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14.2.4 Example: Martian lander with drag and entry angle variability

MO2.3 MO2.13 MO2.15

Now we consider the Martian lander problem with two parameters varying, specifically C_{Dl} and θ_e, using the uniform distributions over the ranges previously described. The implementation of the Monte Carlo method for this problem is shown in the code below. In this implementation the entire array of random values for C_{Dl} and for θ_e are done by calling `rng.uniform` with the size set to **`Nsample`**. The results for a typical simulation with sample size 100 are shown in Figures 14.9 and 14.10. For this simulation, 37 of the 100 instances had $z_p < 9$ km, thus, the probability estimate would be $P_{\text{low}} = 0.37$.

```
rng = np.random.default_rng()
Nsample = 100
zps     = np.zeros(Nsample)
CDls    = rng.uniform(1.5, 1.9, Nsample)
thetaes = rng.uniform(80., 86., Nsample)
for n in range(Nsample):
   lander_IVP.set_p('CD_l', CDls[n])
   lander_IVP.set_p('theta_e', thetaes[n])
   zps[n] = lander_run_case(lander_IVP, dt,
IVP.step_RK4)
```

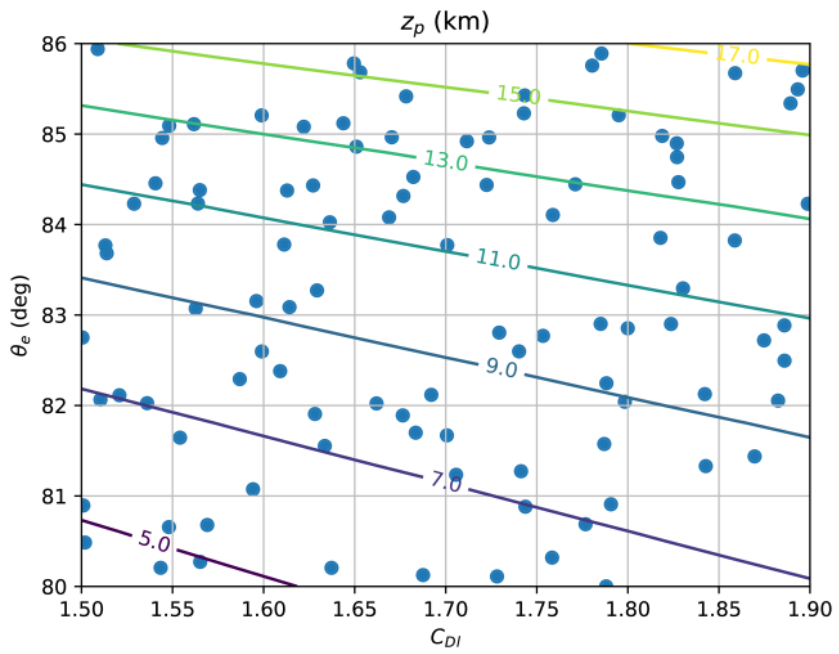
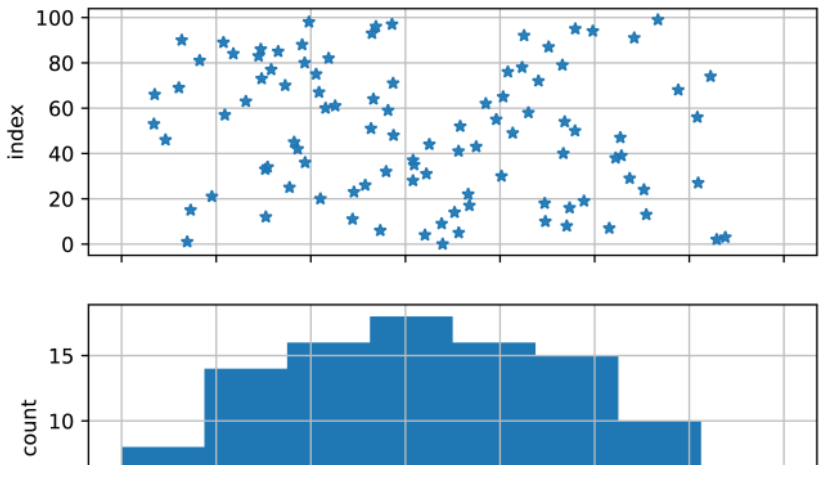


Figure 14.9: Scatter plot of (C_{Dl}, θ_e) values in a Monte Carlo simulation with a sample size of 100 drawn for uniform distributions of C_{Dl} between 1.5 and 1.9 and θ_e between $80°$ and $86°$. Overlayed with contours of z_p.



