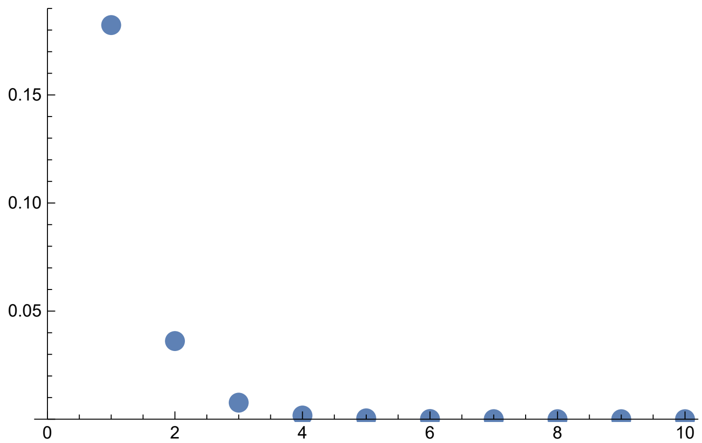



```
(* Product plots of quantile functions, moment functions, and CDFS *)
(* functions were defined above for the hospital data *)

(*Plot the quantile functions *)
Plot[quantile[Drp, i], {i, 0, 1}]
```

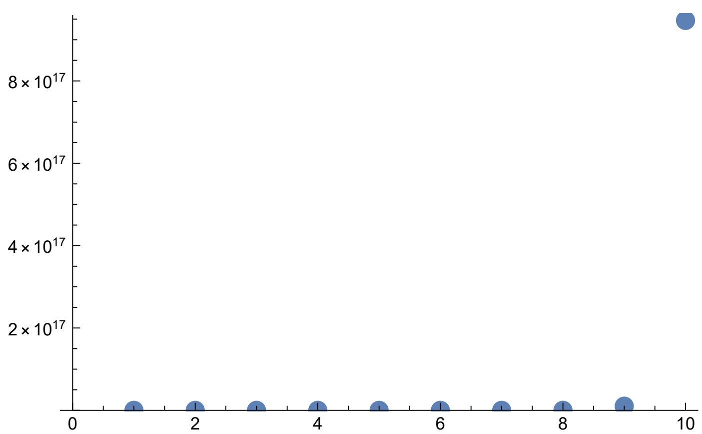



```
(* Plot the moment functions *)
(* Get the first 10 moments for the resistor data in a table *)
momDripData = Table[moment[Drp, i], {i, 1, 10}];
```

```
(* Note that since the drip data's elements are all less than 1, raising these values
  to a power 1-10 be decreasing this value,
as opposed to the other data sets where raising their
  values to a power 1-10 will increase the value *)
ListPlot[momDripData, PlotStyle → PointSize[.03], PlotRange → {0, .19}]
```

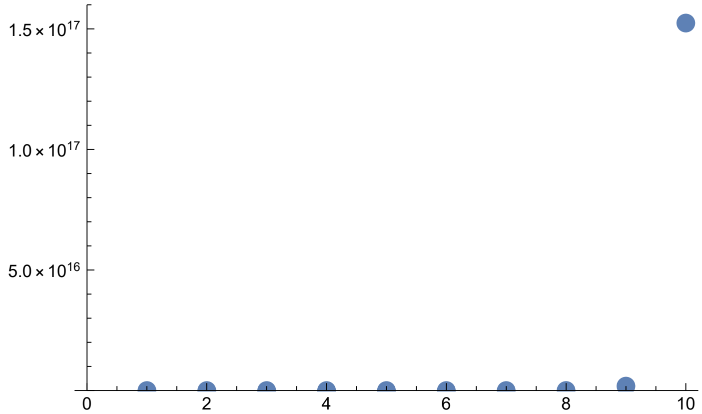



```
(* In comparison, here is what the MData and VData moments looked like *)
(* MData moment *)
ListPlot[momMData, PlotStyle → PointSize[.03], PlotRange → {0, 9.6 * 10^17}]
```

