In[1]:=
```
ClearAll["Global`*"]
SetOptions[$FrontEndSession, NotebookAutoSave → True]
NotebookSave[]
```

Lynx paper notebook 2

Script for analysis presented with respect to bee flights

Preprocessing

Load Trajectory3D package

Package available at Github, download and move to the Applications subdirectory of your user base directory.

In[ ]:=
```
$UserBaseDirectory
```

In[4]:=
```
Needs["Trajectory3D`"]
Names["Trajectory3D`*"]
```

Out[5]=
```
{AngleofFlight, CollettPlot3D, DistanceProfile3D, GetData3D,
 InputUserValues3D, OrthogonalComponentsVelocity3D, ProximityCut3D,
 SpeedCollettPlot3D, SpeedProfile3D, TwinCollettPlot3D}
```

In[12]:=
```
{"AngleofFlight", "CollettPlot3D", "DistanceProfile3D", "GetData3D",
 "InputUserValues3D", "OrthogonalComponentsVelocity3D", "ProximityCut3D",
 "SpeedCollettPlot3D", "SpeedProfile3D", "TwinCollettPlot3D"}
```

Out[12]=
```
{AngleofFlight, CollettPlot3D, DistanceProfile3D, GetData3D,
 InputUserValues3D, OrthogonalComponentsVelocity3D, ProximityCut3D,
 SpeedCollettPlot3D, SpeedProfile3D, TwinCollettPlot3D}
```

Import Data

project specific constants and other variables

In[6]:=
```
fps = 1 / 500;(*frame rate*)
beefolder =
  "/Users/dinesh/Dropbox/projects/lynx/lynx prey response/Data/processed
    data/beedata"; (*insert folder path to csv files *)
bdata = Import[#, "CSV"] & /@ FileNames["*.csv", beefolder];
bflights = Range@Length@bdata
```

Out[9]=
```
{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12}
```

Segment trajectory to closest approach to flower (point chosen visually)

In[10]:=
```
SpecialProximityCut3Db[file_, n_] := Module[{head, obj, cuts, cuttraj},
head = file[[All, {1, 2, 3}]];
obj = file[[All, {7, 8, 9}]];
cuts = {56, 128, 67, 261, 168, 374, 176, 193, 32, 75, 313, 144};
cuttraj = file[[ ;; cuts[[n]], All]];
cuttraj
]
```

In[11]:=
```
bmpc = SpecialProximityCut3Db[bdata[[#]], #] & /@ bflights;
```

Analyses

Minimum distance

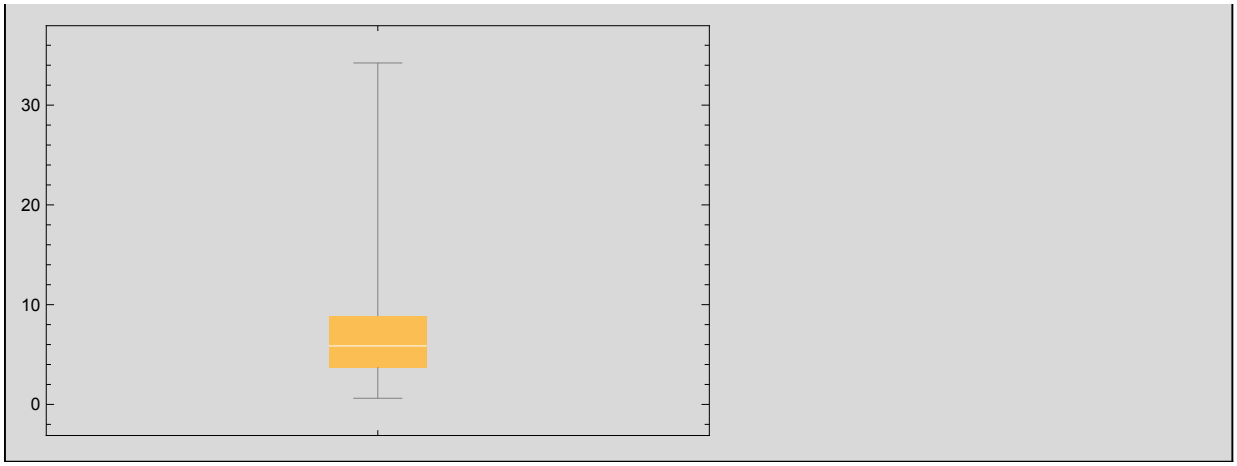
Yellows vs whites

In[•]:=
```
Min[DistanceProfile3D[bmpc[[#]]] & /@ bflights
```

Out[•]=
```
{34.2263, 7.88898, 5.964, 3.50584, 6.51213, 4.50407,
 3.97183, 5.75997, 11.6021, 9.81431, 0.617638, 3.46956}
```