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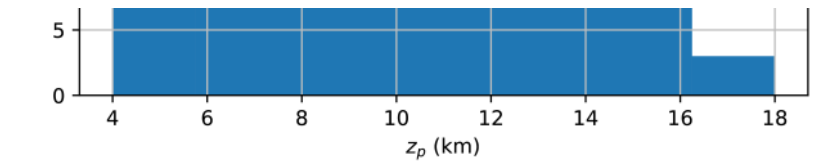

Figure 14.10: Scatter plot and histogram showing variability in z_p from a Monte Carlo simulation of sample size 100 with uniform distributions of C_{Dl} between 1.5 and 1.9 and θ_e between $80°$ and $86°$.

Similar to Figure 14.8, Figure 14.11 shows the values of C_{Dl} in the Monte Carlo sample and the corresponding values of z_p. Because both C_{Dl} and θ_e are varying in this Monte Carlo simulation, the dependence of z_p on C_{Dl} is not evident since variations in θ_e create variations in z_p as well.

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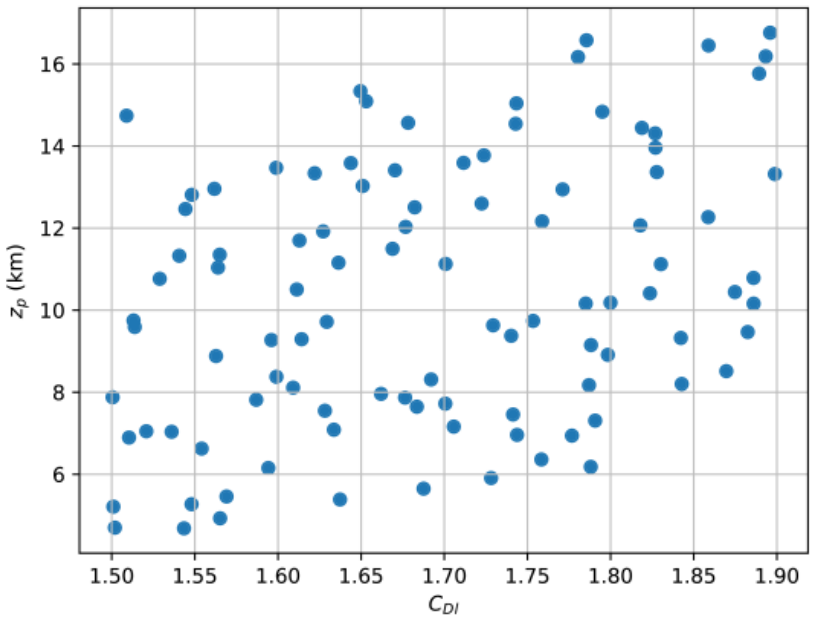
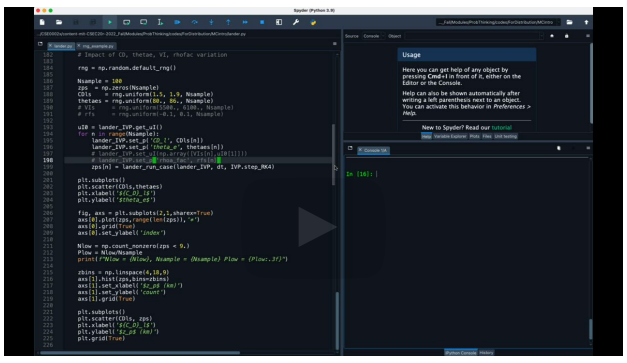


Figure 14.11: Plot of z_p versus C_{Dl} values from the Monte Carlo simulation results shown in Figure 14.10.

The Python scripts used in the videos below (and several others) are available here.

Video demonstrating Monte Carlo for Martian lander with CD and theta variation

Start of transcript.
Skip to the end.



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PROFESSOR: OK, now we're going to look

at varying two parameters-- in this case, the drag

coefficient, and theta, the entry

Video

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