Chapter D

SMEFT

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Program summary
Program title: `CoDEx`
Version: `1.0.0`
Licensing provisions: `CC By 4.0`
Programming language: `Wolfram Language®`
Mathematica® Version: `10+`
URL: `https://effexteam.github.io/CoDEx`
Send BUG reports and questions: `effex.package@gmail.com`

1.1 Introduction

In spite of the non-observation of any new resonances after the discovery of the Standard Model (SM) Higgs-like particle, which announces the success of the SM, we have enough reason to believe the existence of theories beyond it (BSM), with the SM as a part. As any such theory will affect the electroweak and the Higgs sector, and the sensitivity of these precision observables is bound to increase in the near future, indirect estimation of the allowed room left for BSM using Standard Model effective field theory (SMEFT) is well motivated.

Provided that the S-matrix can be expanded perturbatively in the inverse powers of the ultraviolet scale (Λ^{-1}), and the resultant series is convergent, we can integrate out heavy degrees of freedom and the higher mass dimensional operators capture their impact through – $\sum_i (1/\Lambda^{d_i-4}) C_i \mathcal{O}_i$, where d_i is the operator mass dimension (>5), and C_i, a function of BSM parameters, is the corresponding Wilson coefficient. Among different choices of operator base, we restrict ourselves to '`SILH`' [1, 2] and '`Warsaw`' [3–6] bases. All WCs are computed at the cut-off scale Λ, usually identified as the mass of the heavy field. The truncation the $1/\Lambda$ series depends on the experimental precision of the observables [7]. Already, there has been quite good progress in building packages and libraries [8–13].

One can justifiably question the validity of choosing to use SMEFT over the full BSM Lagrangian; the answer lies in the trade-off between the computational challenge of the full BSM and the precision of the observables. The choice of Λ ensures the convergence of the M_Z/Λ series. Using the anomalous dimension matrix (γ) (which is basis dependent), the SMEFT WCs

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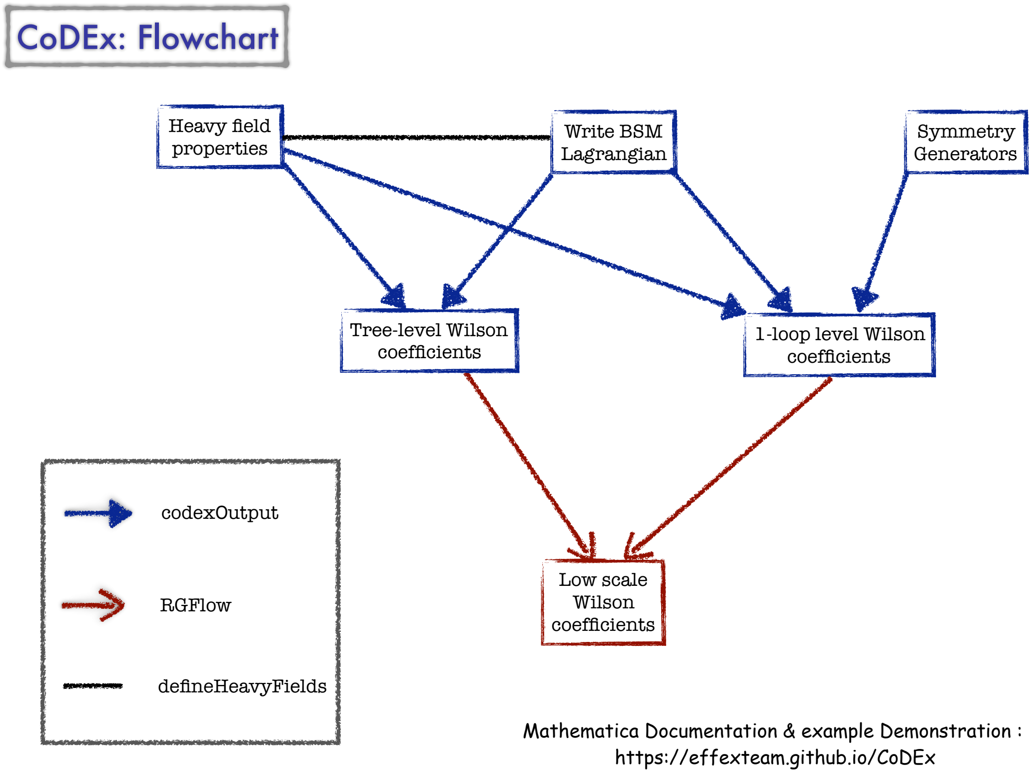

Fig. D.1.1: Flow-chart demonstrating the working principle of `CoDEx`

$C_i(\Lambda)$ (computed at Λ) are evolved to $C_i(M_Z)$, some of which are absent at the Λ scale, as the matrix γ contains non-zero off-diagonal elements. See Refs. [4–6, 14] regarding the running of the SMEFT operators. We need to choose only those 'complete' bases in which the precision observables are defined.

