One Loop Heptagon **(Hard)**

This exercise assumes you did the previous exercise on the *Tree Level Heptagon*. We shall consider again so called *gluonic* component of the NMHV seven point amplitude. The source of data will be the `Mathematica` package `loop_amplitudes.m` which can be found in http://arxiv.org/abs/1303.4734.

- Download and load the package.
- We parametrize the kinematical data for this amplitude by defining the seven corresponding momentum twistors as in the tree level exercise. To extract the gluonic component $\mathcal{R}^{(1111)}$ at one loop we run

  ```
  superComponent[{1,2,3,4},{},{},{},{},{},{}]@ratioIntegral[7,1]
  ```

  However, very likely, you will find that this takes forever. To solve this you should open the package and look for the implementation of the function `superComponent` and "fix" it by removing the `FullSimplify`'s that are slowing it down dramatically without too much benefit. Save it and run again (now it should be immediate). (Disregard this it the extraction works fine for you)
- Write the one loop ratio function $\mathcal{R}^{(1111)}$ in terms of the OPE parameters $T_1, \ldots, F_2$ (as in the tree level exercise). Evaluate it at some numerical values. (for $T_1 = \cdots = F_2 = 1/2$ you should get -1.31742.) Observe, numerically, that $\mathcal{R}^{(1111)}$ vanishes for very small T_1, T_2.
- Expand one loop ratio function $\mathcal{R}^{(1111)}$ to order $T_1^4 T_2^4$. Save the result into a text file.

  As a cross-check, for $S_1 = S_2 = F_1 = F_2 = 1/2$ you should get -2.81451 for the coefficient of $T_1^2 T_2^2 \log(T_1)$. More generally you should find $\log(T_1)$ and $\log(T_2)$ factors but no $\log(T_1)^2$ or $\log(T_1)\log(T_2)$ etc. Hint: $T_1^4 T_2^4$ is a lot; warm up with a much lower order. Same advice applies to the next point.
- Continue by expanding $\mathcal{R}^{(1111)}$ further at large S_1, S_2 to order $S_1^{-20} S_2^{-20}$. Save the result into a text file.

  These are the sort of multiple expansions that are most straightforwardly analyzed when using the OPE approach to constrain perturbative results. See e.g. http://arxiv.org/abs/1407.4724 for a recent account for the hexagon case. So far all these huge expansions neatly come out of very simple OPE integrands.