ChickenRanging NB3

Statistical analysis. Summary statistics of space use. Inspection of weather data. Calculation of sample entropy, coordination (gap times) and leader-follower index.
Creation of the file “rangingdata”

Version: 6.0.
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Created in: *Mathematica* 10.2
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Initialization

```
SetDirectory["L://Chicken Research/ChickenRanging4"]
```

```
L:\Chicken Research\ChickenRanging4
```

```
data = Get["transitiondata"];
```

```
allhens = Get["allhens"];
```

```
columns = {"tag", "hen", "ranger", "pen", "date", "absolut time", "from", "to",
  "time", "WG open", "LH open", "FR open", "WG closed", "LH closed", "FR closed"}
```

```
{tag, hen, ranger, pen, date, absolut time, from, to,
 time, WG open, LH open, FR open, WG closed, LH closed, FR closed}
```

```
tags = allhens[[All, 3]];
```

```
datelist = Union[data[[All, 5]]];
```

```
datelist = datelist[[Ordering[Table[AbsoluteTime[{datelist[[i]],
       {"DayName", " ", "Day", "/", "Month", "/", "Year"}}], {i, Length[datelist]}]]]];
```

```
allhentimestats = Get["allhentimestats"];
```

```
hentimeslist = Get["hentimeslist"];
```

Summary Statistics

```
Length[allhens]
```

```
421
```

We have records from 421 hens

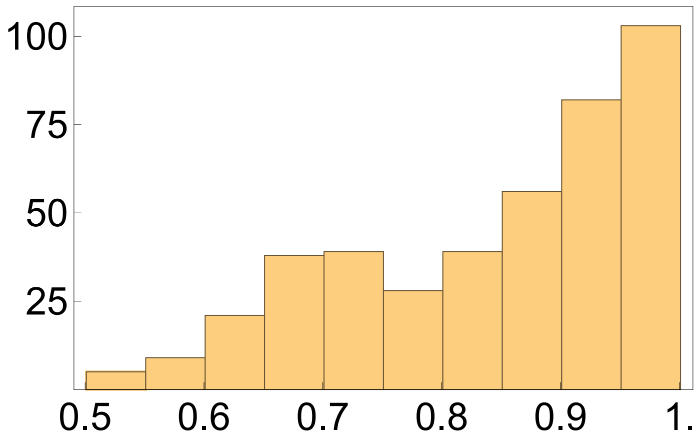
```
Length[datelist]
```

```
72
```

The number of days included in the analysis

```
coverageperbird =
  Table[Mean[Cases[allhentimestats, {tags[[i]], __}][[All, 11]]], {i, Length[tags]}];
```

```
Histogram[coverageperbird, {0.501, 1.001, 0.05},
 Frame → True, FrameStyle → Directive[Black, 20],
 FrameTicks → {{{25, 50, 75, 100}, None}, {Table[i, {i, 0.5, 1, 0.1}], None}}]
```



Histogram of coverage per bird

```
Mean[coverageperbird]
```

```
0.843461
```

Mean coverage over all birds

```
{Max[coverageperbird], Min[coverageperbird]}
```

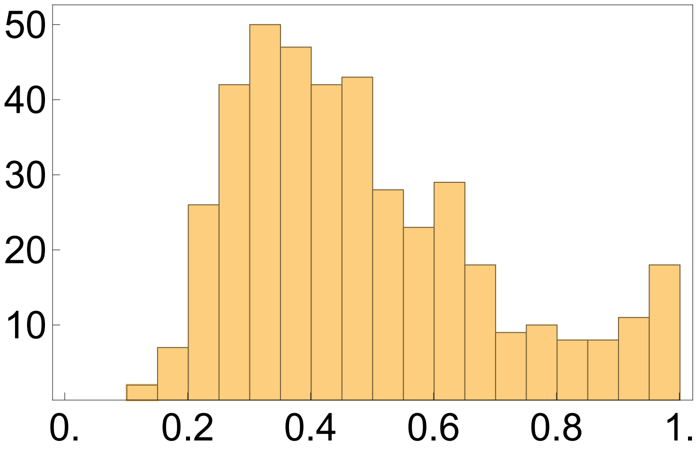
```
{1., 0.477195}
```

```
N[Count[allhentimestats[[All, 11]], 1.] / Length[allhentimestats]]
0.28009
```

This is the proportion of hen days for which we have 100% coverage of the hen for that day (i.e. we know for the total time from opening to closing of the WG where the animal was)

```
proportiontimeindoors = Table[Total[(Cases[allhentimestats, {tags[[i]], __}][[All, 13]])] /
    Total[Cases[allhentimestats, {tags[[i]], __}][[All, 10]]], {i, 1, Length[tags]}];
```

```
histinbarn = Histogram[proportiontimeindoors,
  {0.001, 1.001, 0.05}, Frame → True, FrameStyle → Directive[Black, 20],
  FrameTicks → {{{10, 20, 30, 40, 50}, None}, {Table[i, {i, 0., 1, 0.2}], None}}]
```



Proportion of time spent indoors per hen

```
Export["histinbarn.tiff", histinbarn];
```

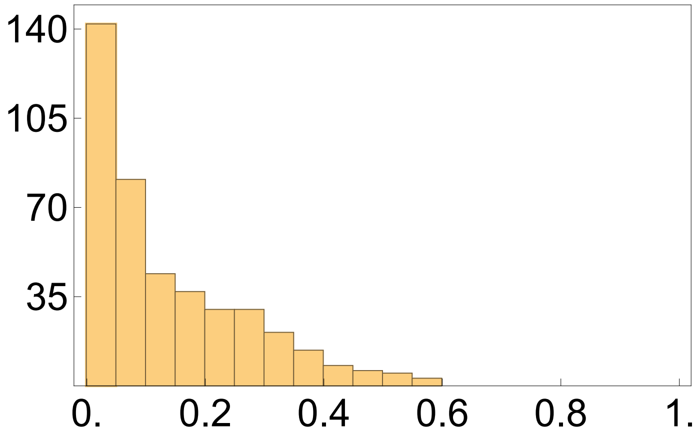
```
{Min[proportiontimeindoors], Max[proportiontimeindoors]}
```

```
{0.130654, 1.}
```

The min and max of the proportion of the time a hen spent in the barn.

```
proportionoutdoors = Table[(Total[(Cases[allhentimestats, {tags[[i]], __}][[All, 17]])] +
      Total[(Cases[allhentimestats, {tags[[i]], __}][[All, 19]])]) /
    (Total[(Cases[allhentimestats, {tags[[i]], __}][[All, 13]])] +
      Total[(Cases[allhentimestats, {tags[[i]], __}][[All, 13]])] +
      Total[(Cases[allhentimestats, {tags[[i]], __}][[All, 17]])] +
      Total[(Cases[allhentimestats, {tags[[i]], __}][[All, 19]])]), {i, 1, Length[tags]}];
```

```
Histogram[proportionoutdoors, {-0.001, 1.001, 0.05},
 Frame → True, FrameStyle → Directive[Black, 20],
 FrameTicks → {{{35, 70, 105, 140}, None}, {Table[i, {i, 0., 1, 0.2}], None}}]
```



Proportion of Time spent outdoors (in FR or LH)

```
{Min[proportionoutdoors], Max[proportionoutdoors]}
```

```
{0., 0.589872}
```

The min and max of the proportion of the time a hen spent outdoors (LH+FR).

Times

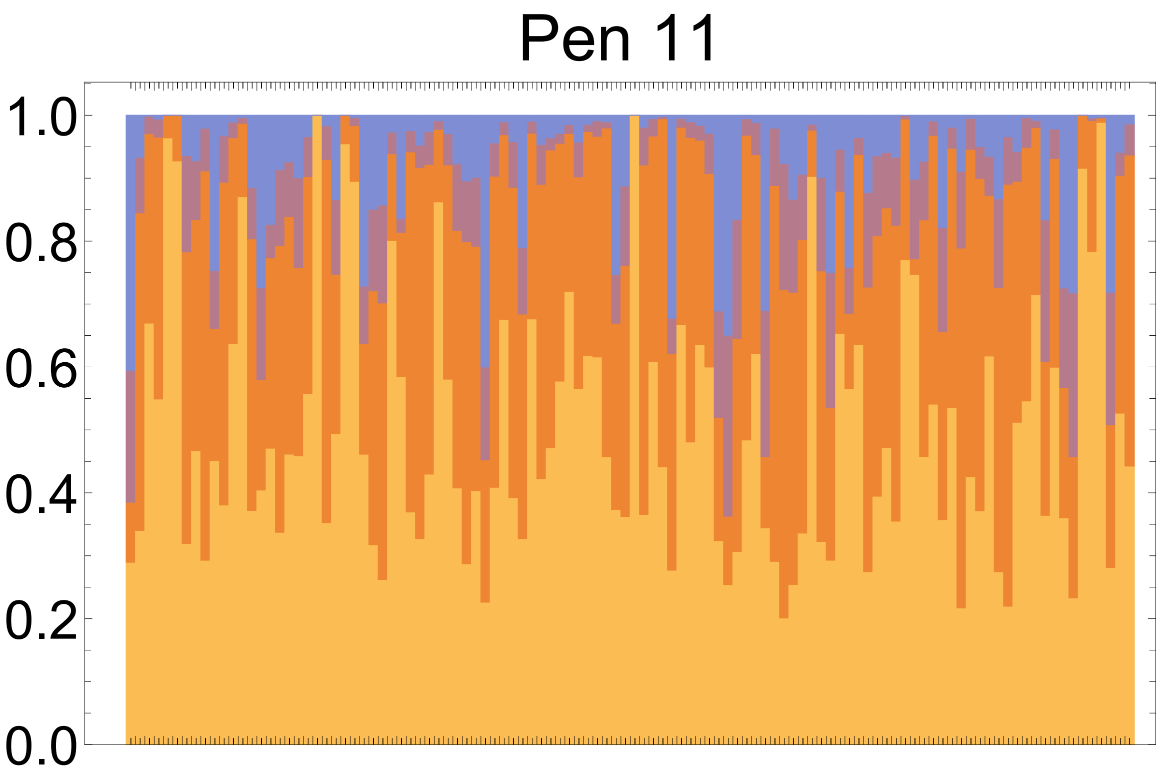
Here I create stacked bar charts for overall space use. Each hen is one bar, Yellow: IN, orange: WG, purple: LH, blue: FR.

```
hens11 = Cases[allhens, {_, "11", _}];
hens12 = Cases[allhens, {_, "12", _}];
hens13 = Cases[allhens, {_, "13", _}];
hens14 = Cases[allhens, {_, "14", _}];
```