`CoDEx`, a *Mathematica*® package [15], in addition to integrating out the heavy field propagators from tree and one-loop processes and generating SMEFT operators up to dimension-6, provides the WCs as a function of BSM parameters (Fig. D.1.1). In this draft, we briefly discuss the underlying principle of **`CoDEx`**, and give one illustrative example of the workflow. Details about downloading, installation, and detailed documentation of the functions are available at the website [16].

1.2 The package in detail

`CoDEx` is a Wilson coefficient calculator, developed in the Mathematica environment. The algorithm of this code is based on the 'covariant derivative expansion' method discussed in Refs. [17–31]. Each and every detail of this package can be found in Ref. [16]. The main functions provided by this program are given in Table D.1.1. Here we have demonstrated the working methodology of **`CoDEx`** with an explicit example.

Table D.1.1: Main functions provided by CoDEx

Function	Details
CoDExHelp	Opens the **CoDEx** guide, with all help files listed
treeOutput	Calculates WCs generated from tree-level processes
loopOutput	Calculates WCs generated from one-loop processes
codexOutput	Generic function for WC calculation with choices for level, bases, etc., given with **OptionValues**
defineHeavyFields	Creates representation of heavy fields Use the output to construct BSM Lagrangian
texTable	Given a **List**, returns the LaTeX output of a tabular environment, displayed or copied to clipboard*
formPick	Applied on a list of WCs from a specific operator basis, reformats the output in the specified style
RGFlow	RG Flow of WCs of dim. 6 operators in **'Warsaw'** basis, from matching scale to a lower (arbitrary) scale
initializeLoop	Prepares the Isospin and colour symmetry generators for a specific model with a specific heavy field content: loopOutput can only be run after this step is completed

*This is a simplified version of the package titled TeXTableForm [32].

1.2.1 Detailed example: electroweak $SU(2)_L$ triplet scalar with hypercharge $Y = 1$

Here, we have demonstrated the workflow of **CoDEx** with the help of a complete analysis of a representative model.

$$\mathcal{L}_{\rm BSM} = \mathcal{L}_{\rm SM} \; + \mathrm{Tr}[(\mathcal{D}_\mu\Delta)^\dagger(\mathcal{D}^\mu\Delta)] - m_\Delta^2 \mathrm{Tr}[\Delta^\dagger\Delta] + \mathcal{L}_{\rm Y} - V(H,\Delta), \tag{1.1}$$

where

$$V(H,\Delta) = \zeta_1(H^\dagger H)\mathrm{Tr}[\Delta^\dagger\Delta] + \zeta_2(H^\dagger\tau^i H)\mathrm{Tr}[\Delta^\dagger\tau^i\Delta] + \left[\mu(H^{\rm T}\mathrm{i}\sigma^2\Delta^\dagger H) + \mathrm{h.c.}\right], \tag{1.2}$$

and

$$\mathcal{L}_Y = y_\Delta L^{\rm T} C\mathrm{i}\tau^2\Delta L + \mathrm{h.c.} \tag{1.3}$$

Here, the heavy field is Δ. Once this heavy field, Δ, is integrated out using **CoDEx**, the effective operators up to dimension-6 for both bases are generated. The effective operators and their respective Wilson coefficients are listed in Tables D.1.2 to D.1.4. Next, we give the exact steps that must be followed to run the code and compute the desired results.

1. First, load the package:

```
In[1]:= Needs["CoDEx"]
```

2. We have to define the field Δ as:

```
fields =
{
{fieldName, components, colorDim, isoDim,
hyperCharge, spin, mass}
};
```

Table D.1.2: Effective operators and Wilson coefficients in 'SILH' basis for complex triplet scalar ($Y = 1$) model.