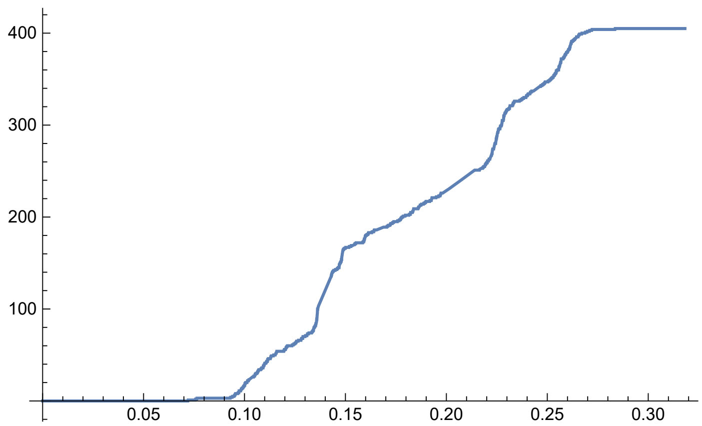



```
(* VData moment *)
```

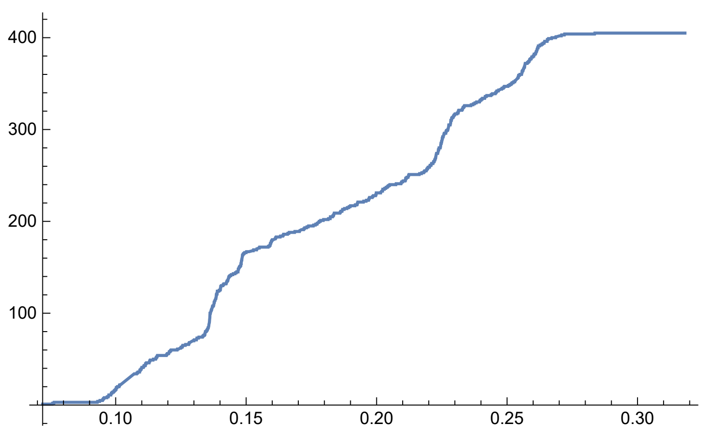
```
ListPlot[momVData, PlotStyle → PointSize[.03], PlotRange → {0, 1.6 * 10^17}]
```



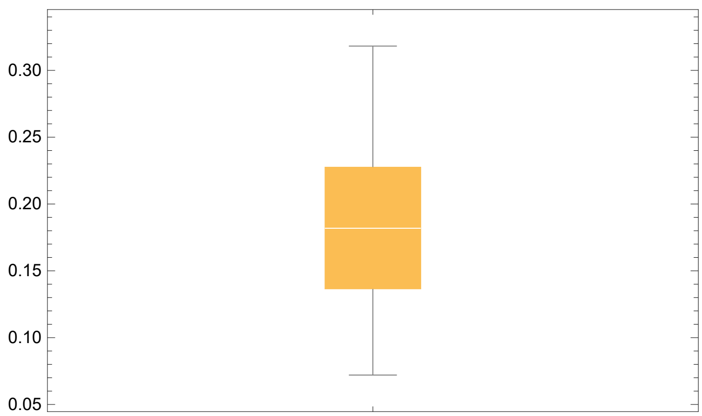

```
(* Plot the CDF functions *)
(* CDf for range 0 to the maximum element in the data set *)
Plot[cdf[Drp, i], {i, 0, Max[Drp]}]
```