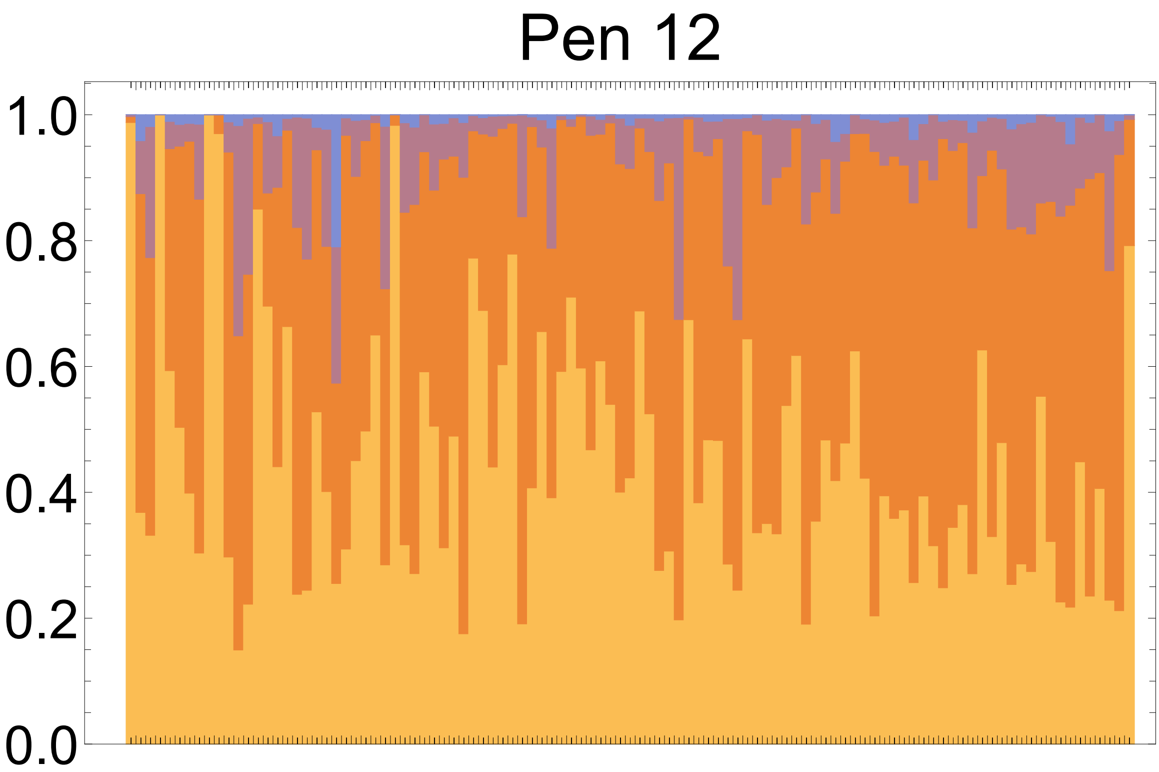
```
pen11times = Table[
   Table[Total[Cases[allhentimestats, {_, hens11[[i, 1]], __}][[All, c]]], {c, 13, 19, 2}] /
    Total[Cases[allhentimestats, {_, hens11[[i, 1]], __}][[All, 10]]], {i,
    Length[hens11]}];
pen12times = Table[Table[Total[Cases[allhentimestats, {_, hens12[[i, 1]], __}][[All, c]]],
     {c, 13, 19, 2}] / Total[
     Cases[allhentimestats, {_, hens12[[i, 1]], __}][[All, 10]]], {i, Length[hens12]}];
pen13times = Table[Table[Total[Cases[allhentimestats, {_, hens13[[i, 1]], __}][[All, c]]],
     {c, 13, 19, 2}] / Total[
     Cases[allhentimestats, {_, hens13[[i, 1]], __}][[All, 10]]], {i, Length[hens13]}];
pen14times = Table[Table[Total[Cases[allhentimestats, {_, hens14[[i, 1]], __}][[All, c]]],
     {c, 13, 19, 2}] / Total[
     Cases[allhentimestats, {_, hens14[[i, 1]], __}][[All, 10]]], {i, Length[hens14]}];
```

```
bc11 = BarChart[pen11times, ChartLayout → "Stacked", ChartLegends → None,
   Frame → True, PlotLabel → "Pen 11", LabelStyle → Directive[Black, 28],
   FrameStyle → Directive[Black, 28], ImageSize → 600];
bc12 = BarChart[pen12times, ChartLayout → "Stacked", ChartLegends → None,
   Frame → True, PlotLabel → "Pen 12", LabelStyle → Directive[Black, 28],
   FrameStyle → Directive[Black, 28], ImageSize → 600];
bc13 = BarChart[pen13times, ChartLayout → "Stacked", ChartLegends → None,
   Frame → True, PlotLabel → "Pen 13", LabelStyle → Directive[Black, 28],
   FrameStyle → Directive[Black, 28], ImageSize → 600];
bc14 = BarChart[pen14times, ChartLayout → "Stacked", ChartLegends → None,
   Frame → True, PlotLabel → "Pen 14", LabelStyle → Directive[Black, 28],
   FrameStyle → Directive[Black, 28], ImageSize → 600];
```

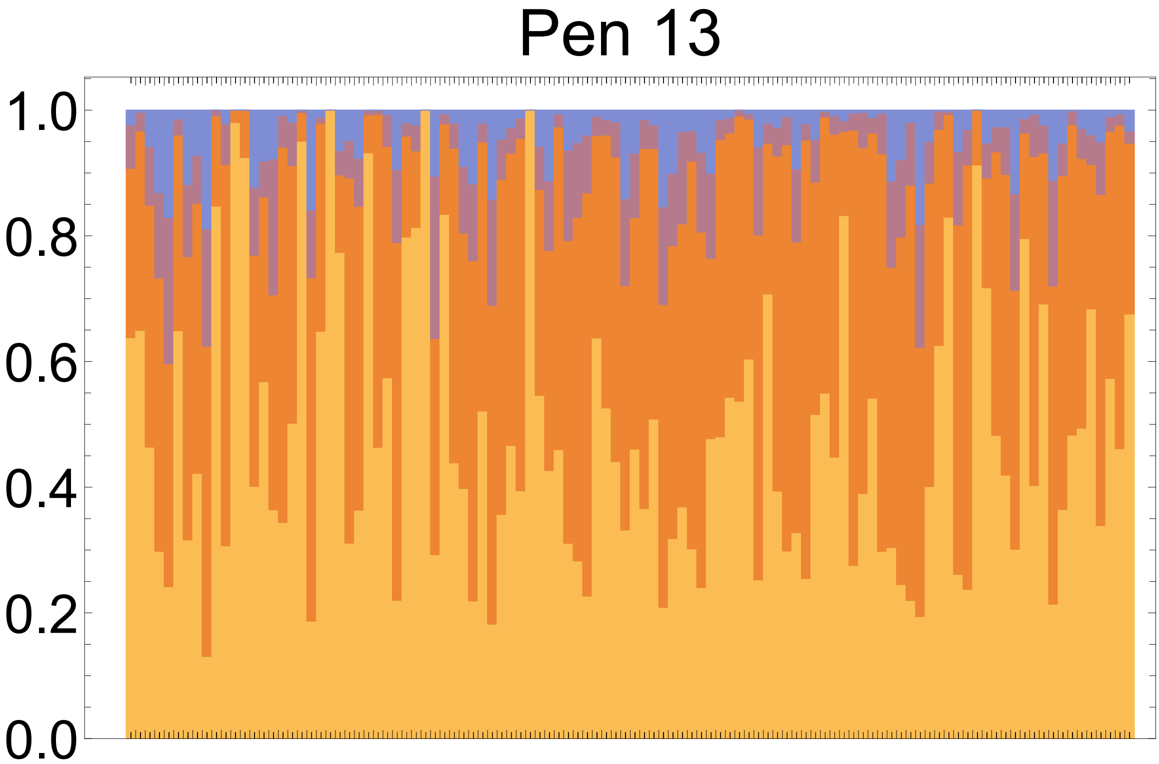
bc11



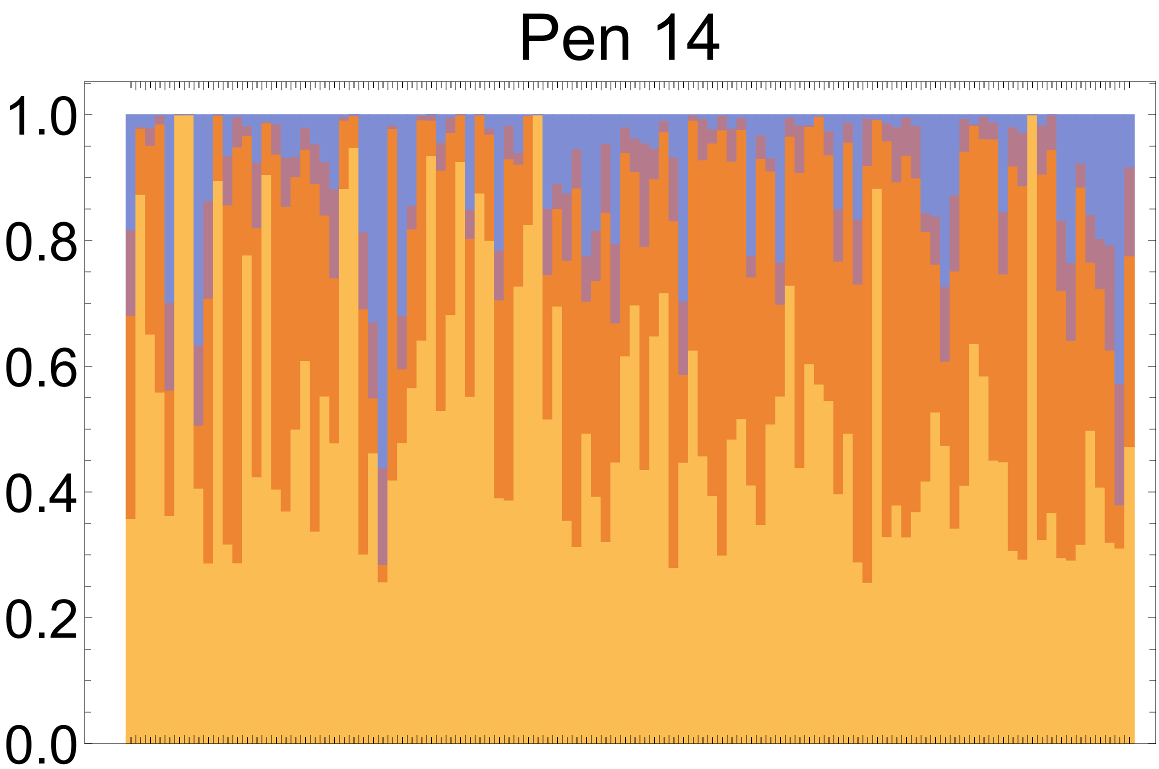
bc12



bc13



bc14



```
Export["bc11.tiff", bc11];
Export["bc12.tiff", bc12];
Export["bc13.tiff", bc13];
Export["bc14.tiff", bc14];
```

```
hensalltimes = Join[
   Transpose[Join[Transpose[hens11], Transpose[pen11times]]],
   Transpose[Join[Transpose[hens12], Transpose[pen12times]]],
   Transpose[Join[Transpose[hens13], Transpose[pen13times]]],
   Transpose[Join[Transpose[hens14], Transpose[pen14times]]]
  ];
```

```
Save["hensalltimes.csv", hensalltimes]
```

```
Export["hensalltimes.csv", hensalltimes]
```

```
hensalltimes.csv
```

```
{Count[hensalltimes[[All, 4]], 1.],
 100 N[Count[hensalltimes[[All, 4]], 1.] / Length[allhens]]}
```

```
{10, 2.3753}
```

The number of birds and percentage never leaving IN

```
{Count[hensalltimes[[All, 6]], 0.],
 100 N[Count[hensalltimes[[All, 6]], 0.] / Length[allhens]]}
```

```
{19, 4.51306}
```

The number of birds and percentage never entering LH

```
{Count[hensalltimes[[All, 7]], 0.],
 100 N[Count[hensalltimes[[All, 7]], 0.] / Length[allhens]]}
```

```
{33, 7.83848}
```

The number of birds and percentage never entering FR

```
100 Quartiles[Total /@ hensalltimes[[All, {6, 7}]]]
```

```
{3.41836, 8.66026, 19.6923}
```