$O_{2\mathrm{B}}$	$\frac{g_{\mathrm{Y}}^2}{160\pi^2 m_\Delta^2}$
$O_{2\mathrm{W}}$	$\frac{g_{\mathrm{W}}^2}{240\pi^2 m_\Delta^2}$
$O_{3\mathrm{W}}$	$\frac{g_{\mathrm{W}}^2}{240\pi^2 m_\Delta^2}$
O_6	$-\frac{\zeta_1\mu^2}{m_\Delta^4} - \frac{\zeta_2\mu^2}{4m_\Delta^4} - \frac{\zeta_1^3}{4\pi^2 m_\Delta^2} - \frac{\zeta_2^2\zeta_1}{32\pi^2 m_\Delta^2}$
O_{BB}	$\frac{\zeta_1}{32\pi^2 m_\Delta^2}$
O_{H}	$\frac{\zeta_1^2}{8\pi^2 m_\Delta^2} + \frac{\mu^2}{2m_\Delta^4}$
O_{R}	$\frac{\zeta_2^2}{96\pi^2 m_\Delta^2} + \frac{\mu^2}{m_\Delta^4}$
O_{T}	$\frac{\zeta_2^2}{192\pi^2 m_\Delta^2} - \frac{\mu^2}{2m_\Delta^4}$
O_{WB}	$-\frac{\zeta_2}{96\pi^2 m_\Delta^2}$
O_{WW}	$\frac{\zeta_1}{48\pi^2 m_\Delta^2}$

Table D.1.3: Effective operators and Wilson coefficients in 'Warsaw' basis for complex triplet scalar ($Y = 1$) model.

Q_{H}	$-\frac{\zeta_1\mu^2}{m_\Delta^4} - \frac{\zeta_2\mu^2}{4m_\Delta^4} - \frac{\zeta_1^3}{4\pi^2 m_\Delta^2} - \frac{\zeta_2^2\zeta_1}{32\pi^2 m_\Delta^2}$
$Q_{\mathrm{H}\Box}$	$\frac{\zeta_2^2}{192\pi^2 m_\Delta^2} + \frac{\mu^2}{2m_\Delta^4}$
Q_{HD}	$\frac{\zeta_1^2}{4\pi^2 m_\Delta^2} + \frac{\zeta_2^2}{96\pi^2 m_\Delta^2} - \frac{2\mu^2}{m_\Delta^4}$
Q_{HW}	$\frac{\zeta_1 g_{\mathrm{W}}^2}{48\pi^2 m_\Delta^2}$
Q_{HWB}	$-\frac{\zeta_2 g_{\mathrm{W}} g_{\mathrm{Y}}}{48\pi^2 m_\Delta^2}$
Q_{ll}	$\frac{\mathrm{y}_\Delta^2}{4m_\Delta^2}$
Q_{W}	$\frac{g_{\mathrm{W}}^3}{1440\pi^2 m_\Delta^2}$

Table D.1.4: Mass dimension-5 effective operators and Wilson coefficients for complex triplet scalar ($Y = 1$) model.

Dimension-5 operator	Wilson coefficient
llHH	$\frac{y_\Delta^2}{m_\Delta}$

We follow the convention in this line.

```
In[2]:= fieldewcts=
        {
        {hf,3,1,3,1,0,mΔ}
        };

In[3]:= hfvecst2ss=defineHeavyFields[fieldewcts];

In[4]:= δ=hfvecst2ss[[1,1]]

Out[4]= {hf[1,1]+i ihf[1,1],hf[1,2]+i ihf[1,2],hf[1,3]+i ihf[1,3]}
```

3. Now, we will build the Lagrangian after defining the heavy field. We need to provide only those terms that contain the heavy fields. The kinetic terms (covariant derivative and mass terms) of the heavy field will not play any role in this construction, and thus can be ignored. The Lagrangian is written in the following way:

```
In[5]:= Δ=Sum[δ[[i]] PauliMatrix[i], {i,3}];

In[6]:= Δc =i tau[2].Δ;

In[7]:= V=ζ1 dag[H].H Tr[dag[Δ].Δ]
           +ζ2 Sum[dag[H].tau[i].H Tr[dag[Δ].tau[i].Δ], {i,3}]
           +μ H.(i tau[2].dag[Δ]).H
           +μ dag[H].(-i Δ.tau[2]).hermitianConjugate[H];

In[8]:= lyukawa=Expand[yΣ Sum[Sum[hermitianConjugate[lepb[1][[i]]].
             gamma[0].chargeC.(Δc[[i,j]] lep[1][[j]]), {j,2}], {i,2}]
             +yΣ Sum[Sum[lepb[1][[i]].gamma[0].
             (dag[Δc][[i,j]] dag[chargeC].lep[1][[j]]), {j,2}], {i,2}]];

In[9]:= Lpotent2ss=Expand[lyukawa-V];

In[10]:= initializeLoop["t2ss",fieldt2ss]

Out[10]= Check the documentation page CoDExParafernalia for details.
```

