FAIR principles guided end-to-end cyber-infrastructure for preservation of UFO models

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Background: UFO models

- Universal FEYNRULES Output (UFO) model [1]
  - Model of Beyond the Standard Model theory used by Monte Carlo event generators
  - Store different information of the particle model, in a generator-independent way, into different python files
  - A convenient way to access physics models on different platforms

Background: UFO models

- Model-independent files
  - `__init__.py` To make it a Python Package
  - `object_library.py` Classes for other variables (Attributes and functions)
  - `function_library.py` Define customized mathematical functions
  - `write_param_card.py` Generates a “param_card” for MadGraph

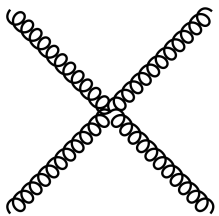
Background: UFO models

- Model-independent files
  - `parameters.py` Particle width
  - `particles.py` Properties and

[4]

Background: UFO models

- Format: Model-dependent files
  - `vertices.py` Information about interaction vertices in Feynman diagrams
  - `coupling_orders.py` Orders of couplings
  - `couplings.py` Coupling tensors
  - `lorentz.py` Lorentz tensors



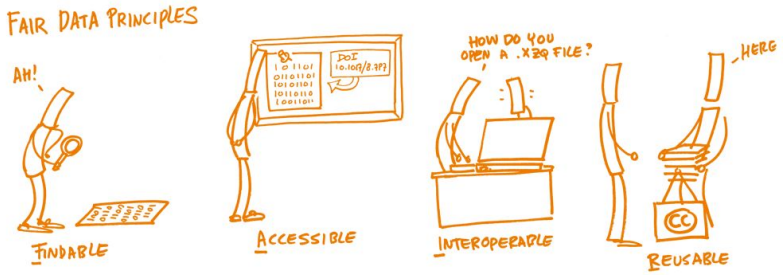
$$ig_s^2 f^{a_1a_2b} f^{ba_3a_4} \left(\eta^{\mu_1\mu_4}\eta^{\mu_2\mu_3} - \eta^{\mu_1\mu_3}\eta^{\mu_2\mu_4}\right) + ig_s^2 f^{a_1a_3b} f^{ba_2a_4} \left(\eta^{\mu_1\mu_4}\eta^{\mu_2\mu_3} - \eta^{\mu_1\mu_2}\eta^{\mu_3\mu_4}\right)$$
$$+ ig_s^2 f^{a_1a_4b} f^{ba_2a_3} \left(\eta^{\mu_1\mu_3}\eta^{\mu_2\mu_4} - \eta^{\mu_1\mu_2}\eta^{\mu_3\mu_4}\right),$$

```
V_37 = Vertex(name = 'V_37',
              particles = [ P.g, P.g, P.g, P.g ],
              color = [ 'f(-1,1,2)*f(3,4,-1)',
                        'f(-1,1,3)*f(2,4,-1)',
                        'f(-1,1,4)*f(2,3,-1)' ],
              lorentz = [ L.VVVV4, L.VVVV7, L.VVVV8 ],
              couplings = {(1,1):C.GC_12,(0,0):C.GC_12,(2,2):C.GC_12})
```

[4]

Background: FAIR Principles

- UFO Models stored in FeynRules Model Database[3]
  - Simply stored as compress containers
  - Inadequate trackable version controlling
  - Lack of findability and accessbility
- Findable, Accessible, Interoperable, Reusable (FAIR) Principles [2]
  - Guidelines for long term preservation of data/digital objects
  - Improve the ability of machines automatically search/use data
  - Help users better access/reuse existing data



Goal for the project

- Develop FAIR-inspired guidelines for UFO model preservation
- Create a set of tools, guided by the FAIR Principles, as an end-to-end cyberinfrastucture to bridge among the developers and users of UFO models
- For developers, a central, public repository will be published to handle registration and verification of the UFO models. Each model will be identified with a set of keywords, including the arXiv identifier and/or the Digital Object Identifier(DOI) for the associated publication.
- For users, a Python-based program will be built for searching and downloading UFO models

