Maximum Lift to Drag Ratio Glider Optimization

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Since last week:

- Consolidated optimization
- Ran test cases for simple 2D section models (flat plate, ...)
- Ran a full sweep on aircraft weight and tried to understand results

1. Optimization Problem

2. Sweep on W

Optimizing Glider L/D

- Maximizing gliding distance
- Fixed weight W
- Fixed airfoil section, known function $\boldsymbol{c_{d_p}}^{\mathbf{2D}}(Re, c_l)$ for $c_l \in [c_{l\mathbf{lb}}, c_{l\mathbf{ub}}]$ and $Re \in [Re_{\mathbf{lb}}, Re_{\mathbf{ub}}]$

minimize	C_D/C_L
subject to	$C_L^2 + C_D^2 = C_W^2$
	$c_{l\mathbf{lb}} \leq c_{l\mathbf{k}} \leq c_{l\mathbf{ub}}$
	$Re_{\mathbf{lb}} \leq Re_{\mathbf{k}} \leq Re_{\mathbf{ub}}$

Reformulated Objective Function

$$\underset{Vb,\left(\frac{c}{b}\right)_{1:N_y},\bar{A2:}N_a}{\text{minimize}} \quad \frac{4W}{\pi\rho^2(Vb)^2}\left(1+\sum_{n=2}^{N_a} n\bar{A}n^2\right)+(Vb)^2\sum_{k=0}^{N_y} w_k\left(\frac{c}{b}\right)_k \boldsymbol{c_{d_p}}^{\mathbf{2D}}(c_{l\mathbf{k}}, Re_k)$$

subject to

$$c_{l\mathbf{lb}} \leq c_l \leq c_{l\mathbf{ub}}$$

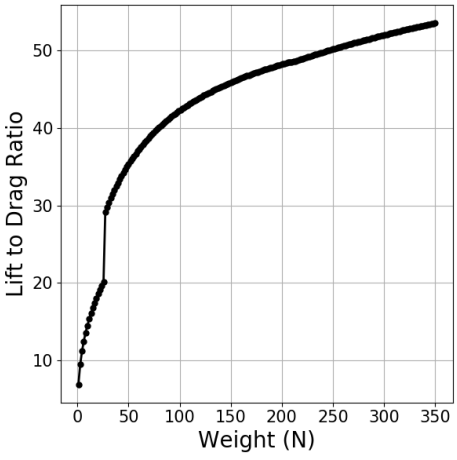
$$Re_{\mathbf{lb}} \leq Re \leq Re_{\mathbf{ub}}$$

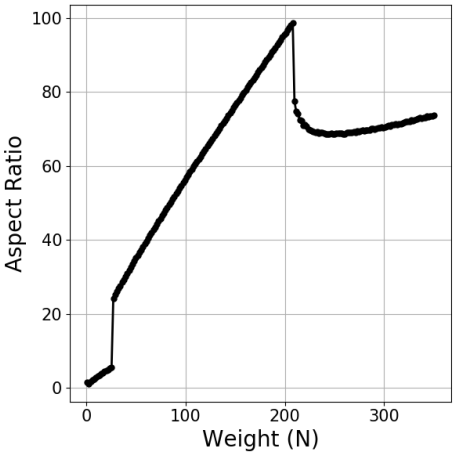
with:

$$Re_k = \frac{\rho}{\nu}\left(\frac{c}{b}\right)_k (Vb)$$

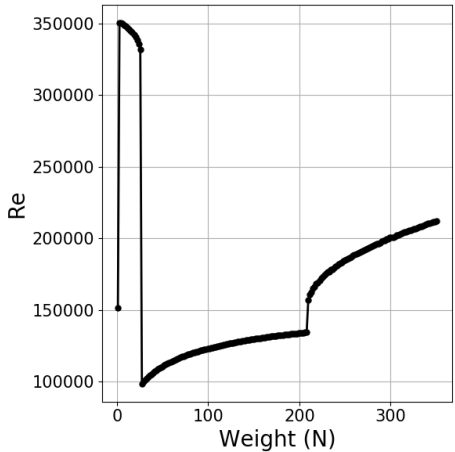
$$c_{l\mathbf{k}} = \frac{8W}{\pi\rho(Vb)^2\left(\frac{c}{b}\right)_k}\left(\sin(\theta_k)+\sum_{n=2}^{N_a}\bar{A}n\sin(n\theta_k)\right)$$