This line gives the quartiles for percentages in LH + FR combined

Weather Data

```
maxtemperatures = Quiet[Table[Max[WeatherData["Bern", "Temperature",
      DateList[{datelist⟦i⟧, {"DayName", "Day", "Month", "Year"}}]⟦1 ;; 3⟧,
      "DateValue"]⟦2, 1, 1⟧], {i, Length[datelist]}]]
```

```
{22.2 °C, 27.2 °C, 20.6 °C, 26.2 °C, 29 °C, 30.5 °C, 32.2 °C, 28.5 °C,
 22.5 °C, 23.2 °C, 26.5 °C, 25.1 °C, 27.6 °C, 26.7 °C, 25.2 °C, 27.5 °C,
 28.5 °C, 22.6 °C, 26.5 °C, 17 °C, 19.2 °C, 22.7 °C, 26.6 °C, 28.5 °C,
 27 °C, 28 °C, 25 °C, 20.9 °C, 21.7 °C, 25.7 °C, 28.2 °C, 30.5 °C, 31.5 °C,
 30.5 °C, 29.6 °C, 23.2 °C, 27.2 °C, 26.2 °C, 26.5 °C, 26.2 °C, 24 °C,
 21.6 °C, 24 °C, 26.5 °C, 26.2 °C, 26.2 °C, 26.2 °C, 27.2 °C, 27 °C, 26.6 °C,
 Missing[NotAvailable]⟦2, 1, 1⟧, Missing[NotAvailable]⟦2, 1, 1⟧, 19.2 °C, 20.2 °C,
 21.7 °C, 19.7 °C, 20 °C, 21.1 °C, 23 °C, 22.9 °C, 18 °C, 15.2 °C, 15.2 °C,
 10.5 °C, 11.6 °C, 11.5 °C, 10.5 °C, 9.2 °C, 9.5 °C, 9.6 °C, 7 °C, 13.1 °C}
```

```
Quiet[{Max[DeleteCases[maxtemperatures, Missing["NotAvailable"]⟦2, 1, 1⟧]],
  Min[DeleteCases[maxtemperatures, Missing["NotAvailable"]⟦2, 1, 1⟧]]}]
```

```
{32.2 °C, 7 °C}
```

This is the range for the maximum temperature within this period

```
rain =
 Quiet[Total /@ Table[DeleteCases[WeatherData["Bern", "PrecipitationRate", DateList[
        {datelist⟦i⟧, {"DayName", "Day", "Month", "Year"}}]⟦1 ;; 3⟧, "DateValue"]⟦
      2, 1, 1⟧, Missing["NotAvailable"]], {i, Length[datelist]}]]
```

```
{0. cm/h, 1.08 cm/h, 0. cm/h, 0. cm/h, 0. cm/h, 0. cm/h, 0, 0.07 cm/h, 0.16 cm/h,
 0.06 cm/h, 0, 0, 0, 0, 0. cm/h, 0. cm/h, 0, 0. cm/h, 0, 0.01 cm/h, 0, 0. cm/h,
 0. cm/h, 0. cm/h, 0. cm/h, 0. cm/h, 1.25 cm/h, 0.27 cm/h, 0. cm/h, 0. cm/h,
 0, 0. cm/h, 0. cm/h, 0, 0, 0. cm/h, 0. cm/h, 0. cm/h, 0. cm/h, 0, 0.7 cm/h, 0,
 0. cm/h, 0. cm/h, 0. cm/h, 0. cm/h, 0. cm/h, 0, 0, 0. cm/h, 4, 4, 0, 0. cm/h,
 0. cm/h, 0. cm/h, 0. cm/h, 0. cm/h, 0. cm/h, 0. cm/h, 0.17 cm/h, 0, 0. cm/h,
 0, 0, 0. cm/h, 0. cm/h, 0. cm/h, 0. cm/h, 0. cm/h, 0.47 cm/h, 0. cm/h}
```

```
Length[datelist] - (Count[rain, 0] + Count[rain, 0.` cm/h])
```

```
12
```

This is the number of days it rained

```
minwindchill = Quiet[Table[Min[WeatherData["Bern", "WindChill",
       DateList[{datelist⟦i⟧, {"DayName", "Day", "Month", "Year"}}]⟦1 ;; 3⟧,
       "DateValue"]⟦2, 1, 1, 8 ;; 17⟧], {i, Length[datelist]}]];
```

```
minwindchill = ReplacePart[minwindchill,
   53 -> Min[WeatherData["Bern", "WindChill", DateList[{datelist⟦53⟧,
          {"DayName", "Day", "Month", "Year"}}]⟦1 ;; 3⟧, "DateValue"]⟦2, 1, 1, 4 ;; 9⟧]];
```

```
minwindchill = Quiet[minwindchill //. Missing["NotAvailable"][[2, 1, 1, 8 ;; 17]] → "NA"]
```

{19.3 °C, 21.91 °C, 11.73 °C, 15.21 °C, 21.14 °C, 21.67 °C, 23.14 °C, 22.73 °C, 19.2 °C, 19.67 °C, 19.41 °C, 21.48 °C, 22.33 °C, 20.14 °C, 18.56 °C, 20.53 °C, 21.72 °C, 18.27 °C, 18.71 °C, 13.48 °C, 12.79 °C, 14.5 °C, 17.4 °C, 20.34 °C, 20.82 °C, 20.88 °C, 15.1 °C, 17.65 °C, 14.25 °C, 15.74 °C, 19.15 °C, 21.94 °C, 23.3 °C, 21.21 °C, 22.42 °C, 17.3 °C, 18.54 °C, 18.77 °C, 17.97 °C, 16.3 °C, 15.51 °C, 11.62 °C, 14.39 °C, 16.75 °C, 19.03 °C, 17.34 °C, 17.87 °C, 17.51 °C, 19.14 °C, 19.21 °C, NA, NA, 12.99 °C, 10.58 °C, 12.03 °C, 12.07 °C, 15.19 °C, 10.77 °C, 12.58 °C, 15.13 °C, 12.69 °C, 12.05 °C, 6.65 °C, 5.03 °C, 1.02 °C, 7.66 °C, 6.61 °C, 0.55 °C, 3.14 °C, 2.22 °C, -0.05 °C, 5.93 °C}

```
{Max[DeleteCases[minwindchill, "NA"]], Min[DeleteCases[minwindchill, "NA"]]}
```

{23.3 °C, -0.05 °C}

This is the lowest windchill factor for each day for the time between 8:00 and 17:00

```
weatherdata = {maxtemperatures, rain, minwindchill};
Save["weatherdata", weatherdata]
```

Weather and time outside

```
henhoursout =
 Table[Total[DeleteCases[Flatten[Cases[allhentimestats, {_, _, _, _, datelist[[i]], __}][[
      All, {17, 19}]]], Null]], {i, Length[datelist]}] / 3600
```

{311.693, 223.966, 352.866, 259.799, 165.107, 117.81, 74.0558, 156.657, 544.051, 368.477, 320.217, 195.838, 110.791, 205.367, 141.651, 213.607, 155.081, 304.56, 189.549, 423.956, 284.899, 321.611, 223.475, 192.929, 240.399, 189.182, 229.803, 452.939, 290.539, 218.7, 201.25, 151.732, 151.712, 173.536, 182.665, 319.811, 236.19, 272.392, 221.308, 237.429, 359.962, 327.914, 286.992, 303.447, 283.079, 283.507, 266.671, 268.084, 143.969, 224.198, 443.845, 442.059, 383.092, 342.381, 359.145, 408.126, 236.794, 414.431, 361.126, 355.354, 562.795, 442.991, 363.253, 478.581, 313.343, 522.562, 615.174, 234.247, 445.061, 343.966, 464.536, 383.194}

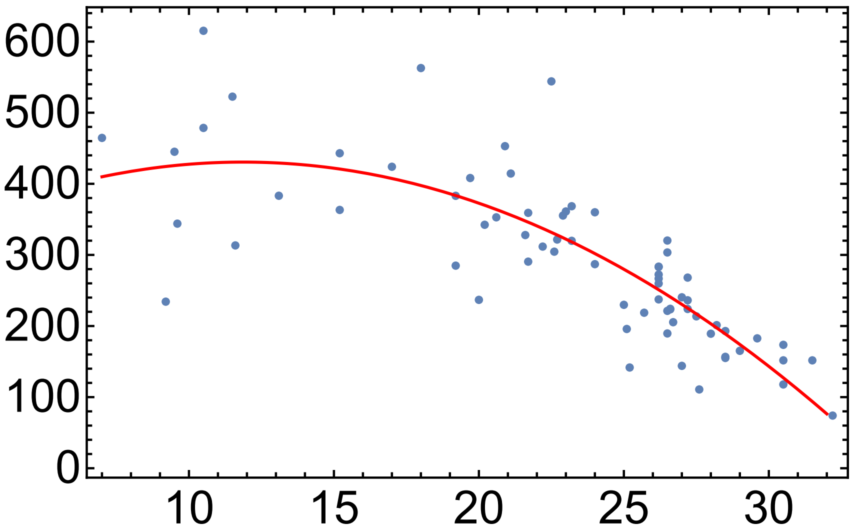
```
maxtemptime = Delete[Transpose[{maxtemperatures, henhoursout}], {{51}, {52}}]
```

{{22.2 °C, 311.693}, {27.2 °C, 223.966}, {20.6 °C, 352.866},
{26.2 °C, 259.799}, {29 °C, 165.107}, {30.5 °C, 117.81}, {32.2 °C, 74.0558},
{28.5 °C, 156.657}, {22.5 °C, 544.051}, {23.2 °C, 368.477},
{26.5 °C, 320.217}, {25.1 °C, 195.838}, {27.6 °C, 110.791}, {26.7 °C, 205.367},
{25.2 °C, 141.651}, {27.5 °C, 213.607}, {28.5 °C, 155.081}, {22.6 °C, 304.56},
{26.5 °C, 189.549}, {17 °C, 423.956}, {19.2 °C, 284.899}, {22.7 °C, 321.611},
{26.6 °C, 223.475}, {28.5 °C, 192.929}, {27 °C, 240.399}, {28 °C, 189.182},
{25 °C, 229.803}, {20.9 °C, 452.939}, {21.7 °C, 290.539}, {25.7 °C, 218.7},
{28.2 °C, 201.25}, {30.5 °C, 151.732}, {31.5 °C, 151.712}, {30.5 °C, 173.536},
{29.6 °C, 182.665}, {23.2 °C, 319.811}, {27.2 °C, 236.19}, {26.2 °C, 272.392},
{26.5 °C, 221.308}, {26.2 °C, 237.429}, {24 °C, 359.962}, {21.6 °C, 327.914},
{24 °C, 286.992}, {26.5 °C, 303.447}, {26.2 °C, 283.079}, {26.2 °C, 283.507},
{26.2 °C, 266.671}, {27.2 °C, 268.084}, {27 °C, 143.969}, {26.6 °C, 224.198},
{19.2 °C, 383.092}, {20.2 °C, 342.381}, {21.7 °C, 359.145}, {19.7 °C, 408.126},
{20 °C, 236.794}, {21.1 °C, 414.431}, {23 °C, 361.126}, {22.9 °C, 355.354},
{18 °C, 562.795}, {15.2 °C, 442.991}, {15.2 °C, 363.253}, {10.5 °C, 478.581},
{11.6 °C, 313.343}, {11.5 °C, 522.562}, {10.5 °C, 615.174}, {9.2 °C, 234.247},
{9.5 °C, 445.061}, {9.6 °C, 343.966}, {7 °C, 464.536}, {13.1 °C, 383.194}}

```
lmq = LinearModelFit[QuantityMagnitude[maxtemptime], {x, x^2}, x]
```

FittedModel[$307.585 + 20.725\,x - 0.873388\,x^2$]

```
weatherfig1 = Show[ListPlot[maxtemptime, Frame → True, PlotRange → All,
   FrameStyle → Thickness[0.003], FrameTicksStyle → Directive[24, Black]],
  Plot[lmq[x], {x, 7, 32}, PlotStyle → Red], ImageSize → 800]
```




```
Export["weatherfig1.tif", weatherfig1]
```

weatherfig1.tif

Impact of Max Temperature on Henhours outside

```
lmq["RSquared"]
```

```
0.655561
```