Current Achievements

- UFOManager
  - https://github.com/Neubauer-Group/UFOManager
  - Programs for registering UFO models and searching/downloading UFO models
  - Uploadv2.py and Uploadv3.py
  - Download.py
- UFOMetadata
  - https://github.com/Neubauer-Group/UFOMetadata
  - Preservation of UFO model metadata files
  - Continuous Integration on Github Workflow

UFOManager: Preparation for Upload

- Model folder
  - Compressed folder or directory containing model files
  - metadata.json
    - Author: name, (affiliation, contact)
    - Description
    - Paper_id: arXiv, DOI
- .txt files
  - Input to Upload.py
  - Paths to model folder

```
{
    "Author": [
        {"name" : "NAME",
         "affiliation(optional)": "AFFILIATION",
         "contact(optional)": "contact email address",
         "Comment (Don't include)": "Affiliation and contact are optional, but at least one contact is needed."},
        {"name" : "NAME",
         "affiliation(optional)": "AFFILIATION",
         "contact(optional)": "contact email address"}
    ],
    "Paper_id": {
        "doi" : "Digital Object Identifier",
        "arXiv" : "arXiv Identifier",
        "comment (Don't need to include)": "At least one of doi or arXiv identifier must be given"
    },
    "Description": "Write your description of your model here.",
    "Existing Model Doi(if you are using 'Update new version')": "Zenodo-issued concept-DOI for your model",
    "Model Doi(if you are using 'Upload metadata to GitHub')": "Zenodo DOI of your model"
}
```

UFOMana

- Validation c
  - metad
  - Model
  - Neces
  - Check
    - (
    - (
- Generate m
  - Model
  - Model

```
File count check: PASSED!
Check if initial "metadata.json" exists and correctly formatted: PASSED!
Check author information and contact information in initial metadata: PASSED!
Check paper information in initial metadata: PASSED!
Check for module imported as a python package: PASSED!
Check if model contains necessary model-independent files: PASSED!
Check if model contains necessary model-dependent files: PASSED!
Check if model contains well behaved "parameters.py": PASSED!
The model contains 98 parameters.
Check if model contains well behaved "particles.py": PASSED!
The model contains 51 fundamental particles
The model contains 11 new elementary particles and corresponding pdg codes are:
('G0', 250)
('y~', -6000008)
('tp', 6000006)
('bp', 6000007)
('x~', -6000005)
('x', 6000005)
('y', 6000008)
('tp~', -6000006)
('G-', -251)
('G+', 251)
('bp~', -6000007)
Check if model contains well behaved "vertices.py": PASSED!
The model contains 125 vertices
Check if model contains well behaved "coupling_orders.py": PASSED!
The model contains 3 coupling_orders
Check if model contains well behaved "couplings.py": PASSED!
The model contains 97 couplings
Check if model contains well behaved "lorentz.py": PASSED!
The model contains 39 lorentz tensors
Check if model contains well behaved "propagators.py": PASSED!
The model contains 4 propagators
Check if model contains well behaved "decays.py": PASSED!
The model contains 10 decays
```

