Homework 4

This homework is based off of questions 5.14, 5.15, and 5.16 in the book. There are two aspects to these questions. First, you must write the appropriate code and measure its performance. Second, you must think about the theoretical performance — this requires thinking about the data flow of your functions rather than analyzing the performance numbers.

Note that we don't use true CPE values in the experiments. We measure nanoseconds rather than cycles. The main reason for this is simplicity. You can treat the values as if they are CPE jsut keep in mind that the numbers you see will differ both in value and semantics from those in the book.

To get you started, the function `inner` has been provided for you, which implements the calculation of the inner product of two vectors.

1. Implement the function `inner6x1` that uses 6×1 loop unrolling.
2. Implement the function `inner6x6` that uses 6×6 loop unrolling.
3. Implement the function `inner6x1a` that uses 6×1 loop unrolling and the reassociation transformation.
4. Measure the "CPE" (note that our CPE values are not true CPE values, we measure nanoseconds per element as a simplification) for each of these functions using `int` and `float` for `data_t`. Compare these values in a table showing the CPEs for all implementations (including the reference `inner`, which is provided for you). Note: You can change the data type from `int` to `float` by modifying the `typedef` of `data_t` on line 6 of `src/vector.h`.
   (a) Which optimization had the greatest impact on performance? Was this the same for both `int` and `float` data types? Why is this not surprising?
   (b) Assuming we all have the exact same code, would you expect everyone to have the exact same results? Why or why not? (Note: we are not talking about minor fluctuations in CPE values but rather material differences in the measurements).
5. Answer the book questions 5.14 (a and b), 5.15, and 5.16. Do not refer to the results of your own experiments when answering these questions. Instead, use the numbers they give you in the questiond. You will find Figure 5.12 helpful.