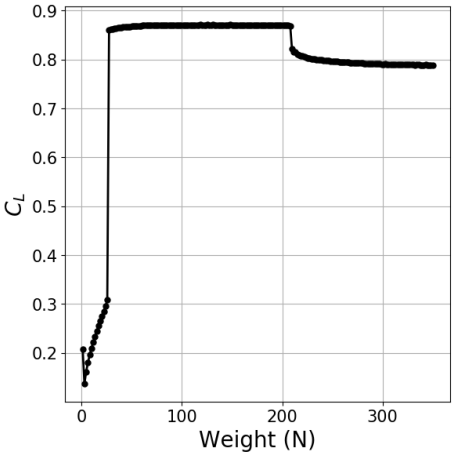
Sweep on W: L_D and $\mathcal{AR}$





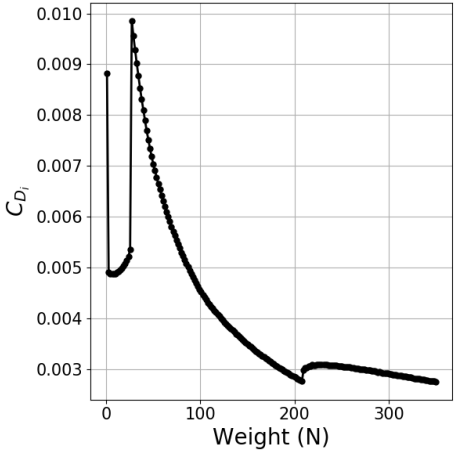
Sweep on W: Re and C_L

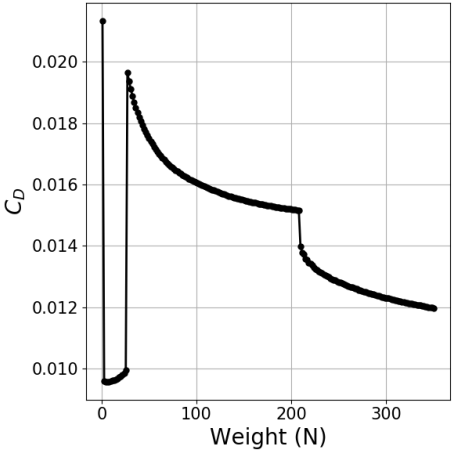




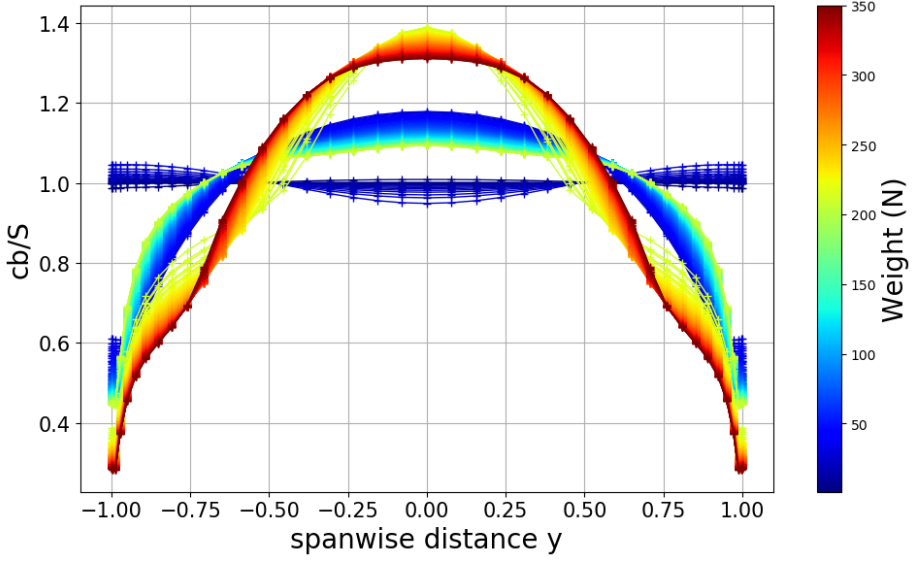
Sweep on W: C_{D_i} and C_{D_p}

Note the difference in scale.





Sweep on W: planform shape



Sweep on W: lift distribution $\frac{c_l c}{c_L S/b}$