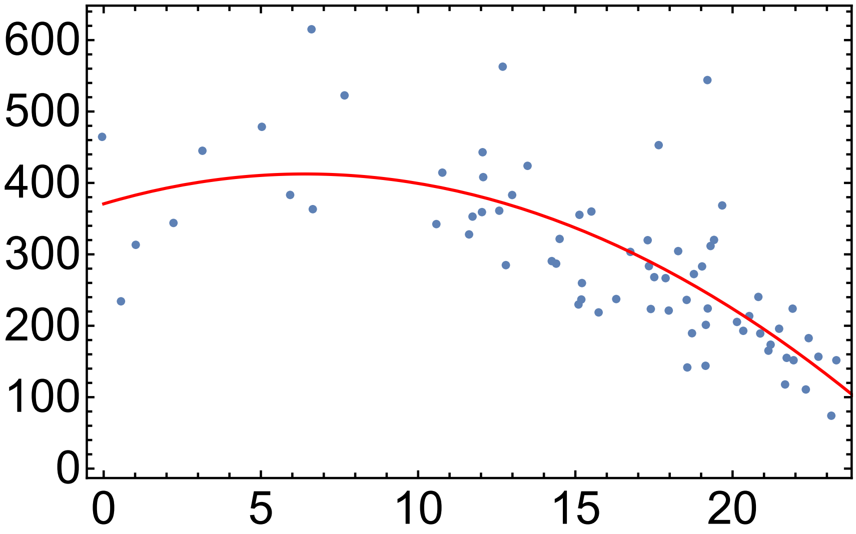
This is R-squared for a quadratic polynomial fit

```
matchill = QuantityMagnitude /@ minchilltime;
```

```
lmc = LinearModelFit[matchill, {x, x^2}, x]
```

FittedModel[$370.734 + 13.0623\,x - 1.02021\,x^2$]

```
weatherfig2 = Show[ListPlot[minchilltime, Frame → True, PlotRange → All,
   FrameStyle → Thickness[0.003], FrameTicksStyle → Directive[24, Black]],
  Plot[lmc[x], {x, 0, 25}, PlotStyle → Red], ImageSize → 800]
```




```
Export["weatherfig2.tif", weatherfig2]
```

```
weatherfig2.tif
```

Impact of Min Windchill on Henhours outside

```
lmc["RSquared"]
```

```
0.540874
```

This is R-squared for a quadratic polynomial fit

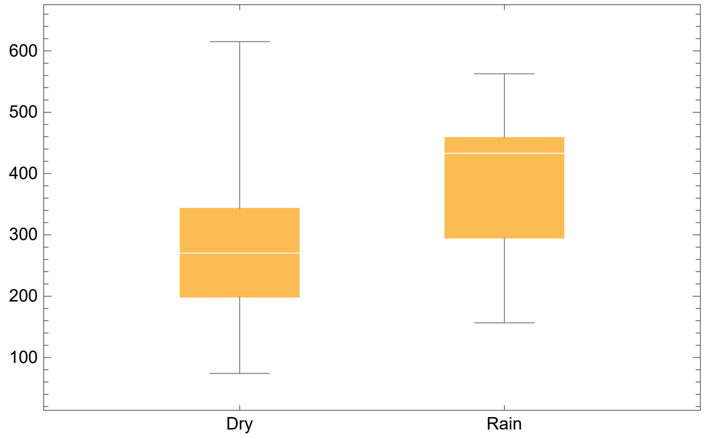
```
drydays = Flatten[Join[Position[rain, 0.` cm/h], Position[rain, 0]]]
```

```
{1, 3, 4, 5, 6, 15, 16, 18, 22, 23, 24, 25, 26, 29, 30, 32, 33, 36, 37, 38,
 39, 43, 44, 45, 46, 47, 50, 54, 55, 56, 57, 58, 59, 60, 63, 66, 67, 68, 69, 70,
 72, 7, 11, 12, 13, 14, 17, 19, 21, 31, 34, 35, 40, 42, 48, 49, 53, 62, 64, 65}
```

```
raindays = Complement[Range[72], drydays]
```

```
{2, 8, 9, 10, 20, 27, 28, 41, 51, 52, 61, 71}
```

```
BoxWhiskerChart[{henhoursout[[drydays]], henhoursout[[raindays]]},
 ChartLabels → {"Dry", "Rain"}]
```



This shows the dayly henhours outside on rainy days (12) and dry days (50).

```
TTest[{henhoursout[[drydays]], henhoursout[[raindays]]}]
```

```
0.00175845
```

Sample Entropy

```
translate[timeseries_] :=
 Drop[timeseries, 1] //. {"IN" → 0, "WG" → 1, "LH" → 2, "FR" → 3}
```

```
sampleEntropy[tsraw_, tau_] :=
 Module[{edim = 4, r = 0.2 * StandardDeviation[tsraw], correl,
   count, d, n, s, ts, datamat, tempmat, x, dst},
  If[tau > 1, s = Table[i, {i, 1, Length[tsraw], tau}];
   ts = tsraw[[s]], ts = tsraw];
  n = Length[ts];
  correl = {};
  datamat = Table[ts[[i ;; n - (edim + 1) + i]], {i, 1, edim + 1}];
  For[m = edim, m ≤ (edim + 1), m++,
    count = {};
    tempmat = datamat[[1 ;; m, All]];
    For[i = 1, i ≤ (n - m - 1), i++,
      x = Abs[tempmat[[All, (i + 1) ;; (n - edim)]] -
      Transpose[Table[tempmat[[All, i]], {n - edim - i}]]];
      dst = Map[Max, Transpose[x]];
      d = Map[Function[# < r], dst];
      AppendTo[count, Count[d, True] / (n - edim)]
    ];
    AppendTo[correl, Total[count] / (n - edim)]
  ];
  If[correl[[1]] * correl[[2]] ≠ 0, N[Log[correl[[1]] / correl[[2]]]], "Na"]
 ]
```

This function needs as input the time series “ts” (a list of integer values) and a pruning factor tau (tau=1: all values are used, tau=20 only every 20th value is used etc..)

```
SetDirectory["F://Chicken Research/ChickenRanging4/henlines4"]
```

```
F:\Chicken Research\ChickenRanging4\henlines4
```

```
hens = allhens[[All, 1]];
```

```
allentropies = {};
For[b = 1, b ≤ Length[hens], b++,
 hl = Transpose[Drop[Get[StringJoin["newhenlines", ToString[hens[[b]]]]], 1]];
 entropies = ParallelTable[sampleEntropy[hl[[i]], 1], {i, Length[hl]}];
 entropies = entropies //. "Na" → Mean[DeleteCases[entropies, "Na"]];
 AppendTo[allentropies, entropies];
 If[Mod[b, 20] == 0, Print[b]]
] (*From time to time there are still INF values on single
 days for a bird: these are replace by the Mean value for that bird*)
```

```
SetDirectory["F://Chicken Research/ChickenRanging4"]
```

```
F:\Chicken Research\ChickenRanging4
```

```
allentropies = allentropies //. Mean[{}] → 0;
(*The ten hens that never went outside have entropy zero*)
```

allentropies is a hens x days matrix giving one sample entropy value per bird per day

```
Save["allentropies", allentropies]
```

Coordination

Time gaps between hens going from IN to WG

Pen11

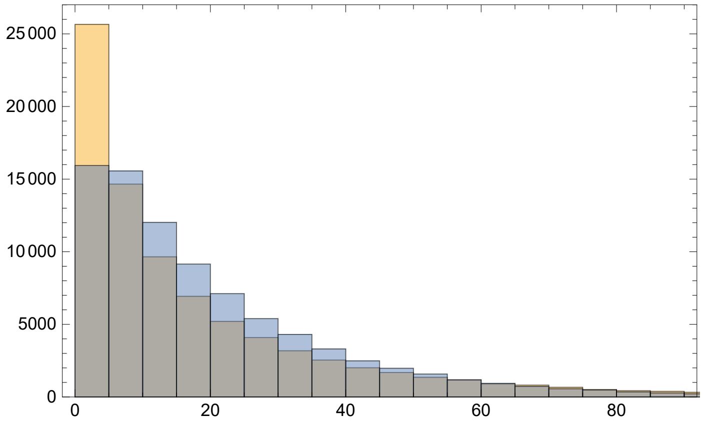
```
distancesLH = {};
expecteddistancesLH = {};
p = 11;
For[d = 1, d ≤ Length[datelist], d++,
  pd = Cases[data, {_, _, _, p, datelist[[d]], _, "IN", "WG", __}][[All, 9]];
  If[Length[pd] > 1,
   AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
   sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
   AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
  ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsINWG11 = {distObs, distExp};
Save["gapsINWG11", gapsINWG11]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the WG (from the IN)

```
Quartiles[distObs]
```

{3, 10, 26}

This says that in 25 % of cases another hen followed within 3 seconds and in 50% within 10 seconds.

```
Quartiles[distExp]
```

{6, 14, 28}

Pen12

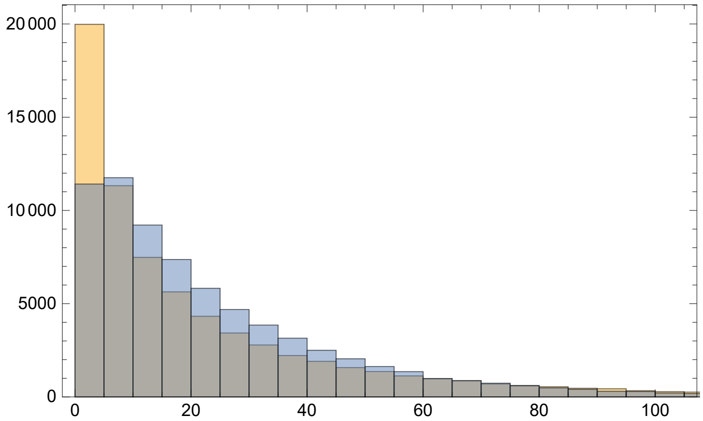
```
distancesLH = {};
expecteddistancesLH = {};
p = 12;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "IN", "WG", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsINWG12 = {distObs, distExp};
Save["gapsINWG12", gapsINWG12]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the WG (from the IN)

```
Quartiles[distObs]
```

```
{4, 12, 31}
```

```
Quartiles[distExp]
```

```
{7, 16, 33}
```

Pen13

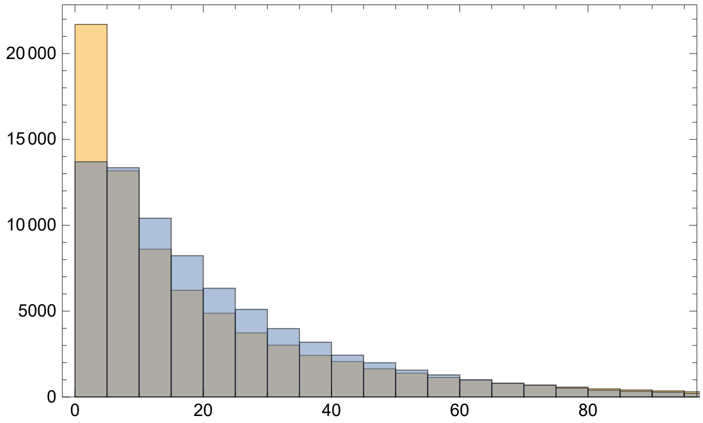
```
distancesLH = {};
expecteddistancesLH = {};
p = 13;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "IN", "WG", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsINWG13 = {distObs, distExp};
Save["gapsINWG13", gapsINWG13]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the WG (from the IN)

