Manual
TLDR: Two Loop Diagram Repository
v0.1

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1 Introduction

The package TLDR, available from http://tldr.hepforge.org, contains the results for the scalar self-energies and tadpoles in Feynman gauge, along with rules for transforming them into the basis of integrals that can be evaluated by TSIL [1].

2 Getting started

The code can be downloaded to any directory. To load it, type

```
<<"[TDLR Directory]TLDR.m"
```

into Mathematica.

This will load the set of simple commands, rules, and results. The set of raw results are available as the arrays

```
unexpS, unexpSS
```

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which contain the 25 tadpoles and 121 self-energies in Feyman gauge, respectively.

Currently the *combined* results (that is, with ghost and four-point interactions involving gauge bosons removed) are available for self-energies only, and stored in

```
combinedSS
```

The format for this array is, e.g. for `combinedSS[[1]]`:

```
{1, SSS[i1 , i3 , i4 , 1] SSS[i2 , i3 , i5 , 1] SSSS[i4 , i5 , i6 , i6 , 1] (−(1/2)
   T[Df[k1, MS[i4 ]] Df[k1, MS[i5 ]] Df[k2, MS[i3 ]] Df[k3, MS[i6 ]]] + (
    MS[i6]^2 TOneLoop[Df[k1, MS[i4 ]] Df[k1, MS[i5 ]] Df[k2, MS[i3 ]]])/(2 del))}
```

The first entry is the "representative diagram" (i.e. the equivalent topology in the list unexpS) and the second is the combined expression. In this example unexpSS[[1]] and `combinedSS[[1,2]]` are identical, but `combinedSS` is significantly shorter: it only has 58 entries.

There are two special cases: `combinedSS[[52]]` and `combinedSS[[55]]`, corresponding to the self-energy diagrams 107 and 112. These still contain ghost/unexpanded four-point couplings involving vectors; we choose to leave them unreplaced. In future we will also give a version with the replaced couplings, but for now the rules to transform them can be found in our paper.

3 Replacement rules

The replacement rules are found in the directory

```
[TLDR DIRECTORY]/Package/Rules
```

but are loaded into memory once the package is started. They include rules that act on unexpanded expressions:

```
yintreds , p2intreds , ssintreds , ctintreds , myextraTreps
```

(here p2intreds is relevant for special cases of external momenta) and those that act on expanded expressions:

```
newtyrules , newttrules , newtcrules .
```

4 Applying the rules

To use them, we provide a (so-far rather primitive) function `expandanint`. For example,

```
expandanint[unexpSS[[1]]]
```

gives

```
B0fin[0, 0, MS[i6]^2] ((B0fin[p2, MS[i3]^2, MS[i5]^2] MS[i6]^2 SSS[i1, i3, i4,
   1] SSS[i2, i3, i5, 1] SSSS[i4, i5, i6, i6, 1])/(2 MS[i4]^2 − 2 MS[i5]^2) −
   (B0fin[p2, MS[i3]^2, MS[i4]^2] MS[i6]^2 SSS[i1, i3, i4, 1] SSS[i2, i3, i5,
   1] SSSS[i4, i5, i6, i6, 1])/(2 (MS[i4]^2 − MS[i5]^2)))
```

The set of functions returned are

```
B0fin, B0del, SMI, SMS, SMU, SMV, SMTT, SMTbar, SMM
```

The first two are one-loop functions, corresponding to

$$\begin{aligned} \texttt{B0fin}[p2,x,y] &= \mathrm{Fin}\Big[B_0(p2,x,y)\Big] \\ \texttt{B0del}[p2,x,y] &= \mathrm{Fin}\Big[\frac{1}{\epsilon}B_0(p2,x,y)\Big] \end{aligned}$$

while the others represent the integrals in the TSIL basis $I, S, U, V, T, \overline{T}, M$ respectively.

To simplify calculations we also provide the function `CouplingCollect` which draws out a the factor of the couplings, and `SimpleCollect` which provides the same information as an array.

To evaluate expressions we provide the command `TSILEvaluate`:

```
TSILEvaluate[expression, momentum−squared, renormalisation scale squared]
```

To use it you must set the path to the TSIL executable via $TSILExec; e.g.:

```
  $TSILExec=[path−to−TSIL]/tsil;
  TSILEvaluate[B0fin[0,100.0, 200.0], 0.0, 150.0]
```

gives:

```
 0.0191707 + 0. I
```

Currently `expandanint` will not deal with the special momentum cases and the user must apply our replacement rules themselves.

5 Other data

Other data are included in the directory `[TLDR Directory]/Repository`. In particular this includes postscript images of the generic topologies and diagrams, and `FeynArts` information about the topologies and insertions for the diagrams in the subdirectory `[TLDR Directory]/Repository/`

We include information about the special cases for each diagram in

```
{\tt [TLDR Directory]/Repository/Feynman/Uncombined}
```

in the files S_diagdeg.m, SS_diagdeg.m and information about the degeneracies of the integrals in S_intdeg.m, SS_intdeg.m.

We also provide the uncombined Landau gauge tadpoles in

```
[TLDR Directory]/Repository/Landau/Uncombined/RAW_unexpanded_LG_S.m
```

6 Outlook

The current version is little more than a collection of the results. In future, as we start to implement the results in SARAH, we intend to add many more features, in particular fully expanded versions of each degenerate case explicitly in a code that can be linked to TSIL. Please visit the website in future for more updates.

References

[1] S. P. Martin, D. G. Robertson, "TSIL: A Program for the calculation of two-loop self-energy integrals", Comput. Phys. Commun. **174**, 133 (2006), arXiv:hep-ph/0501132. 1