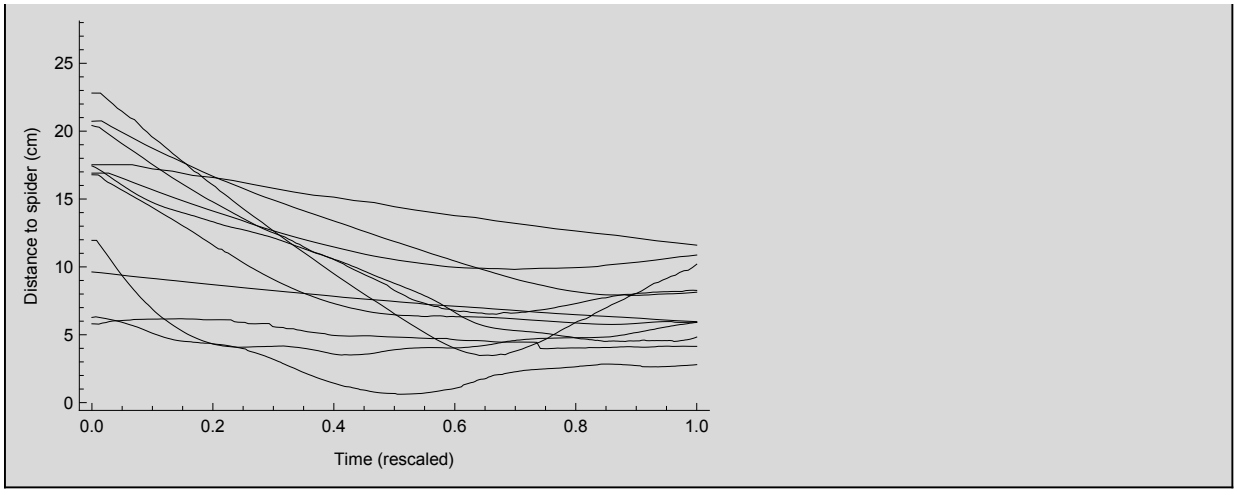
In[ ]:=
```
BoxWhiskerChart[{34.2263, 7.88898, 5.964, 3.50584, 6.51213,
  4.50407, 3.97183, 5.75997, 11.6021, 9.81431, 0.617638, 3.46956}]
```

Out[ ]=



In[ ]:=
```
ListLinePlot[
 N@TimeSeriesRescale[DistanceProfile3D[bmpc[[#]], {0, 1}] & /@ bflights,
 PlotStyle → Directive[{Black, Thin}], Frame → {{True, False}, {True, False}},
 FrameLabel → {{HoldForm["Distance to spider (cm)"], None},
   {HoldForm["Time (rescaled)"], None}},
 PlotLabel → None, LabelStyle → {GrayLevel[0]}]
```