```
Quartiles[distObs]
```

```
{4, 11, 28}
```

```
Quartiles[distExp]
```

```
{6, 15, 30}
```

Pen14

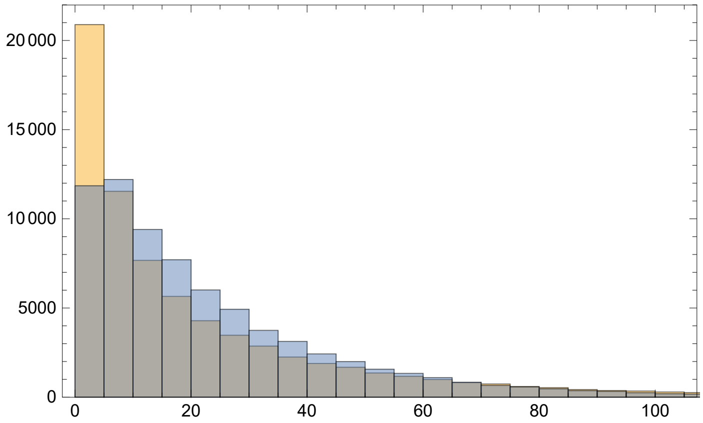
```
distancesLH = {};
expecteddistancesLH = {};
p = 14;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist⟦d⟧, _, "IN", "WG", __}]⟦All, 9⟧;
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd⟦1⟧, pd⟦-1⟧], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsINWG14 = {distObs, distExp};
Save["gapsINWG14", gapsINWG14]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the WG (from the IN)

```
Quartiles[distObs]
```

```
{4, 12, 30}
```

```
Quartiles[distExp]
```

```
{7, 16, 32}
```

Time gaps between hens going from WG to LH

Pen11

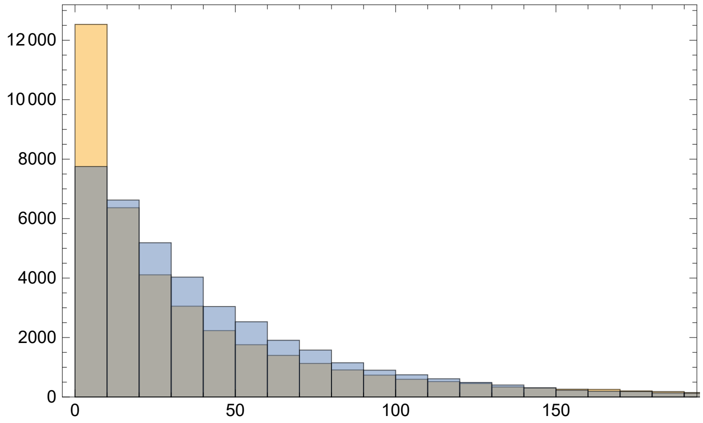
```
distancesLH = {};
expecteddistancesLH = {};
p = 11;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "WG", "LH", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH11 = {distObs, distExp};
Save["gapsWGLH11", gapsWGLH11]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the LH (from the WG)

```
Quartiles[distObs]
```

```
{6, 20, 53}
```

```
Quartiles[distExp]
```

```
{12, 29, 59}
```

Pen12

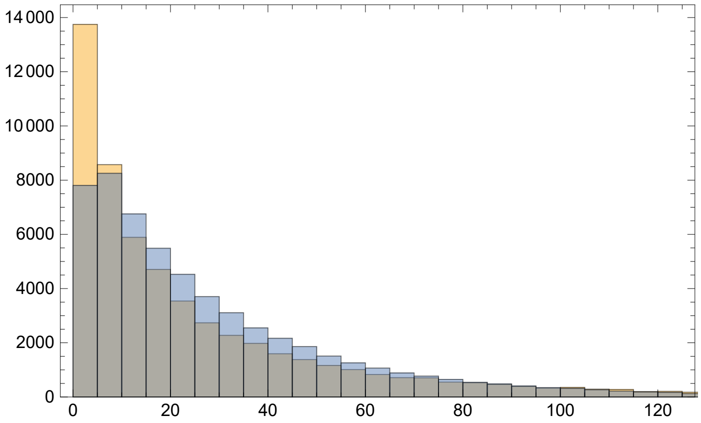
```
distancesLH = {};
expecteddistancesLH = {};
p = 12;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist⟦d⟧, _, "WG", "LH", __}]⟦All, 9⟧;
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd⟦1⟧, pd⟦-1⟧], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH12 = {distObs, distExp};
Save["gapsWGLH12", gapsWGLH12]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the LH (from the WG)

```
Quartiles[distObs]
```

```
{5, 15, 37}
```

```
Quartiles[distExp]
```

```
{8, 19, 40}
```

Pen13

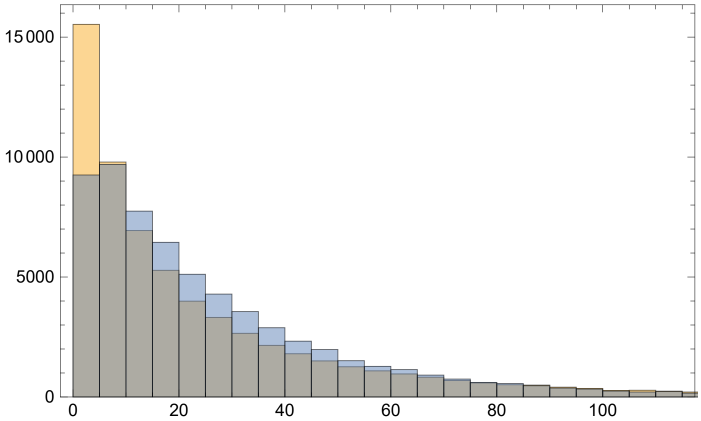
```
distancesLH = {};
expecteddistancesLH = {};
p = 13;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "WG", "LH", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH13 = {distObs, distExp};
Save["gapsWGLH13", gapsWGLH13]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the LH (from the WG)

```
Quartiles[distObs]
```

```
{5, 14, 34}
```

```
Quartiles[distExp]
```

```
{8, 18, 36}
```

Pen14

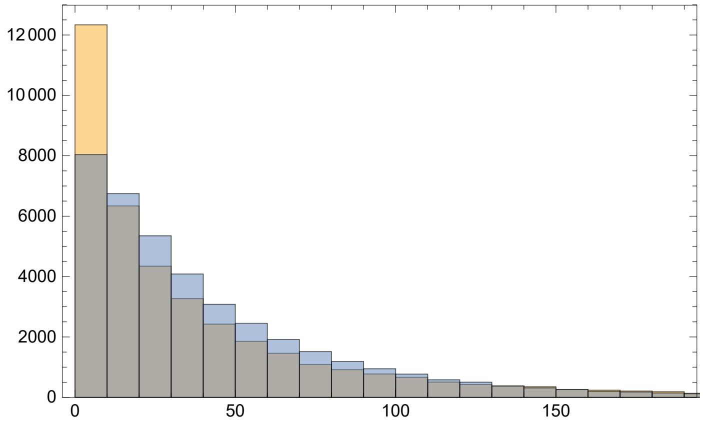
```
distancesLH = {};
expecteddistancesLH = {};
p = 14;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "WG", "LH", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH14 = {distObs, distExp};
Save["gapsWGLH14", gapsWGLH14]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the LH (from the WG)

```
Quartiles[distObs]
```

```
{7, 21, 53}
```

```
Quartiles[distExp]
```

```
{12, 29, 58}
```

Time gaps between hens going from LH to FR

Pen11

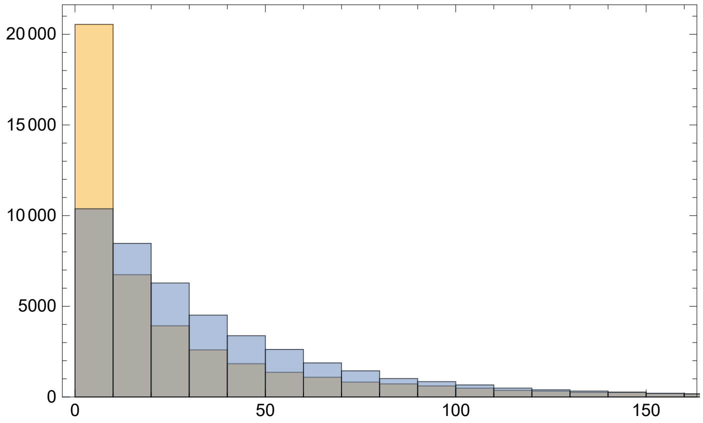
```
distancesLH = {};
expecteddistancesLH = {};
p = 11;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist⟦d⟧, _, "LH", "FR", __}]⟦All, 9⟧;
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd⟦1⟧, pd⟦-1⟧], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsLHFR11 = {distObs, distExp};
Save["gapsLHFR11", gapsLHFR11]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the FR (from the LH)

```
Quartiles[distObs]
```

```
{3, 11, 37}
```

```
Quartiles[distExp]
```

```
{10, 24, 50}
```

Pen12

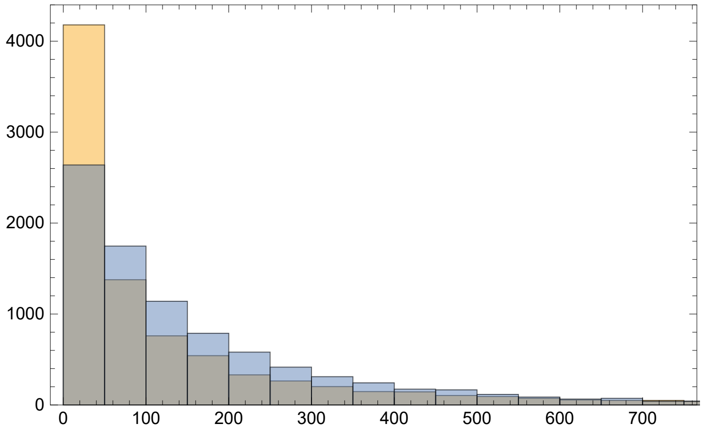
```
distancesLH = {};
expecteddistancesLH = {};
p = 12;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "LH", "FR", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsLHFR12 = {distObs, distExp};
Save["gapsLHFR12", gapsLHFR12]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the FR (from the LH)

```
Quartiles[distObs]
```

```
{13, 56, 178}
```

```
Quartiles[distExp]
```

```
{40, 101, 226}
```

Pen13

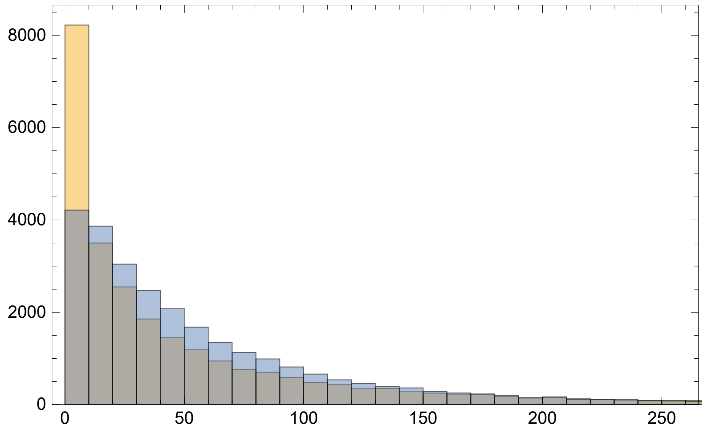
```
distancesLH = {};
expecteddistancesLH = {};
p = 13;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "LH", "FR", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsLHFR13 = {distObs, distExp};
Save["gapsLHFR13", gapsLHFR13]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the FR (from the LH)