UFOManager: Functions of Upload

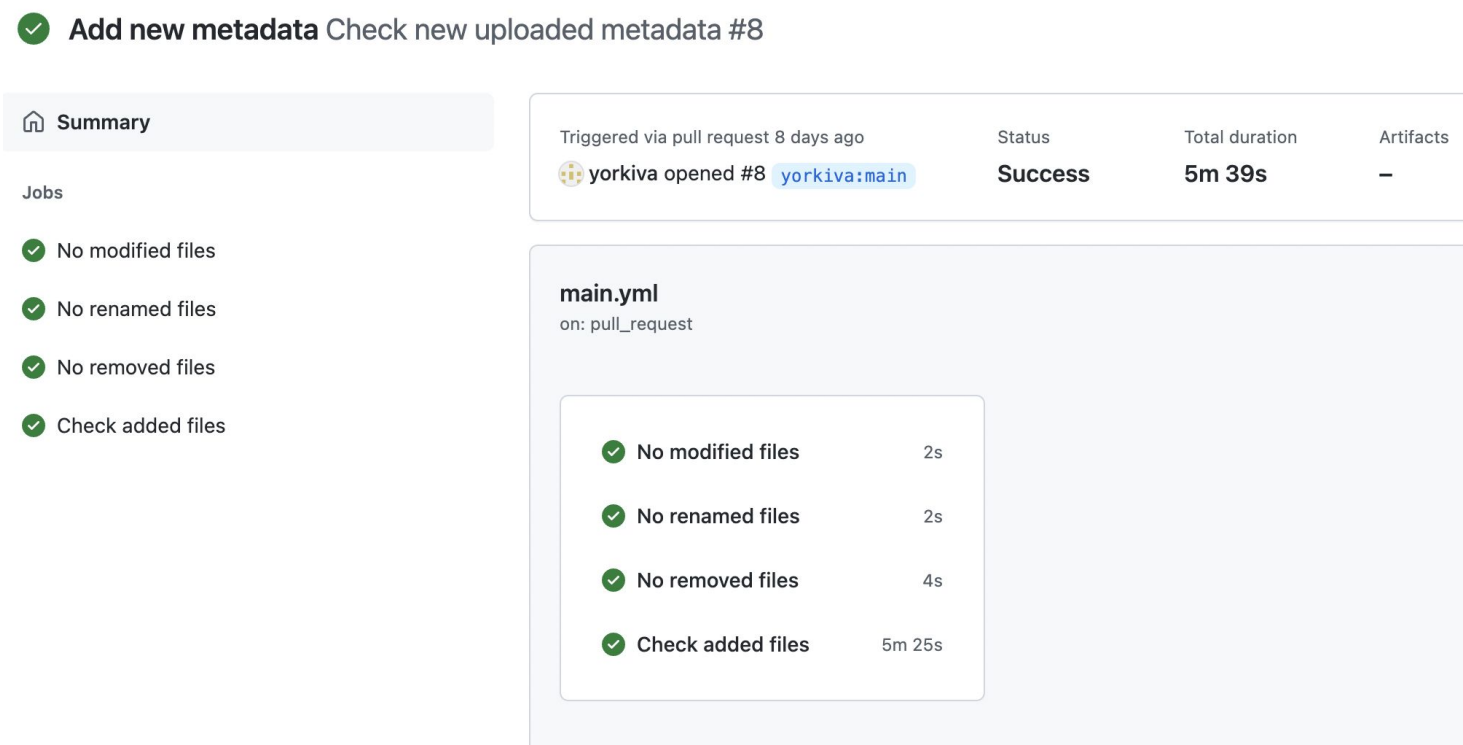
- Enriched Metadata example


```
{
    "Author": [
        {"name" : "NAME",
         "affiliation(optional)": "AFFILIATION",
         "contact(optional)": "contact email address",
         "comment (Don't include)": "affiliation and contact are optional, but at least one contact information is required."},
        {"name" : "NAME",
         "affiliation(optional)": "AFFILIATION",
         "contact(optional)": "contact email address"}
    ],
    "Paper_id": {
        "doi" : "Digital Object Identifier",
        "arXiv" : "arXiv Identifier",
        "comment (Don't include)": "At least one of doi or arXiv identifier must be given."
    },
    "Description": "Write your description of your model here.",
    "Model name" : "Name of your UFO model",
    "Model Doi" : "DOI of your model files, we encourage you to upload your model to Zenodo. Other organizations's DOI may not be downlable for now.",
    "Existing Model Doi" : "Add this if this metadata is a new version of existing,registered model",
    "Model Version" : "Your Model Version",
    "Model Python Version" : "Python2 or Python3",
    "All Particles": {
        "particle name1" : "corresponding pdg code, this input should be integer.",
        "particle name2" : "corresponding pdg code, this input should be integer.",
        "Comment (Don't include)": "For all particles, the key-value form should be kept in order to be readable by python."
    },
    "New elementary particles": {
        "new elementary particle 1": "new pdg code for this particle, this input should be integer",
        "new elementary particle 2": "new pdg code for this particle, this input should be integer"
    },
    "Number of parameters": "Number of parameters defined in your parameters.py, this input should be integer.",
    "Number of vertices": "Number of vertices defined in your vertices.py, this input should be integer.",
    "Number of coupling orders": "Number of coupling orders defined in your coupling_orders.py, this input should be integer.",
    "Number of coupling tensors": "Number of coupling tensors defined in your couplings.py, this input should be integer.",
    "Number of lorentz tensors": "Number of lorentz tensors defined in your lorentz.py, this input should be integer.",
    "Number of propagators": "Number of propagators defined in your propagators.py, this input should be integer. 0 if no propagators defined",
    "Number of decays": "Number of decays defined in your decays.py, this input should be integer. 0 if no decays defined"
}
```