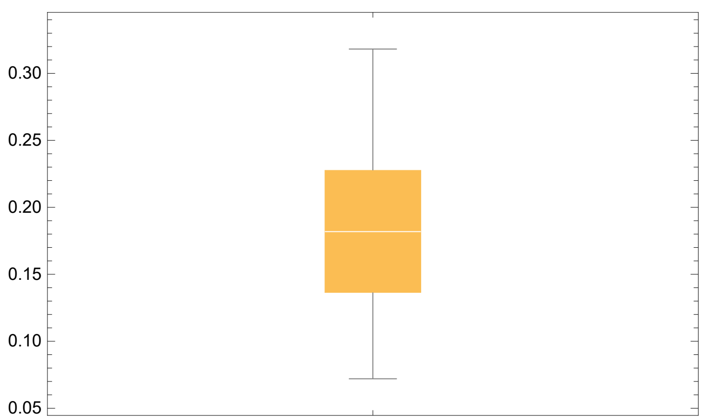

```
(* CDf for range minimum element to maximum element in the data set *)
Plot[cdf[Drp, i], {i, Min[Drp], Max[Drp]}]
```



```
(* Box and Whisker plots *)
(* A box and whisker plot takes a min, q1, q2 (median), q3, and max *)

(* Box and whisker, drip, data, outliers not shown *)
BoxWhiskerChart[Drp]
```

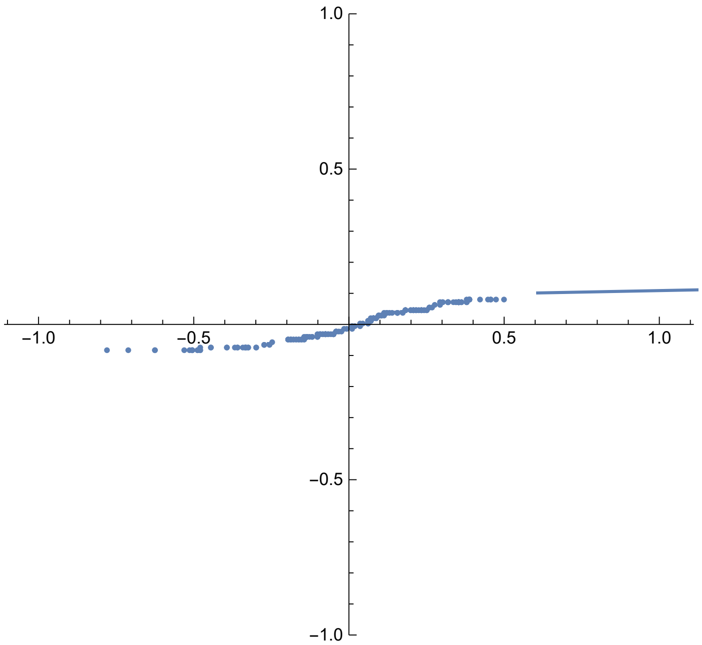



```
(* Box and whisker, drip, data, outliers shown *)
BoxWhiskerChart[Drp, "Outliers"]
```




```
(* QQ plot compairson for drip and resistor data *)
(* Data must be centered (subtract the means) for both data sets *)

(* "Centering simply means subtracting a constant from every value of a variable.
  What it does is redefine the 0 point for that predictor to be whatever
  value you subtracted.  It shifts the scale over, but retains the units." *)

(* Centering function *)
(* Subtract the mean off of every value in the data set *)
Centering[x_, meanValue_] :=
  (s = x;  For[i = 1, i <= Length[s], i++, s[[i]] = s[[i]] - meanValue]; Return[s]);

(* Center the drip and resistor data *)
DripCentered = Centering[Drp, dripMean];

ResistorCentered = Centering[resistors, resistorMean];
```

```
(* Parametric Plots (QQ Plots), resistor data on x axis, drip data on y axis *)
ParametricPlot[{quantile[ResistorCentered, i], quantile[DripCentered, i]},
 {i, 0, 1}, PlotRange → {-1, 1}]
```




```
(* If the two sets come from a population with the same distribution,
the points should fall approximately
 along a 45 degree reference line. As we can see,
the 2 batches do not appear to have come from populations with
 a common distribution, as they do not fit along a straight line. *)
(* The QQ plot looks logarithmic,
meaning that it dos not look like a straight line. This suggests that the two
 data sets came from populations with different distributions. *)
```