» `Isospin Symmetry Generators for the field ‘hf’ are isot2ss[1,a] = tauadj[a]`

» `colour Symmetry Generators for the field ‘hf’ are colt2ss[1,a] = 0`

(See the documentation of **initializeLoop** for details.)

```
In[13]:= wcT2SSwar=codexOutput[Lpotent2ss,fieldt2ss,model→"t2ss"];
         formPick["Warsaw","Detailed2",wcT2SSwar,FontSize→Medium,
         FontFamily→"Times New Roman",Frame→All]
```

4. The operators can be generated in both ‘**SILH**’ and ‘**Warsaw**’ bases along with their respective Wilson coefficients. This output can be exported into a LaTeX format as well; see Table D.1.3.

```
In[14]:= wcT2SSsilh=codexOutput[Lpotent2ss,fieldt2ss,model→"t2ss",
         operBasis→"SILH"];
         formPick["SILH","Detailed2",wcT2SSsilh,FontSize→Medium,
         FontFamily→"Times New Roman",Frame→All]
```

The output of this is given in Table D.1.2.

```
In[15]:= wcT2SSdim5=codexOutput[Lpotent2ss,fieldt2ss,model→"t2ss",
                    operBasis→"Dim5"];
         formPick["Dim5","Detailed2",wcT2SSdim5,FontSize→Medium,
         FontFamily→"Times New Roman",Frame→All]
```

The output of this is given in Table D.1.4.

5. The RG evolution of these WCs can be performed only in the ‘**Warsaw**’ basis, as this is the complete one using **RGFlow**:

```
In[16]:= RGFlow[wcT2SSwar,m,μ]
```

Let us consider that the **CoDEx** output, which is the WCs at the high scale, is generated, and saved as:

In[17]:=
$$\texttt{wcT2SSwar}=\{\{\text{"qH"},-\frac{\zeta 1^3}{4\, m_\Delta^2\, \pi^2}-\frac{\zeta 1\, \zeta 2^2}{32\, m_\Delta^2\, \pi^2}-\frac{\zeta 1\, \mu^2}{m_\Delta^4}-\frac{\zeta 2\, \mu^2}{4\, m_\Delta^4}\},\ \{\text{"qHbox"},\frac{\zeta 2^2}{192\, m_\Delta^2\, \pi^2}+\frac{\mu^2}{2\, m_\Delta^4}\},\ \{\text{"qHD"},\frac{\zeta 1^2}{4\, m_\Delta^2\, \pi^2}+\frac{\zeta 2^2}{96\, m_\Delta^2\, \pi^2}-\frac{2\, \mu^2}{m_\Delta^4}\},\{\text{"qHW"},\frac{gW^2\, \zeta 1}{48\, m_\Delta^2\, \pi^2}\},\ \{\text{"qHWB"},-\frac{gW\, gY\, \zeta 2}{48\, m_\Delta^2\, \pi^2}\},\{\text{"qll[1,1,1,1]"},\frac{y\Sigma^2}{4\, m_\Delta^2}\},\{\text{"qW"},\frac{gW^3}{1440\, m_\Delta^2\, \pi^2}\}\}$$

Once we declare the matching scale (high scale) as the mass of the heavy particle (‘**m**’), we need to recall the function **RGFlow** to generate the WCs at low scale, as:

```
In[18]:= floRes1 = RGFlow[wcT2SSwar,m,μ]
```