UFOManager: Functions of Upload

- Upload model
  - Upload and publish model to Zenodo
  - Add enriched metadata of models to UFOMetadata
- Update new version
  - Publish new version of existing, registered models
  - “Existing Model Doi” required in metadata.json
- Uploade metadata to Github
  - Only add metadata of existing, registered models to UFOMetadata
  - “Model Doi” required in metadata.json

UFOMetadata: CI checks



UFOManager: Functions of Download

```
Please enter you Github access token:
Here is the UFOModel metadata file list.
['DMSimpt_NLO_v1_2_UFO.json', 'DMspin2.json', 'sgluons_NLO.json', 'stop_ttmet_NLO.json', 'SUSYQCD_UFO.json', 'vlq_v4_4fns.json', 'VLQ_v4_5FNS_UFO.json', 'VLQ_v5_4FNS_NLO_UFO.V2.0.json', 'VLQ_v5_4FNS_NLO_UFO.V3.0.json', 'VLQ_v5_4FNS_only3rd_NLO_UFO.json', 'VLQ_v5_5FNS_NLO_UFO.V2.0.json', 'VLQ_v5_5FNS_only3rd_NLO_UFO.json', 'VPrime_NLO.json']
You can choose the metadata you want to download:VLQ_v4_5FNS_UFO.json,vlq_v4_4fns.json
Please name your download folder:DownloadUFOmodels
Title: VLQ UFO model at NLO QCD with 5FS
Keywords:
Publication date: 2022-08-14
DOI: 10.5281/zenodo.6991118
Total size: 0.0 MB

Link: https://zenodo.org/api/files/7c85d4e9-d35f-4746-8bdb-c26873bd8037/VLQ_v4_5FNS_UFO.tgz   size: 0.0 MB
100% [.....................................................................] 32652 / 32652
Checksum is correct. (0c80fdca68512076 7ef928f6dbf0b576)
All files have been downloaded.
Title: VLQ UFO model at NLO QCD with 4FS
Keywords:
Publication date: 2022-08-09
DOI: 10.5281/zenodo.6977663
Total size: 0.0 MB

Link: https://zenodo.org/api/files/31e8d1be-01b6-41d0-bffd-0ffed14d7a53/vlq_v4_4fns.ufo.tgz   size: 0.0 MB
100% [.....................................................................] 37806 / 37806
Checksum is correct. (59323448b0e338b230835b3656321d59)
All files have been downloaded.
You have successfully downloaded your needed models in DownloadUFOmodels under the same path with this python script.
(VENV) zijun@DESKTOP-OD2C4L7:/mnt/c/Users/zijun/desktop/FormalAPI$ cd DownloadUFOmodels
(VENV) zijun@DESKTOP-OD2C4L7:/mnt/c/Users/zijun/desktop/FormalAPI/DownloadUFOmodels$ ls
VLQ_v4_5FNS_UFO.tgz  md5sums.txt  vlq_v4_4fns.ufo.tgz
You can search for model with Paper_id, Model Doi, pdg code or name (of certain particles).
Please choose your keyword type:Model Doi
Please enter your needed Model doi:10.5281/zenodo.7038908
Based on your search, we find models below:
Metadata file                 Model Name                                                  Paper ID                Description
----------------------------  ----------------------------------------------------------  ----------------------  ------------------------------------------------------------
VLQ_v5_4FNS_NLO_UFO.V2.0.json  Vector-like Quark UFO Model at NLO QCD with four flavour scheme  {'arXiv': '1610.04622'}  Vector-like Quark UFO Model at NLO QCD with four flavour scheme