```
Quartiles[distObs]
```

```
{6, 25, 72}
```

```
Quartiles[distExp]
```

```
{15, 38, 80}
```

Pen14

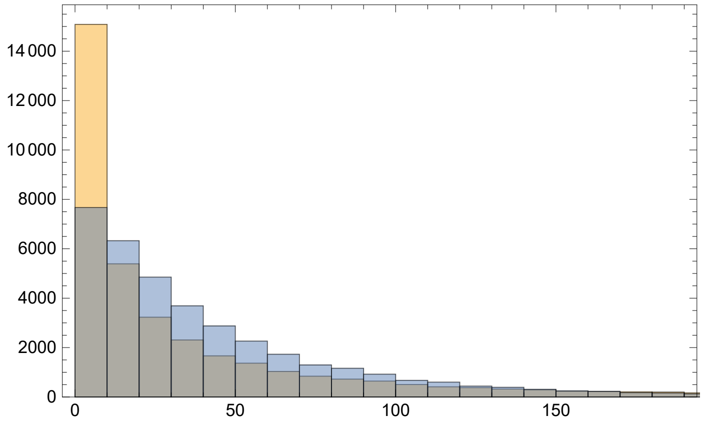
```
distancesLH = {};
expecteddistancesLH = {};
p = 14;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "LH", "FR", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsLHFR14 = {distObs, distExp};
Save["gapsLHFR14", gapsLHFR14]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the FR (from the LH)

```
Quartiles[distObs]
```

```
{4, 15, 49}
```

```
Quartiles[distExp]
```

```
{12, 29, 59}
```

Time gaps between hens going from FR to LH

Pen11

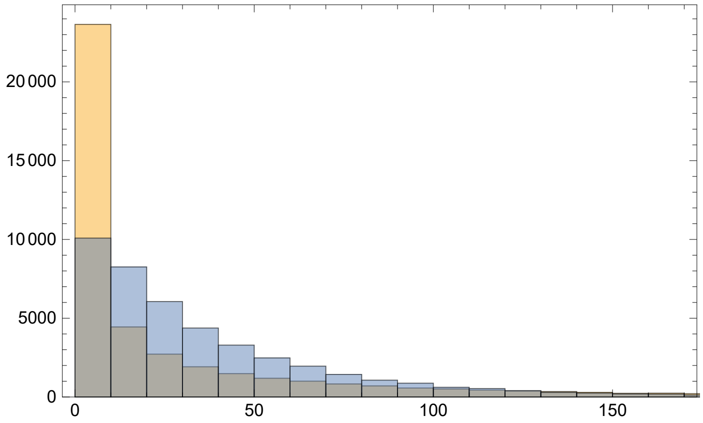
```
distancesLH = {};
expecteddistancesLH = {};
p = 11;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist⟦d⟧, _, "FR", "LH", __}]⟦All, 9⟧;
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd⟦1⟧, pd⟦-1⟧], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH11 = {distObs, distExp};
Save["gapsFRLH11", gapsWGLH11]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the LH (from the FR)

```
Quartiles[distObs]
```

$\{1, 7, \frac{151}{4}\}$

```
Quartiles[distExp]
```

{10, 24, 51}

Pen12

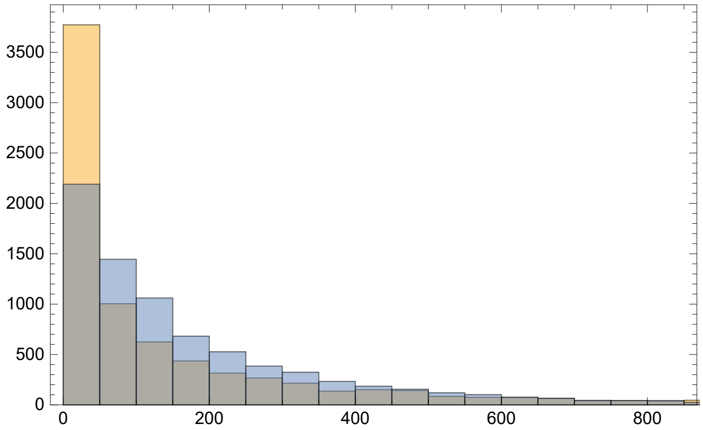
```
distancesLH = {};
expecteddistancesLH = {};
p = 12;
For[d = 1, d ≤ Length[datelist], d++,
  pd = Cases[data, {_, _, _, p, datelist⟦d⟧, _, "FR", "LH", __}]⟦All, 9⟧;
  If[Length[pd] > 1,
   AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
   sim = Sort[RandomSample[Range[pd⟦1⟧, pd⟦-1⟧], Length[pd]]];
   AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
  ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH12 = {distObs, distExp};
Save["gapsFRLH12", gapsWGLH12]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the LH (from the FR)

```
Quartiles[distObs]
```

```
{7, 58, 213}
```

```
Quartiles[distExp]
```

```
{44, 112, 254}
```

Pen13

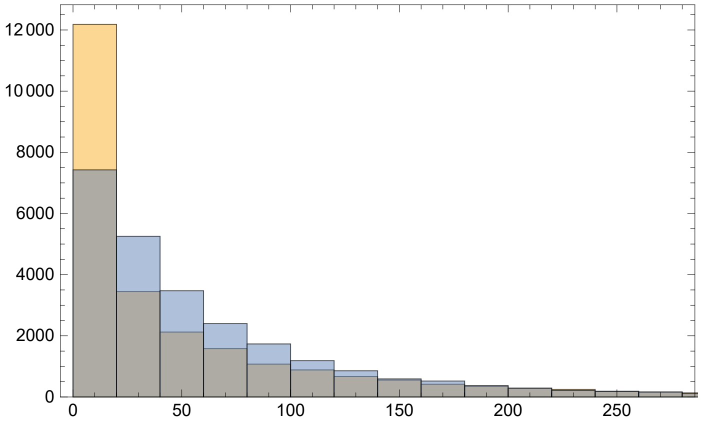
```
distancesLH = {};
expecteddistancesLH = {};
p = 13;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist⟦d⟧, _, "FR", "LH", __}]⟦All, 9⟧;
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd⟦1⟧, pd⟦-1⟧], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH13 = {distObs, distExp};
Save["gapsFRLH13", gapsWGLH13]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the LH (from the FR)

```
Quartiles[distObs]
```

```
{4, 21, 74}
```

```
Quartiles[distExp]
```

```
{16, 39, 84}
```

Pen14

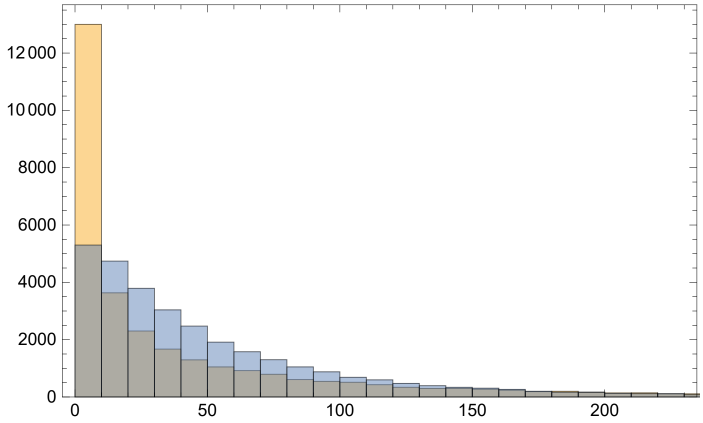
```
distancesLH = {};
expecteddistancesLH = {};
p = 14;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "FR", "LH", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH14 = {distObs, distExp};
Save["gapsFRLH14", gapsWGLH14]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the LH (from the FR)

```
Quartiles[distObs]
```

```
{3, 15, 60}
```

```
Quartiles[distExp]
```

```
{14, 34, 71}
```

Time gaps between hens going from LH to WG

Pen11

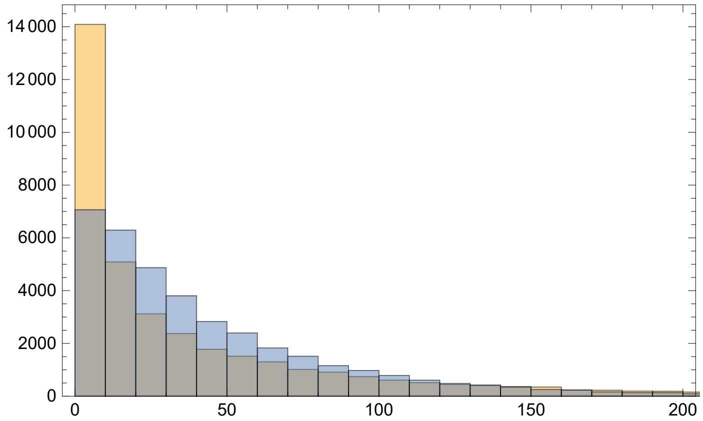
```
distancesLH = {};
expecteddistancesLH = {};
p = 11;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist⟦d⟧, _, "LH", "WG", __}]⟦All, 9⟧;
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd⟦1⟧, pd⟦-1⟧], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsINWG11 = {distObs, distExp};
Save["gapsLHWG11", gapsINWG11]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the WG (from the LH)

```
Quartiles[distObs]
```

```
{4, 18, 58}
```

```
Quartiles[distExp]
```

```
{13, 30, 62}
```

Pen12

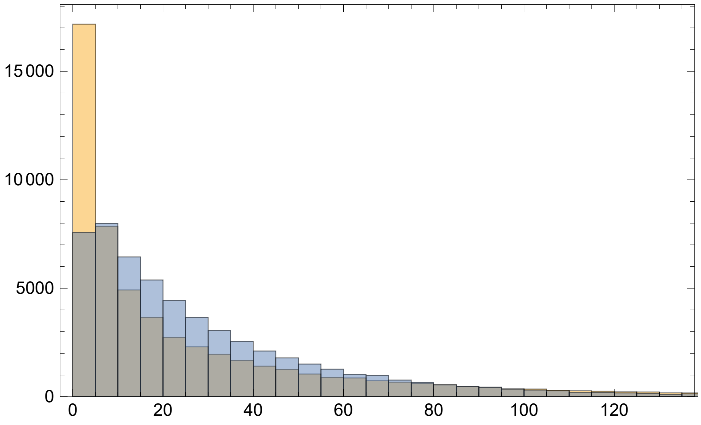
```
distancesLH = {};
expecteddistancesLH = {};
p = 12;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "LH", "WG", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsINWG12 = {distObs, distExp};
Save["gapsLHWG12", gapsINWG12]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the WG (from the LH)

```
Quartiles[distObs]
```

```
{3, 12, 37}
```

```
Quartiles[distExp]
```

```
{8, 20, 41}
```

Pen13

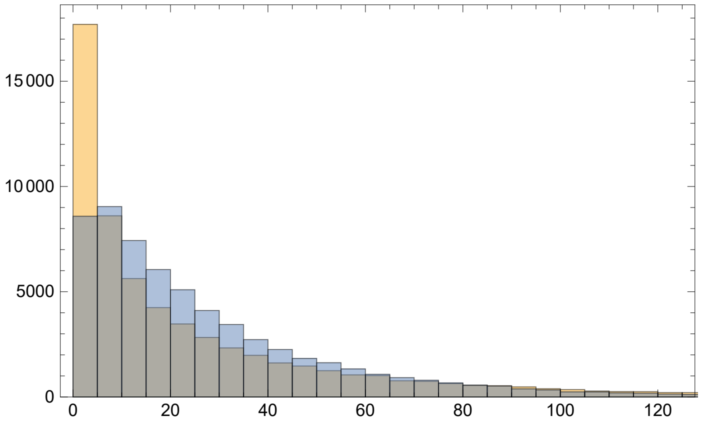
```
distancesLH = {};
expecteddistancesLH = {};
p = 13;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "LH", "WG", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsINWG13 = {distObs, distExp};
Save["gapsLHWG13", gapsINWG13]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the WG (from the LH)