Out[18]=

$$\Big\{\Big\{\text{qW},\frac{\text{gW}^3}{1440\,m_\triangle^2\,\pi^2}+\frac{29\,\text{gW}^5\,\text{Log}[\frac{\mu}{m}]}{46080\,m_\triangle^2\,\pi^4}\Big\},\Big\{\text{qH},-\frac{\zeta1^3}{4\,m_\triangle^2\,\pi^2}-\frac{\zeta1\,\zeta2^2}{32\,m_\triangle^2\,\pi^2}-\frac{\zeta1\,\mu^2}{m_\triangle^4}-\frac{\zeta2\,\mu^2}{4\,m_\triangle^4}-\frac{3\,\text{gW}^6\,\zeta1\,\text{Log}[\frac{\mu}{m}]}{256\,m_\triangle^2\,\pi^4}$$
$$-\frac{\text{gW}^4\,\text{gY}^2\,\zeta1\,\text{Log}[\frac{\mu}{m}]}{256\,m_\triangle^2\,\pi^4}-\frac{3\,\text{gW}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]}{32\,m_\triangle^2\,\pi^4}-\frac{3\,\text{gW}^4\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]}{256\,m_\triangle^2\,\pi^4}+\frac{3\,\text{gY}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]}{32\,m_\triangle^2\,\pi^4}$$
$$-\frac{3\,\text{gW}^2\,\text{gY}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]}{128\,m_\triangle^2\,\pi^4}-\frac{3\,\text{gY}^4\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]}{256\,m_\triangle^2\,\pi^4}+\frac{27\,\text{gW}^2\,\zeta1^3\,\text{Log}[\frac{\mu}{m}]}{128\,m_\triangle^2\,\pi^4}+\frac{9\,\text{gY}^2\,\zeta1^3\,\text{Log}[\frac{\mu}{m}]}{128\,m_\triangle^2\,\pi^4}$$
$$+\frac{\text{gW}^4\,\text{gY}^2\,\zeta2\,\text{Log}[\frac{\mu}{m}]}{256\,m_\triangle^2\,\pi^4}+\frac{\text{gW}^2\,\text{gY}^4\,\zeta2\,\text{Log}[\frac{\mu}{m}]}{256\,m_\triangle^2\,\pi^4}-\frac{\text{gW}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{256\,m_\triangle^2\,\pi^4}-\frac{\text{gW}^4\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{2048\,m_\triangle^2\,\pi^4}+\frac{\text{gY}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{256\,m_\triangle^2\,\pi^4}$$
$$-\frac{\text{gW}^2\,\text{gY}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{1024\,m_\triangle^2\,\pi^4}-\frac{\text{gY}^4\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{2048\,m_\triangle^2\,\pi^4}+\frac{27\,\text{gW}^2\,\zeta1\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{1024\,m_\triangle^2\,\pi^4}$$
$$+\frac{9\,\text{gY}^2\,\zeta1\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{1024\,m_\triangle^2\,\pi^4}+\frac{3\,\text{gW}^4\,\zeta1\,\lambda\,\text{Log}[\frac{\mu}{m}]}{64\,m_\triangle^2\,\pi^4}-\frac{\text{gW}^2\,\text{gY}^2\,\zeta2\,\lambda\,\text{Log}[\frac{\mu}{m}]}{64\,m_\triangle^2\,\pi^4}+\frac{5\,\text{gW}^2\,\zeta2^2\,\lambda\,\text{Log}[\frac{\mu}{m}]}{1152\,m_\triangle^2\,\pi^4}$$
$$+\frac{3\,\text{gW}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{4\,m_\triangle^4\,\pi^2}+\frac{3\,\text{gW}^4\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{32\,m_\triangle^4\,\pi^2}-\frac{3\,\text{gY}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{4\,m_\triangle^4\,\pi^2}$$
$$+\frac{3\,\text{gW}^2\,\text{gY}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{16\,m_\triangle^4\,\pi^2}+\frac{3\,\text{gY}^4\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{32\,m_\triangle^4\,\pi^2}+\frac{27\,\text{gW}^2\,\zeta1\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{32\,m_\triangle^4\,\pi^2}$$
$$+\frac{9\,\text{gY}^2\,\zeta1\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{32\,m_\triangle^4\,\pi^2}+\frac{27\,\text{gW}^2\,\zeta2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{128\,m_\triangle^4\,\pi^2}+\frac{9\,\text{gY}^2\,\zeta2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{128\,m_\triangle^4\,\pi^2}+\frac{5\,\text{gW}^2\,\lambda\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{12\,m_\triangle^4\,\pi^2}\Big\},$$

$$\Big\{\text{qHbox},\frac{\zeta2^2}{192\,m_\triangle^2\,\pi^2}+\frac{\mu^2}{2\,m_\triangle^4}+\frac{5\,\text{gY}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]}{192\,m_\triangle^2\,\pi^4}-\frac{\text{gW}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{768\,m_\triangle^2\,\pi^4}$$
$$+\frac{\text{gY}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{1536\,m_\triangle^2\,\pi^4}-\frac{\text{gW}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{8\,m_\triangle^4\,\pi^2}-\frac{\text{gY}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{4\,m_\triangle^4\,\pi^2}\Big\},$$

