Background

Now that you've become with how flow around an airfoil induces forces, we can extend that knowledge to find the total loads on any type of rotor. I say rotor because that could be a propeller, helicopter blade, or wind turbine blade. We will use Blade Element Momentum (BEM) theory to analyze our rotor. This theory is implemented in a package we will use called CCBlade (developed by Dr.Ning).

Assignment

1. Start a new branch on your repository. Name it something relevant to the project. Create issues for each of the following 5 steps of this assignment. Close them with a comment as you finish each step.

2. Read through the Wikipedia article on *Blade element momentum theory* to get a basic understanding. For further understanding, check out chapter 6 of the ME 515 textbook.

3. Complete the *Quick Start* section given in the CCBlade.jl documentation. Also complete the *Airfoil Data* section under *Guided Examples*. Take notes on how the functions are used as you will be using them. You may also consider completing the *Wind Turbine Operation* or *Helicopter Operation* sections under *Guided Examples* if that pertains to your project.

4. Analyze a rotor of your choice:

   - Analyze the APC 10x7. Consider the effect of advance ratio (J) on: the coefficient of thrust (C_T), the coefficient of torque (C_Q), the coefficient of power (C_P), and efficiency (η). Compare to experimental data found on the UIUC propeller database.
   - Analyze the UAE 20 kW wind turbine. Find the normal and tangential loading along the length of the blade. Compare this loading to experimental data.

5. Write a report (paper) on your methods, results, and takeaways as described in the course syllabus. You should include discussion on what you learned steps 2 and 4. Focus on the relationships found steps 4. Use the IMRAD format and the provided 1 column journal paper template. Make sure all of your packages are commented.

6. Submit your code and paper via a pull request as described in the course syllabus. In this assignment we expect a higher level of coding. In your code you should have:

   - Most of your code should be written in functions, with a small script to call your functions. Functions are faster and more modular.
   - All of your code should be commented. This doesn't mean that every line must have a comment, but sufficient comments throughout a required. Comments should make the intent of the code explicit, as well as provide a road map. Any complicated line of code should be commented.

- All of your code should be able to be run from a runfile. This means your code to produce any figures and run any experiements. The file shouldn't be too long because all of your functions should be in other files. Any data referenced in your code should be referenced by a relative path.
- ~~Your code should include a composite parametric type.~~ I'm sure that is a realistic requirement. Most code that the students will be writing won't have need of a composite type. I'm not sure contriving a situation for them to solve that would be best solved with a composite type is the best solution either.

Useful Resources

- ME 515 Textbook : Chapter 6
- Julia Documentation
- Google