Out[ ]=



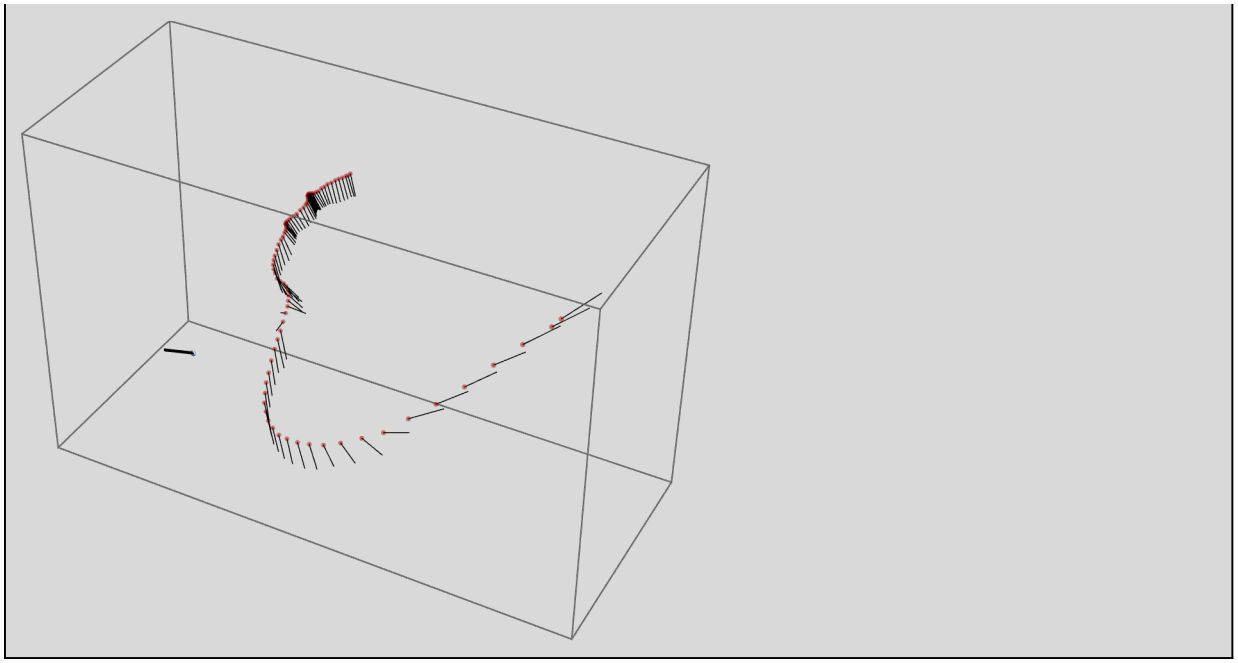
Trajectory Plots

Plots of selected trajectories

Ball and pin plot of a typical trajectory

In[ ]:=
```
TwinCollettPlot3D[bmpc[[4]]]
```

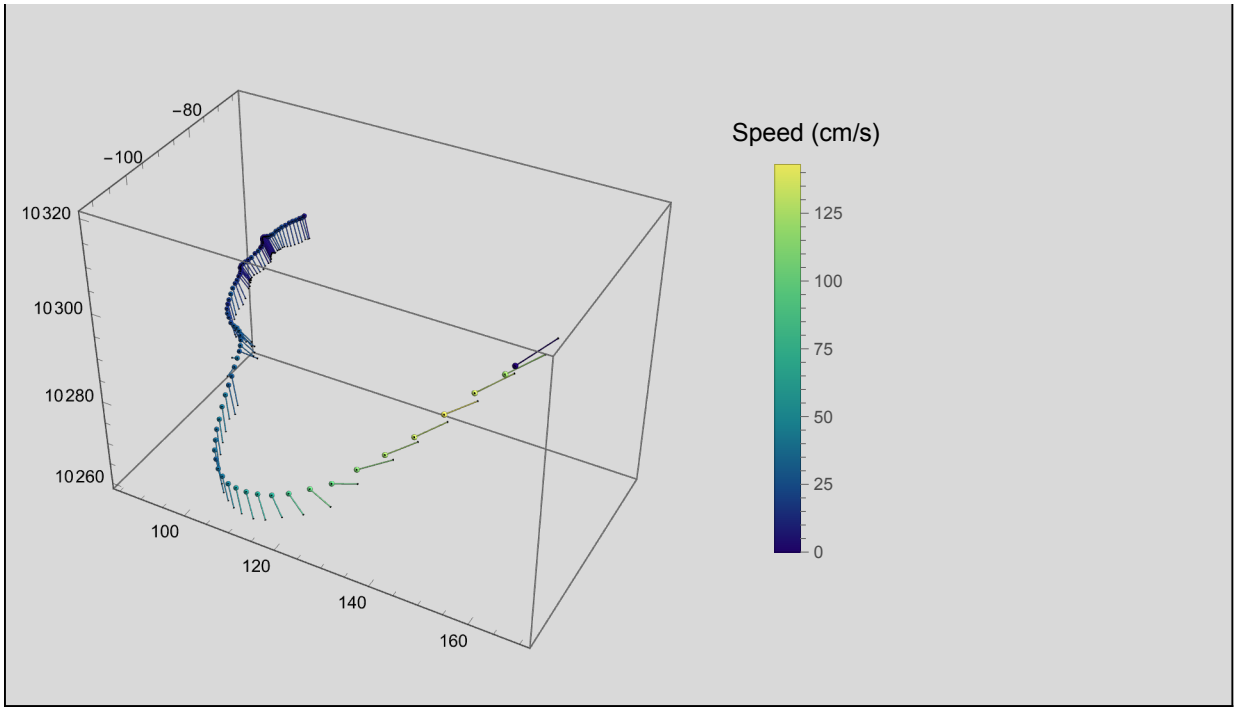
Out[ ]=



Colour coded to speed

In[ ]:=
```
SpeedCollettPlot3D[bmpc[[4]]]
```

Out[ ]=

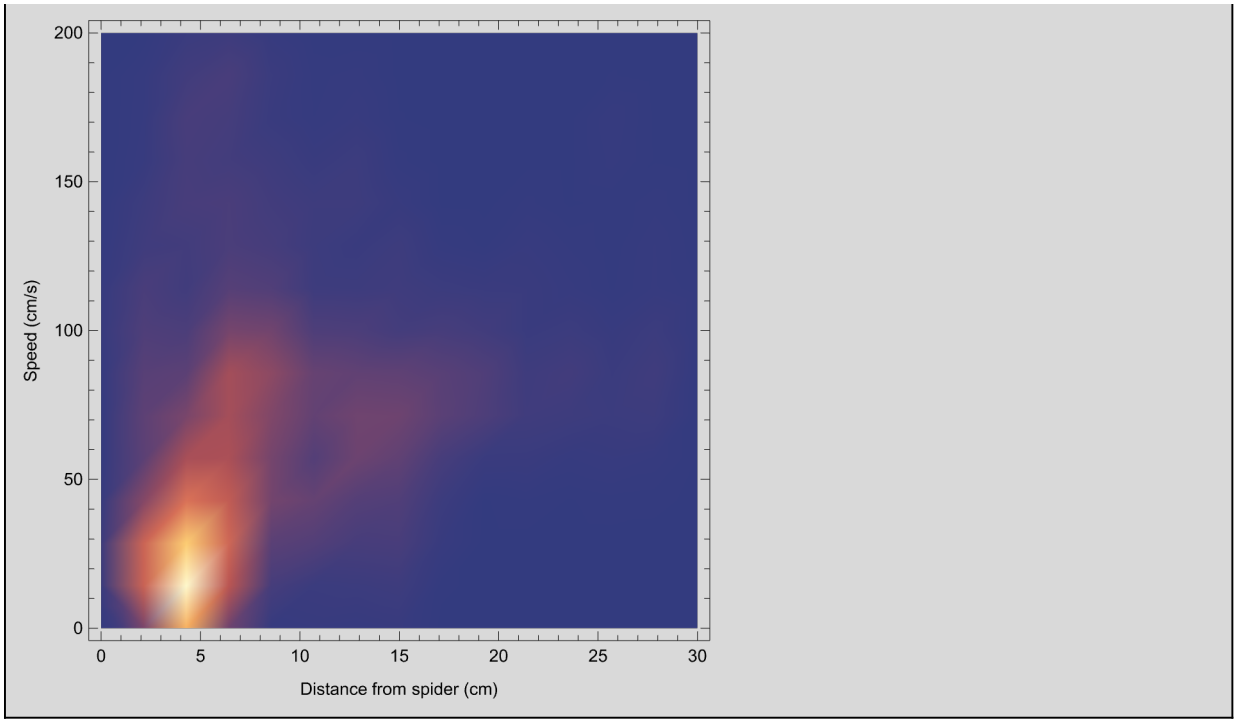


Distance vs Speed

In[13]:=
```
distspeeds = {DistanceProfile3D[bmpc[[#]]], SpeedProfile3D[bmpc[[#]]}^T & /@ bflights;
```

In[14]:=
```
SmoothDensityHistogram[Flatten[distspeeds, 1],
 PlotRange → {{0, 30}, {0, 200}}, FrameLabel → {{HoldForm["Speed (cm/s)"], None},
   {HoldForm["Distance from spider (cm)"], None}},
 PlotLabel → None, LabelStyle → {GrayLevel[0]}]
```

Out[14]=



Persistence Velocity

All flights

Extract persistent velocity values for flights

In[16]:=
```
PVbees = OrthogonalComponentsVelocity3D[bmpc[[#]][[1]] & /@ bflights;
```

Subsample to remove trajectories where computation did not work; standardize (z-score normalisation) and then run a low pass filter

In[17]:=
```
bpv = LowpassFilter[PVbees[[#]], 0.5] & /@ bflights;
```

Distances for yellow flower flights

In[18]:=
```
bdis = DistanceProfile3D[bmpc[[#]] & /@ bflights;
```

Join to a single dataset

In[19]:=
```
bdistPV = {bdis[[#]][[2 ;;]], bpv[[#]]}^T & /@ {1, 2, 3, 4, 5, 6, 7, 8, 9, 10};
```

Smooth density histogram with contours

In[20]:=
```
SmoothDensityHistogram[Flatten[bdistPV, 1], PlotRange → {{0, 25}, {-100, 100}},
 Mesh → 30, FrameLabel → {{HoldForm[ "Persistence Velocity (cm/s)"], None},
   {HoldForm["Distance from spider (cm)"], None}},
 PlotLabel → None, LabelStyle → {GrayLevel[0]}]
```

Out[20]=