Questions and answers - Marius Wiesemann Lecture 2

The following questions were submitted through Google Form. Some / all may have been answered in the Q&A session already. Nevertheless, we request our lecturers to provide written answers here for the benefit of those who could not attend that session. Thank you!

Slide 59-65: Why are there negative weights in NLO+PS events? MC@NLO vs. POWHEG. How to do Machine Learning on events in such case?

—> MC@NLO (as one can see on the slides) is additive and produces two sets of events, soft (B+V) events and hard (R) events. They are seperately showerd starting from a different number of partons in the final state (n and n+1). Both soft and hard events can have negative weights because of the applied subtraction (and adding) of the MC counter term. Only the sum of soft and hard events is physical. In Powheg this is different: The first radiation is completely generated by the Powheg procedure and replaces the first emission by the shower. So the shower starts always from n+1 (almost always, as there is also a no-emission probability in the Powheg factor, but n-parton events are very rare.) and the weights of the generated Powheg events are positive because Virtual and Real is directly added together in Powheg. There can still be a small fraction of negative weights, but it is substantially less than in MC@NLO. (with help from Josh Bendavid:) In principle, one can perform machine learning on the events with both positive and negative weights with an appropriate loss function. However, one has to ensure that one does not overtrain the network, otherwise one might get negative cross sections. If overtraining is avoided though, the network should automatically produce positive cross sections it should learn from the events that all physical observables are actually positive definite (which is true in both MC@NLO and Powheg of course). Otherwise, performing such approach on Powheg might be a bit simpler, as the fraction of negative weights is very low.

Slide 44: why does the no-emission probability have a negative sign in the exponent and the integral from v to v_0?

—> Because v_0 > v the integral has the usual definition from the lower to the higher scale. Note that v_0 > v, because v_0 is the starting scale and the shower produces subsequently softer emissions. The negative sign just reflects the exponentially decreasing propability that the is no emission the larger the integral between v and v_0 is. For instance that there is not a single emission if v_0 is the invariant mass of the system all the way down to v=Lambda_QCD is very unlikely.

Slide 2: How do you match NLO EW corrections to parton showers?

—> Real EW radiation is finite and can be described at the hard-process level. If we build a collider with much more energy, this picture might change, as weak bosons might be considered soft in that case and produce such large logarithms, that it might be required (or at least better) to resum them. At the LHC that is not necessary, and none of the current showers radiates heavy EW bosons. Thus, one is left with photons and QED radiation, which is can be turned on in parton showers. Thus the matching of EW corrections with parton showers, corresponds to matching only QED radiation, and this can be achieved exactly like for the QCD shower matching (of course abelianizing everything appropriately, but the method is in principle the same).