$$\Big\{\text{qHD},\frac{\zeta1^2}{4\,m_\triangle^2\,\pi^2}+\frac{\zeta2^2}{96\,m_\triangle^2\,\pi^2}-\frac{2\,\mu^2}{m_\triangle^4}+\frac{9\,\text{gW}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]}{128\,m_\triangle^2\,\pi^4}-\frac{5\,\text{gY}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]}{384\,m_\triangle^2\,\pi^4}$$
$$+\frac{3\,\text{gW}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{1024\,m_\triangle^2\,\pi^4}+\frac{5\,\text{gY}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{3072\,m_\triangle^2\,\pi^4}-\frac{9\,\text{gW}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{16\,m_\triangle^4\,\pi^2}+\frac{5\,\text{gY}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{16\,m_\triangle^4\,\pi^2}\Big\},$$

$$\Big\{\text{qHW},\frac{\text{gW}^2\,\zeta1}{48\,m_\triangle^2\,\pi^2}-\frac{\text{gW}^6\,\text{Log}[\frac{\mu}{m}]}{1536\,m_\triangle^2\,\pi^4}-\frac{53\,\text{gW}^4\,\zeta1\,\text{Log}[\frac{\mu}{m}]}{4608\,m_\triangle^2\,\pi^4}$$
$$-\frac{\text{gW}^2\,\text{gY}^2\,\zeta1\,\text{Log}[\frac{\mu}{m}]}{512\,m_\triangle^2\,\pi^4}-\frac{\text{gW}^2\,\text{gY}^2\,\zeta2\,\text{Log}[\frac{\mu}{m}]}{768\,m_\triangle^2\,\pi^4}\Big\},\Big\{\text{qHB},-\frac{\text{gW}^2\,\text{gY}^2\,\zeta2\,\text{Log}[\frac{\mu}{m}]}{256\,m_\triangle^2\,\pi^4}\Big\},$$

$$\Big\{\text{qHWB},-\frac{\text{gW}\,\text{gY}\,\zeta2}{48\,m_\triangle^2\,\pi^2}+\frac{\text{gW}^5\,\text{gY}\,\text{Log}[\frac{\mu}{m}]}{7680\,m_\triangle^2\,\pi^4}+\frac{\text{gW}^3\,\text{gY}\,\zeta1\,\text{Log}[\frac{\mu}{m}]}{384\,m_\triangle^2\,\pi^4}-\frac{\text{gW}^3\,\text{gY}\,\zeta2\,\text{Log}[\frac{\mu}{m}]}{576\,m_\triangle^2\,\pi^4}-\frac{19\,\text{gW}\,\text{gY}^3\,\zeta2\,\text{Log}[\frac{\mu}{m}]}{2304\,m_\triangle^2\,\pi^4}\Big\},$$

$$\Big\{\text{qeH}[1,1],\frac{3\,\text{gW}^4\,\zeta1\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{e}]}{256\,m_\triangle^2\,\pi^4}-\frac{3\,\text{gW}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{e}]}{128\,m_\triangle^2\,\pi^4}$$
$$+\frac{3\,\text{gY}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{e}]}{128\,m_\triangle^2\,\pi^4}+\frac{\text{gW}^2\,\text{gY}^2\,\zeta2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{e}]}{256\,m_\triangle^2\,\pi^4}$$
$$+\frac{\text{gW}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{e}]}{9216\,m_\triangle^2\,\pi^4}+\frac{\text{gY}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{e}]}{1024\,m_\triangle^2\,\pi^4}+\frac{7\,\text{gW}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{e}]}{24\,m_\triangle^4\,\pi^2}-\frac{3\,\text{gY}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{e}]}{16\,m_\triangle^4\,\pi^2}\Big\},$$

$$\Big\{\text{quH}[1,1],\frac{3\,\text{gW}^4\,\zeta1\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{512\,m_\triangle^2\,\pi^4}-\frac{3\,\text{gW}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{128\,m_\triangle^2\,\pi^4}$$
$$+\frac{3\,\text{gY}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{128\,m_\triangle^2\,\pi^4}+\frac{\text{gW}^2\,\text{gY}^2\,\zeta2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{768\,m_\triangle^2\,\pi^4}+\frac{\text{gW}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{9216\,m_\triangle^2\,\pi^4}$$
$$+\frac{\text{gY}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{1024\,m_\triangle^2\,\pi^4}+\frac{7\,\text{gW}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{24\,m_\triangle^4\,\pi^2}-\frac{3\,\text{gY}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{16\,m_\triangle^4\,\pi^2}\Big\},$$