```
Quartiles[distObs]
```

```
{4, 13, 36}
```

```
Quartiles[distExp]
```

```
{8, 19, 38}
```

Pen14

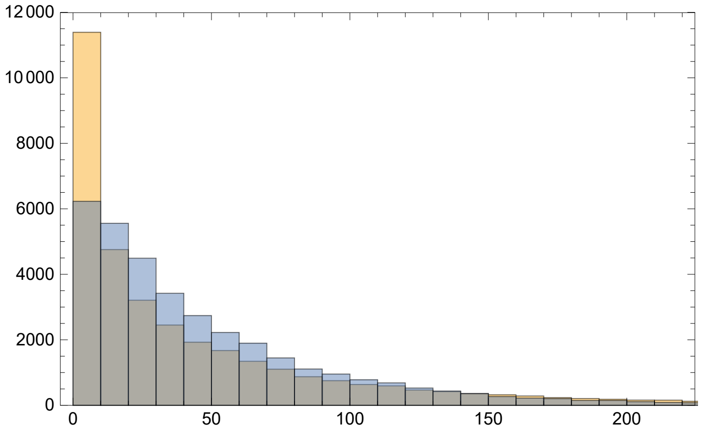
```
distancesLH = {};
expecteddistancesLH = {};
p = 14;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "LH", "WG", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsINWG14 = {distObs, distExp};
Save["gapsLHWG14", gapsINWG14]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the WG (from the LH)

```
Quartiles[distObs]
```

```
{6, 23, 63}
```

```
Quartiles[distExp]
```

```
{14, 32, 66}
```

Time gaps between hens going from WG to IN

Pen11

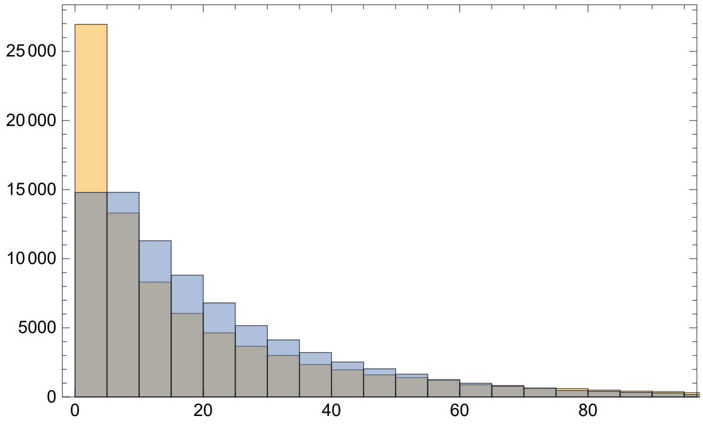
```
distancesLH = {};
expecteddistancesLH = {};
p = 11;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "WG", "IN", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH11 = {distObs, distExp};
Save["gapsWGIN11", gapsWGLH11]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the IN (from the WG)

```
Quartiles[distObs]
```

```
{3, 10, 27}
```

```
Quartiles[distExp]
```

```
{6, 14, 29}
```

Pen12

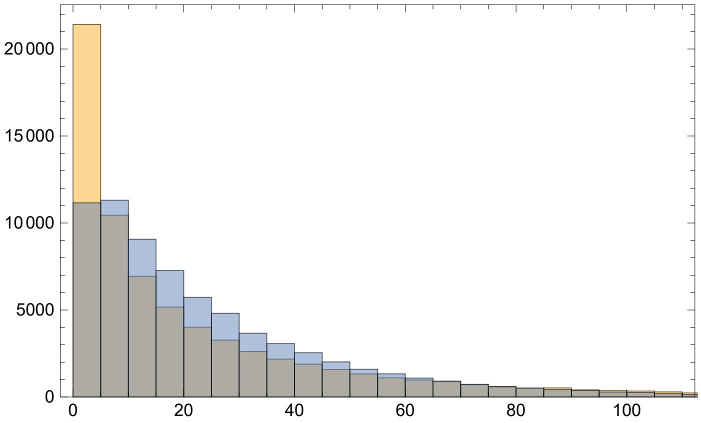
```
distancesLH = {};
expecteddistancesLH = {};
p = 12;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist[[d]], _, "WG", "IN", __}][[All, 9]];
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd[[1]], pd[[-1]]], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH12 = {distObs, distExp};
Save["gapsWGIN12", gapsWGLH12]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the IN (from the WG)

```
Quartiles[distObs]
```

```
{3, 12, 32}
```

```
Quartiles[distExp]
```

```
{7, 17, 34}
```

Pen13

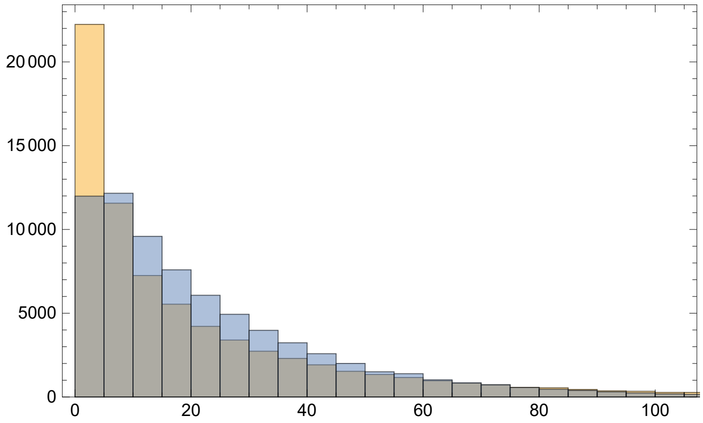
```
distancesLH = {};
expecteddistancesLH = {};
p = 13;
For[d = 1, d ≤ Length[datelist], d++,
 pd = Cases[data, {_, _, _, p, datelist〚d〛, _, "WG", "IN", __}]〚All, 9〛;
 If[Length[pd] > 1,
  AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
  sim = Sort[RandomSample[Range[pd〚1〛, pd〚-1〛], Length[pd]]];
  AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
 ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH13 = {distObs, distExp};
Save["gapsWGIN13", gapsWGLH13]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the IN (from the WG)

```
Quartiles[distObs]
```

```
{3, 11, 30}
```

```
Quartiles[distExp]
```

```
{7, 16, 32}
```

Pen14

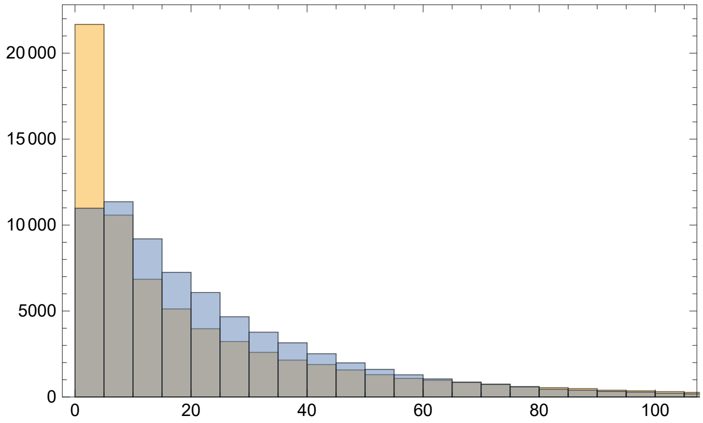
```
distancesLH = {};
expecteddistancesLH = {};
p = 14;
For[d = 1, d ≤ Length[datelist], d++,
  pd = Cases[data, {_, _, _, p, datelist⟦d⟧, _, "WG", "IN", __}]⟦All, 9⟧;
  If[Length[pd] > 1,
   AppendTo[distancesLH, Round[Drop[pd, 1] - Drop[pd, -1]]];
   sim = Sort[RandomSample[Range[pd⟦1⟧, pd⟦-1⟧], Length[pd]]];
   AppendTo[expecteddistancesLH, Round[Drop[sim, 1] - Drop[sim, -1]]]
  ]
]
```

```
distObs = Flatten[Delete[distancesLH, 13]];
```

```
distExp = Flatten[Delete[expecteddistancesLH, 13]];
```

```
gapsWGLH14 = {distObs, distExp};
Save["gapsWGIN14", gapsWGLH14]
```

```
Histogram[{distObs, distExp}, Frame → True]
```



This is the figure showing observed and expected distributions of time gaps between hens entering the IN (from the WG)

```
Quartiles[distObs]
```

```
{3, 11, 31}
```

```
Quartiles[distExp]
```

```
{7, 17, 33}
```

Figures

Expected vs observed gap times

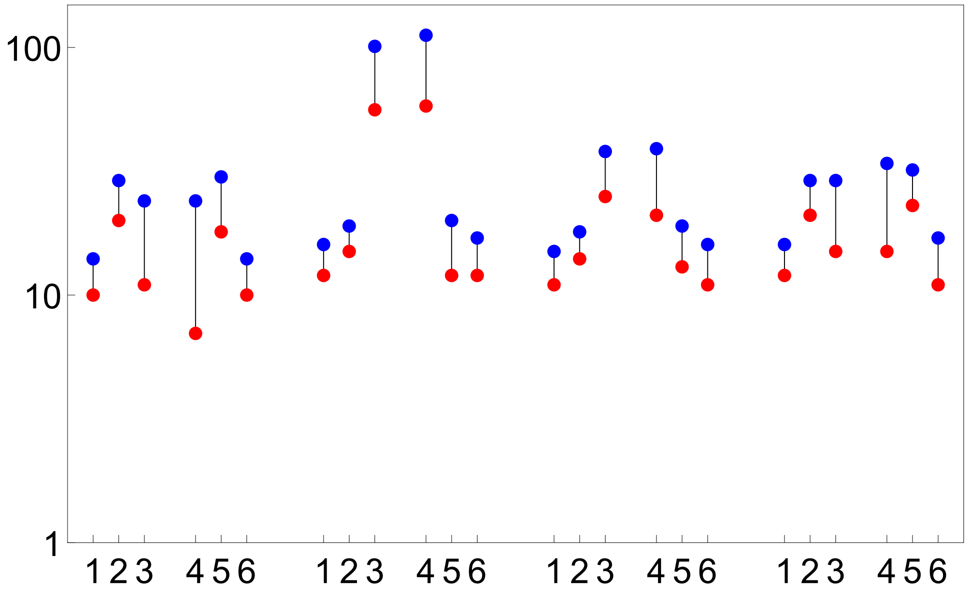
```
contr[{o_, e_}] := Graphics[{Black, Line[{{xpos[[i]], Log[o]}, {xpos[[i]], Log[e]}}], Red,
   PointSize[Large], Point[{xpos[[i]], Log[o]}], Blue, Point[{xpos[[i]], Log[e]}]}]
```

```
transitiongaps = {
   {10, 14}, {20, 29}, {11, 24}, {7, 24}, {18, 30}, {10, 14},
   {12, 16}, {15, 19}, {56, 101}, {58, 112}, {12, 20}, {12, 17},
   {11, 15}, {14, 18}, {25, 38}, {21, 39}, {13, 19}, {11, 16},
   {12, 16}, {21, 29}, {15, 29}, {15, 34}, {23, 32}, {11, 17}
  };
```

```
(*Numbers are meadian durations of gaps between two transitions
 at any antenna manually transcribed from the results above*)
```

```
xpos =
  {1, 2, 3, 5, 6, 7, 10, 11, 12, 14, 15, 16, 19, 20, 21, 23, 24, 25, 28, 29, 30, 32, 33, 34};
```

```
provfig2 = Show[Table[contr[transitiongaps[[i]]], {i, 24}],
  PlotRange → {{0, 35}, {0, 5}}, AspectRatio → 0.6, Frame → True,
  FrameTicks → {Transpose[{xpos, {1, 2, 3, 4, 5, 6, 1, 2, 3, 4, 5, 6, 1, 2, 3, 4, 5, 6, 1,
        2, 3, 4, 5, 6}}], {{0, 1}, {Log[10], 10}, {Log[100], 100}}, None, None},
  FrameTicksStyle → Directive[Black, 18], ImageSize → 500]
```