In[10]:=

```
(* Problem 2 *)
(* Calculate the correlation coefficient between the volume V and mortality M
 of the heart transplants based on the data in hospheart.nb *)

(* hospheart.np data *)
(* {M,V} M = one year mortality rate,
percentage of patients that died within one year of the
 transplant operation,
V = average annual number of transplants at that center during the same 4 years *)
heart = {{17.9, 27}, {23.1, 4}, {40, 3}, {6.5, 35}, {14.9, 17}, {12.5, 4}, {15.7, 45},
   {9.8, 28}, {24, 6}, {5.0, 10}, {15.4, 13}, {4.8, 7}, {0, 1}, {19.1, 47}, {4.5, 6},
   {15, 56}, {12.5, 4}, {33.9, 8}, {10.7, 9}, {13, 14}, {28.3, 12}, {57.1, 2}, {6.3, 4},
   {10, 3}, {8.3, 12}, {17.5, 10}, {20, 3}, {29.3, 10}, {21.4, 7}, {27.3, 8}, {13.6, 6},
   {21.8, 30}, {36.4, 3}, {18.2, 11}, {33.3, 2}, {20, 4}, {38.5, 7}, {20.8, 18}, {12.2, 19},
   {22.2, 18}, {29, 8}, {0, 9}, {5.7, 9}, {50, 2}, {21.7, 15}, {66.7, 4}, {29.4, 17},
   {12.1, 27}, {10.7, 14}, {6.3, 4}, {16.2, 9}, {21.1, 5}, {17.4, 33}, {23.9, 17},
   {42.9, 2}, {40, 2}, {6.7, 15}, {44.4, 3}, {18.7, 34}, {14.7, 24}, {7.4, 7}, {12.6, 24},
   {9.7, 26}, {44.4, 2}, {16.7, 6}, {15.8, 14}, {83.3, 2}, {10.9, 22}, {13.3, 5},
   {11.1, 5}, {75, 2}, {19, 20}, {14, 13}, {60, 1}, {21.2, 8}, {9.7, 8}, {50, 2}, {25, 14},
   {18.6, 15}, {0.0, 1}, {35.3, 9}, {23.5, 85}, {15.6, 11}, {37.5, 2}, {14.3, 28},
   {14.3, 4}, {16.7, 6}, {20.0, 15}, {13.0, 17}, {9.6, 26}, {66.7, 3}, {30.8, 3},
   {14.0, 13}, {27.5, 10}, {37.5, 8}, {18.9, 13}, {0.0, 4}, {12.2, 44}, {57.1, 4},
   {21.4, 35}, {23.4, 16}, {10.9, 12}, {15.6, 8}, {16.7, 2}, {13.9, 9}, {18.2, 11},
   {11.5, 26}, {18.4, 13}, {16.7, 3}, {20.4, 14}, {40.0, 5}, {20.7, 56}, {19.6, 13},
   {13.5, 9}, {29.9, 36}, {8.4, 21}, {28.4, 24}, {7.7, 23}, {19.3, 29}, {0.0, 1},
   {22.2, 20}, {30.0, 5}, {7.0, 11}, {23.8, 7}, {18.8, 29}, {14.5, 16}, {17.0, 16},
   {20.0, 15}, {6.7, 15}, {11.4, 20}, {100.0, 1}, {31.4, 9}, {17.6, 26}, {19.6, 14}};

(* Split this M and V data into separate
 lists via Transpose[] in order to parse through *)
heartTranspose = Transpose[heart];
MData = heartTranspose[[1]];
VData = heartTranspose[[2]];

(* To calculate the correlation coefficient,
we need to define functions to find the means of a data set *)
mean[x_] := Sum[x[[i]], {i, 1, Length[x]}] / Length[x];
(* Sum elements, divide by length *)

meanM  = mean[MData]
```