$$\Big\{\text{qdH}[1,1],\frac{3\,\text{gW}^4\,\zeta1\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{d}]}{512\,m_\triangle^2\,\pi^4}-\frac{3\,\text{gW}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{d}]}{128\,m_\triangle^2\,\pi^4}$$
$$+\frac{3\,\text{gY}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{d}]}{128\,m_\triangle^2\,\pi^4}-\frac{\text{gW}^2\,\text{gY}^2\,\zeta2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{d}]}{768\,m_\triangle^2\,\pi^4}+\frac{\text{gW}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{d}]}{9216\,m_\triangle^2\,\pi^4}$$
$$+\frac{\text{gY}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{d}]}{1024\,m_\triangle^2\,\pi^4}+\frac{7\,\text{gW}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{d}]}{24\,m_\triangle^4\,\pi^2}-\frac{3\,\text{gY}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{d}]}{16\,m_\triangle^4\,\pi^2}\Big\},$$

$$\Big\{\text{qeW}[1,1],-\frac{\text{gW}^3\,\zeta1\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{e}]}{768\,m_\triangle^2\,\pi^4}-\frac{\text{gW}\,\text{gY}^2\,\zeta2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{e}]}{512\,m_\triangle^2\,\pi^4}\Big\},$$

$$\Big\{\text{qeB}[1,1],\frac{\text{gW}^2\,\text{gY}\,\zeta2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{e}]}{512\,m_\triangle^2\,\pi^4}\Big\},$$

$$\Big\{\text{quW}[1,1],-\frac{\text{gW}^3\,\zeta1\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{768\,m_\triangle^2\,\pi^4}-\frac{5\,\text{gW}\,\text{gY}^2\,\zeta2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{4608\,m_\triangle^2\,\pi^4}\Big\},$$

$$\Big\{\text{quB}[1,1],-\frac{\text{gW}^2\,\text{gY}\,\zeta2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{512\,m_\triangle^2\,\pi^4}\Big\},$$

$$\Big\{\text{qdW}[1,1],-\frac{\text{gW}^3\,\zeta1\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{d}]}{768\,m_\triangle^2\,\pi^4}-\frac{\text{gW}\,\text{gY}^2\,\zeta2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{d}]}{4608\,m_\triangle^2\,\pi^4}\Big\},$$

$$\Big\{\text{qdB}[1,1],\frac{\text{gW}^2\,\text{gY}\,\zeta2\,\text{Log}[\frac{\mu}{m}]\,\text{Yu}^\dagger[\text{u}]}{512\,m_\triangle^2\,\pi^4}\Big\},$$

$$\Big\{\text{q1Hl}[1,1],-\frac{\text{gY}^2\,\text{y}\Sigma^2\,\text{Log}[\frac{\mu}{m}]}{96\,m_\triangle^2\,\pi^2}-\frac{\text{gY}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]}{384\,m_\triangle^2\,\pi^4}-\frac{\text{gY}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{6144\,m_\triangle^2\,\pi^4}+\frac{\text{gY}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{64\,m_\triangle^4\,\pi^2}\Big\},$$

$$\Big\{\text{q3Hl}[1,1],\frac{\text{gW}^2\,\text{y}\Sigma^2\,\text{Log}[\frac{\mu}{m}]}{96\,m_\triangle^2\,\pi^2}+\frac{\text{gW}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{18432\,m_\triangle^2\,\pi^4}+\frac{\text{gW}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{192\,m_\triangle^4\,\pi^2}\Big\},$$

$$\Big\{\text{qHe}[1,1],-\frac{\text{gY}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]}{192\,m_\triangle^2\,\pi^4}-\frac{\text{gY}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{3072\,m_\triangle^2\,\pi^4}+\frac{\text{gY}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{32\,m_\triangle^4\,\pi^2}\Big\},$$

$$\Big\{\text{q1Hq}[1,1],\frac{\text{gY}^2\,\zeta1^2\,\text{Log}[\frac{\mu}{m}]}{1152\,m_\triangle^2\,\pi^4}+\frac{\text{gY}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{18432\,m_\triangle^2\,\pi^4}-\frac{\text{gY}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{192\,m_\triangle^4\,\pi^2}\Big\},$$