```
Export["provfig2medians.tif", provfig2]
```

provfig2medians.tif

Example Bursts

```
stream = Cases[data, {_, _, _, 11, __, "LH", "WG", ___}][[All, 6]];
stream = Sort[stream];
min = stream[[1]];
max = stream[[-1]];
triplets = Table[{Length[Select[stream, # ≥ i && # ≤ i + 300 &]],
    Length[Select[stream, # ≥ i + 301 && # ≤ i + 600 &]],
    Length[Select[stream, # ≥ i + 601 && # ≤ i + 1200 &]],
    Length[Select[stream, # ≥ i + 1201 && # ≤ i + 1500 &]],
    Length[Select[stream, # ≥ i + 1501 && # ≤ i + 1800 &]]}, {i, min, max, 1800}];
```

```
rat[{a_, b_, c_, d_, e_}] := c - (a + b + d + e) > 12 && a > 1 && e > 1
```

```
Position[rat /@ triplets, True]
```

{{10}}

```
s = Table[i, {i, min, max, 1800}][[10]]
```

3 674 296 574

```
example = Select[stream, # ≥ s - 300 && # ≤ s + 2000 &]
```

```
{3 674 296 479, 3 674 296 831, 3 674 296 861, 3 674 296 892, 3 674 297 188,
 3 674 297 290, 3 674 297 377, 3 674 297 413, 3 674 297 419, 3 674 297 424,
 3 674 297 426, 3 674 297 427, 3 674 297 488, 3 674 297 515, 3 674 297 516,
 3 674 297 525, 3 674 297 528, 3 674 297 529, 3 674 297 531, 3 674 297 532,
 3 674 297 538, 3 674 297 553, 3 674 297 554, 3 674 297 563, 3 674 297 563,
 3 674 297 579, 3 674 297 595, 3 674 297 750, 3 674 297 820, 3 674 297 834, 3 674 298 035,
 3 674 298 139, 3 674 298 335, 3 674 298 375, 3 674 298 376, 3 674 298 378, 3 674 298 380,
 3 674 298 385, 3 674 298 388, 3 674 298 396, 3 674 298 401, 3 674 298 401, 3 674 298 411}
```

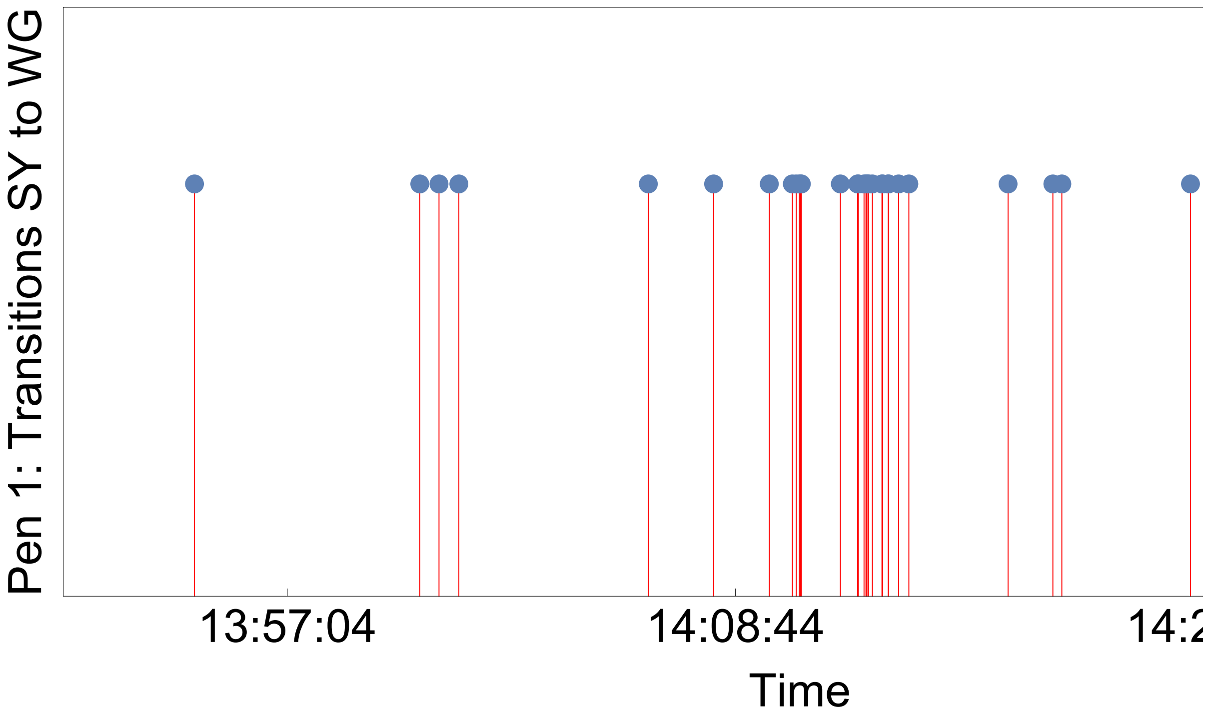
```
DateString[s + 50]
```

```
Tue 7 Jun 2016 13:57:04
```

```
DateString[s + 750]
```

```
Tue 7 Jun 2016 14:08:44
```

```
burstexample = Show[ListPlot[Transpose[{example, Table[1.4, {Length[example]}]}],
   PlotRange → {{s - 300, s + 2001}, {0, 2}}, Filling -> Axis,
   FillingStyle → Red, AspectRatio → 0.4, Frame → True,
   FrameLabel → {{"Pen 1: Transitions SY to WG", None}, {"Time", None}},
   LabelStyle → Directive[24, Black], FrameTicks → {{None, None}, {{{s + 50, "13:57:04"},
      {s + 750, "14:08:44"}, {s + 1500, "14:21:14"}}, None}}], ImageSize → 800]
```



This figure shows an example data stream of transition of hens in pen 11 from LH to WG on June 7th, 2016 from 13:57:04 to 14:08:44

```
Export["burstexample.tif", burstexample]
```

```
burstexample.tif
```

Initiator Follower

```
leaderfollower = {};
For[p = 11, p ≤ 14, p++,
  For[d = 1, d ≤ Length[datelist], d++,
   penday = Cases[data, {_, _, _, p, datelist〚d〛, __}];
   If[Length[penday] ≥ 2,
    AppendTo[leaderfollower,
     Append[
      Prepend[
       Table[If[penday〚i, 6〛 - penday〚i - 1, 6〛 > penday〚i + 1, 6〛 - penday〚i, 6〛,
         {penday〚i, 1〛, "Leader"}, If[penday〚i, 6〛 - penday〚i - 1, 6〛 <
           penday〚i + 1, 6〛 - penday〚i, 6〛, {penday〚i, 1〛, "Follower"},
          {penday〚i, 1〛, "Even"}]], {i, 2, Length[penday] - 1}],
       {penday〚1, 1〛, "Leader"}
      ],
      {penday〚-1, 1〛, "Follower"}
     ]
    ]
   ]
  ]
 ];
```

```
leaderfollowermatrix = Flatten[leaderfollower, 1];
```

```
leaderfollowermatrix = DeleteCases[leaderfollowermatrix, {_, "Even"}];
```

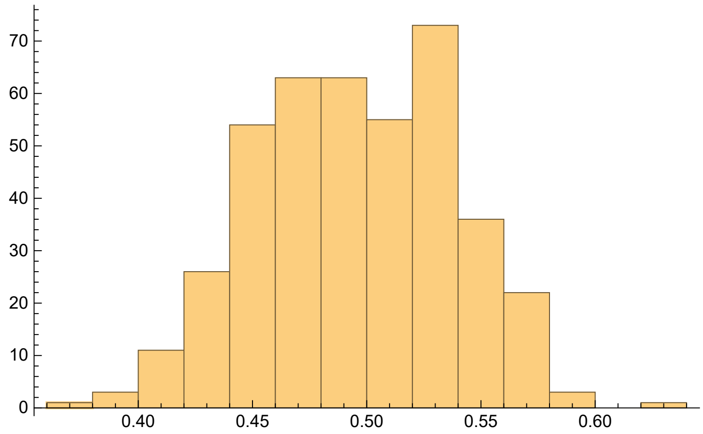
```
smallertail[x_] := If[x < 0.5, x, 1 - x]
```

```
leadingpercent = Table[{tags〚t〛,
    If[Count[leaderfollowermatrix, {tags〚t〛, _}] > 0, N[Count[leaderfollowermatrix,
        {tags〚t〛, "Leader"}] / Count[leaderfollowermatrix, {tags〚t〛, _}]], "NA"],
    smallertail[Probability[x <= Count[leaderfollowermatrix, {tags〚t〛, "Leader"}],
      x ≈ BinomialDistribution[Count[leaderfollowermatrix, {tags〚t〛, _}],
        0.5]]]}, {t, 1, Length[tags]}];
```

```
Quartiles[DeleteCases[leadingpercent〚All, 2〛, "NA"]]
```

```
{0.463412, 0.495756, 0.529612}
```

```
Histogram[leadingpercent[[All, 2]]]
```



This gives the distribution of leading-disposition (i.e. for each hen the proportion of all its transition where it was a leader (defined as being more closely followed by another bird than following another bird))

```
Count[leadingpercent,
 x_ /; x[[3]] ≤ 0.05 / Length[tags] (*Bonferroni*) && x[[2]] > 0.5 (*"Leader"*)]
```

77

```
Count[leadingpercent,
 x_ /; x[[3]] ≤ 0.05 / Length[tags] (*Bonferroni*) && x[[2]] < 0.5 (*"Follower"*)]
```

91

This gives the number of hens which are ‘significant’ leader or follower (Bonferroni corrected): 77 are clear (‘significant’) leaders, 91 are clear (‘significant’) follower. Indicates social enhancement i.e. increasing wave of birds

```
Save["leadingpercent", leadingpercent]
```

Summary Files: “rangingdata”

The variable **rangingdata** is a 421 x 11 matrix. Each row is one hen, columns are:
1. hen-ID,
2. pen-number,
3. tag-number,
4. mean number of transitions per day,
5. percentage time inside (IN),
6. percentage tijme outside (LH+FR),
7. mean entropy,
8. initiator score (proportion of transitions where hen was a leader),
9. mean order for going out (entering the LH for the firs time per day),
10. mean order for going back in (last record of outside area for that henday),

11. Number of days the hen went outside (LH or FR).

```
rangingdata = {};
For[i = 1, i ≤ Length[allhens], i++,
 hen = Cases[allhentimestats, {allhens[[i, 3]], __}];
 AppendTo[rangingdata,
  Join[allhens[[i]],
   {N[Mean[hen[[All, 7]]]] (*Mean number of transitions*),
     Mean[hen[[All, 13]] / (hen[[All, 13]] + hen[[All, 15]] + hen[[All, 17]] + hen[[All, 19]])]
     (*mean percentage inside*),
     Mean[hen[[All, 22]]] (*Mean percentage outside*),
     Mean[allentropies[[i]]] (*Mean entropy*),
     Cases[leadingpercent, {hen[[1, 1]], __}][[1, 2]] (*Initiator-score*),
     N[Median[DeleteCases[hen[[All, 20]], "NA"]]] (*Median order out*),
     N[Median[DeleteCases[hen[[All, 21]], "NA"]]] (*Median order in*),
     Length[hen] - Count[N[hen[[All, 17]] + hen[[All, 19]]], 0.]
     (*Number of days outside*)
    } //. Median[{}] → "NA"]
 ]
]
```

```
Save["rangingdata", rangingdata]
```

```
Export["rangingdata.csv", rangingdata]
```

```
rangingdata.csv
```