Out[15]= 21.9045

In[16]:=
```
meanV = N[mean[VData]]
```

Out[16]= 13.8657

```
In[17]:= (* Create a function to sum (m-meanM)*(v-meanV),
         where m and v are elemnts of M and V respectively. *)
         differenceMeanSum[m_, mBAR_, v_, vBAR_] :=
          Sum[ ((m[[i]] - mBAR) * (v[[i]] - vBAR)), {i, 1, Length[m]}]
         (* Sum the product of (elementInM - meanOfM)(elementInV - meanOfV) *)

In[18]:= (* find the sum of the mean difference as noted above,
         this is the numerator of our correlation coefficient equation *)

In[19]:= MVdifferenceMeanSum = differenceMeanSum[MData, meanM, VData, meanV]

Out[19]= -7238.42

In[20]:= (* The denominator of the correlation coefficient equation is
          the square root of: sum of (x-xBAR)^2 times sum of (y-yBAR)^2 *)
         (* Create a function to Sum a data sets elemnts, by taking an element,
         subtracting the mean from it, and squating the value *)

In[21]:= squaredSum[a_, aMean_] := Sum[(a[[i]] - aMean)^2, {i, 1, Length[a]}];

In[22]:= (* Now find the the squared difference sum for the M and V data *)
         squareDifferenceM = squaredSum[MData, meanM]

Out[22]= 35 996.9

In[23]:= squareDifferenceV = squaredSum[VData, meanV]

Out[23]= 22 305.6

In[24]:= (* Take the root of the product of these sums,
         and that is the denominator of the correlation coefficient equation *)
         rootOfSums = Sqrt[squareDifferenceM * squareDifferenceV]

Out[24]= 28 336.1

In[25]:= (* Now take the numerator and denominator,
         find the decimal of that fraction and we have the correlation coefficient *)
         coefficient = MVdifferenceMeanSum / rootOfSums

Out[25]= -0.255449
```

In[26]:=
```
(* This is negative, so as x increases,
y decreases. As is is close to zero, it is not a strong correlation *)

(* Now, we need to make a scatter plot of this data *)

(* We also need the line of best fit,
which will be calculated manually. Assuming the V data is y axis, M data is x axis*)
(* The numerator for the slope of our
 best fit line is the variable MVdifferenceMeanSum *)
(* The denominator for the slope of our best fit line is the sum of x -
 xMean squared *)

(* This denominator is as follows *)
denom = Sum[(MData[[i]] - meanM)^2, {i, 1, Length[MData]}];
slope = MVdifferenceMeanSum / denom
```

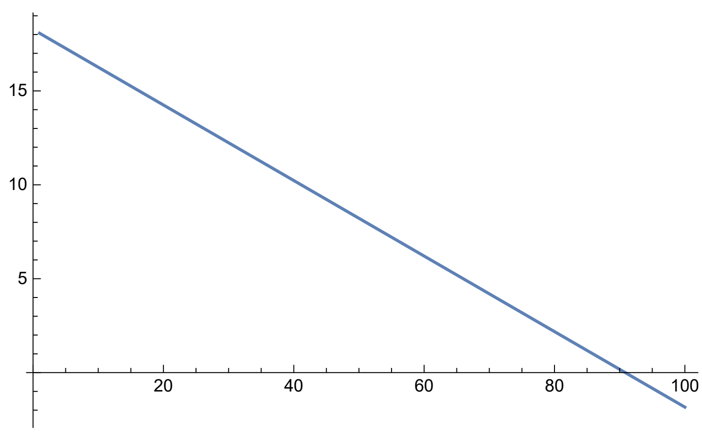
Out[27]= -0.201084

In[28]:=
```
(* The b value is calculated as the y mean, minus slope * x mean *)
b = meanV - slope * meanM
```

Out[28]= 18.2703

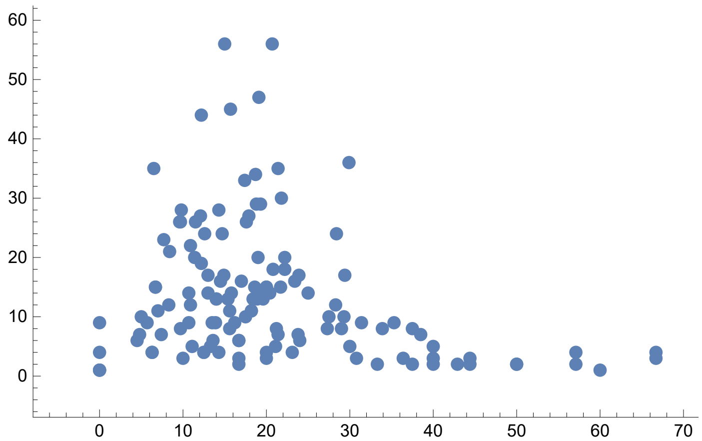
In[29]:=
```
(* The best fit equation is as follows *)
bestFit[x_] := slope * x + b;
```