$$\Big\{\text{q3Hq}[1,1],\frac{\text{gW}^2\,\zeta2^2\,\text{Log}[\frac{\mu}{m}]}{18432\,m_\triangle^2\,\pi^4}+\frac{\text{gW}^2\,\mu^2\,\text{Log}[\frac{\mu}{m}]}{192\,m_\triangle^4\,\pi^2}\Big\},$$

$$
\begin{aligned}
&\{\mathtt{qHu[1,1]}, \frac{gY^2\ \zeta1^2\ \mathrm{Log}[\frac{\mu}{m}]}{288\ m_\triangle{}^2\ \pi^4}+\frac{gY^2\ \zeta2^2\ \mathrm{Log}[\frac{\mu}{m}]}{4608\ m_\triangle{}^2\ \pi^4}-\frac{gY^2\ \mu^2\ \mathrm{Log}[\frac{\mu}{m}]}{48\ m_\triangle{}^4\ \pi^2}\},\\
&\{\mathtt{qHd[1,1]}, -\frac{gY^2\ \zeta1^2\ \mathrm{Log}[\frac{\mu}{m}]}{576\ m_\triangle{}^2\ \pi^4}-\frac{gY^2\ \zeta2^2\ \mathrm{Log}[\frac{\mu}{m}]}{9216\ m_\triangle{}^2\ \pi^4}+\frac{gY^2\ \mu^2\ \mathrm{Log}[\frac{\mu}{m}]}{96\ m_\triangle{}^4\ \pi^2}\},\\
&\{\mathtt{qll[1,1,1,1]}, \frac{y\Sigma^2}{4\ m_\triangle{}^2}+\frac{11\ gW^2\ y\Sigma^2\ \mathrm{Log}[\frac{\mu}{m}]}{192\ m_\triangle{}^2\ \pi^2}+\frac{5\ gY^2\ y\Sigma^2\ \mathrm{Log}[\frac{\mu}{m}]}{64\ m_\triangle{}^2\ \pi^2}\},\{\mathtt{q1lq[1,1,1,1]}, -\frac{gY^2\ y\Sigma^2\ \mathrm{Log}[\frac{\mu}{m}]}{96\ m_\triangle{}^2\ \pi^2}\},\\
&\{\mathtt{q3lq[1,1,1,1]}, \frac{gW^2\ y\Sigma^2\ \mathrm{Log}[\frac{\mu}{m}]}{96\ m_\triangle{}^2\ \pi^2}\},\{\mathtt{qle[1,1,1,1]}, \frac{gY^2\ y\Sigma^2\ \mathrm{Log}[\frac{\mu}{m}]}{16\ m_\triangle{}^2\ \pi^2}\},\\
&\{\mathtt{qlu[1,1,1,1]}, -\frac{gY^2\ y\Sigma^2\ \mathrm{Log}[\frac{\mu}{m}]}{24\ m_\triangle{}^2\pi^2}\},\{\mathtt{qld[1,1,1,1]}, \frac{gY^2\ y\Sigma^2\ \mathrm{Log}[\frac{\mu}{m}]}{48\ m_\triangle{}^2\ \pi^2}\}\}
\end{aligned}
$$

We have provided the flexibility to users to reformat, save, or export all these WCs corresponding to the effective operators at the electroweak scale ($\boldsymbol{\mu}$) to LaTeX, using **formPick**. We have also provided an illustrative example:

```
In[19]:= formPick["Warsaw","Detailed2",floRes1,Frame→All,
                  FontSize→Medium,FontFamily→"Times New Roman"]
```

Out[19]=

Q_{W}	$\epsilon^{\mathrm{abc}}\mathrm{W}_{\rho}{}^{\mathrm{a},\mu}\mathrm{W}_{\mu}{}^{\mathrm{b},\nu}\mathrm{W}_{\nu}{}^{\mathrm{c},\rho}$	$\dfrac{29 g_{\mathrm{W}}{}^5 \log\left(\frac{\mu}{m_\Delta}\right)}{46080\pi^4 m_\Delta^2}+\dfrac{g_{\mathrm{W}}{}^3}{1440\pi^2 m_\Delta^2}$
$\vdots$	$\vdots$	$\vdots$
Q_{ld}	$(\bar{\mathrm{l}}\gamma_\mu\ \mathrm{l})(\bar{\mathrm{d}}\gamma_\mu\ \mathrm{d})$	$\dfrac{g_{\mathrm{Y}}{}^2 \mathrm{y}_{\Sigma}{}^2 \log\left(\frac{\mu}{m_\Delta}\right)}{48\pi^2 m_\Delta^2}$

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