In[30]:=
```
(* Now, superimpose this regression line on the scatter plot *)
bestFitGraph = Plot[bestFit[x], {x, 1, 100}]
```

Out[30]=


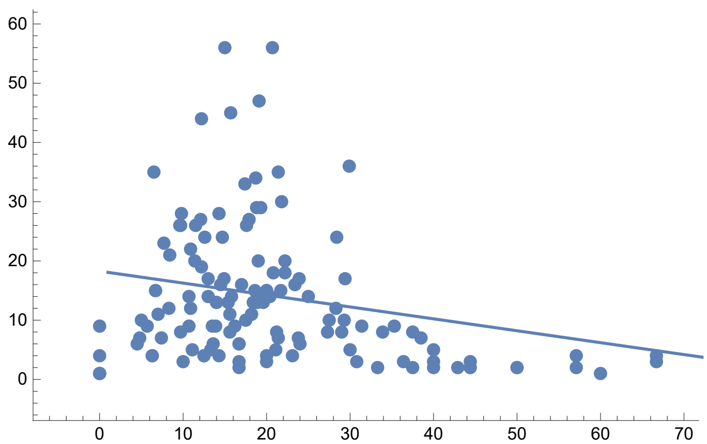
In[31]:=
```
scatterPlot = ListPlot[heart, PlotStyle → PointSize[.02],
  PlotRangePadding → Scaled[0.1], Axes → False, Frame → {True, True, False, False}]
(* Extra paramets on this scatter plot to best show the data *)
```

Out[31]=



In[32]:=
```
superimpose = Show[scatterPlot, bestFitGraph]
```

Out[32]=



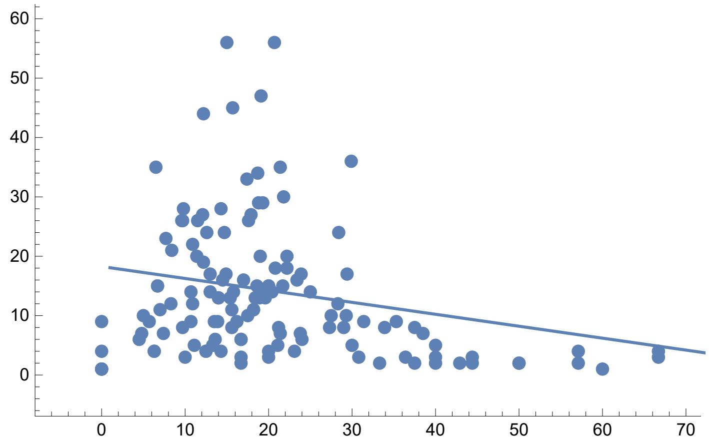
In[33]:=
```
(* To double check my calculations are correct,
I will let Mathematica generate a scatter plot and best fit line *)
```

In[34]:=
```
Fit[heart, {1, x}, {x}]
```

Out[34]= $18.2703 - 0.201084\, x$

In[35]:=
```
bestLine[x_] := 18.270320917115342` - 0.20108442453442926` x;
Show[ListPlot[heart, PlotStyle → PointSize[.02], PlotRangePadding → Scaled[0.1],
  Axes → False, Frame → {True, True, False, False}], Plot[bestLine[x], {x, 1, 100}]]
```

Out[36]=



In[37]:=
```
(* Conclusions *)
(* This is negative, so as x increases,
y decreases. As is is close to zero, it is not a strong correlation *)
(* The one year mortality rate,
and average annual number of transplants at that center during the same 4 years, are
 not correlated strongly. The correlation is very weak *)
```