vlq_v4_4fns.json              VLQ UFO model at NLO QCD with 4FS                           {'arXiv': '1610.04622'}  Vector-like Quark UFO Model at NLO QCD with four flavour scheme
VLQ_v5_4FNS_NLO_UFO.V3.0.json  Vector-like Quark UFO Model at NLO QCD with four flavour scheme  {'arXiv': '1610.04622'}  Vector-like Quark UFO Model at NLO QCD with four flavour scheme
Do you still want to search for models? Please type in Yes or No.Yes
Please choose your keyword type:pdg code
Please enter your needed pdg code:250,6000006
Based on your search, we find models below:
Metadata file                   Model Name                                                                    Paper ID                Description
------------------------------  ----------------------------------------------------------------------------  ----------------------  ----------------------------------------------------------------------------------------------
vlq_v4_4fns.json                VLQ UFO model at NLO QCD with 4FS                                             {'arXiv': '1610.04622'}  Vector-like Quark UFO Model at NLO QCD with four flavour scheme
VLQ_v4_5FNS_UFO.json            VLQ UFO model at NLO QCD with 5FS                                             {'arXiv': '1610.04622'}  Vector-like Quark UFO Model at NLO QCD with five flavour scheme
VLQ_v5_4FNS_NLO_UFO.V2.0.json   Vector-like Quark UFO Model at NLO QCD with four flavour scheme               {'arXiv': '1610.04622'}  Vector-like Quark UFO Model at NLO QCD with four flavour scheme
VLQ_v5_4FNS_NLO_UFO.V3.0.json   Vector-like Quark UFO Model at NLO QCD with four flavour scheme               {'arXiv': '1610.04622'}  Vector-like Quark UFO Model at NLO QCD with four flavour scheme
VLQ_v5_4FNS_only3rd_NLO_UFO.json  Vector-like Quark UFO Model at NLO QCD with four flavour scheme (third generation)  {'arXiv': '1610.04622'}  Vector-like Quark UFO Model at NLO QCD with four flavour scheme (3rd generation only)
VLQ_v5_5FNS_NLO_UFO.V2.0.json   Vector-like Quark UFO Model at NLO QCD with five flavour scheme               {'arXiv': '1610.04622'}  Vector-like Quark UFO Model at NLO QCD with five flavour scheme
VLQ_v5_5FNS_only3rd_NLO_UFO.json  Vector-like Quark UFO Model at NLO QCD with five flavour scheme (third generation)  {'arXiv': '1610.04622'}  Vector-like Quark UFO Model at NLO QCD with five flavour scheme (3rd generation only)
Do you still want to search for models? Please type in Yes or No.No
```

August 9, 2022

Dataset | Open Access

VLQ UFO model at NLO QCD with 4FS

Luca Panizzi; Benjamin Fuks

Vector-like Quark UFO Model at NLO QCD with four flavour scheme

Files (37.8 kB)

Name	Size	
vlq_v4_4fns.ufo.tgz	37.8 kB	Download

md5:59323448b0e338b230835b3656321d59

Beta

Citations 0

Show only: Literature (0) Dataset (0) Software (0) Unknown (0)

Citations to this version

Search

No citations.

Publication date:
August 9, 2022

DOI:
DOI 10.5281/zenodo.6977663

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Versions

Version 3.0 10.5281/zenodo.7039382	Aug 31, 2022
Version 2.0 10.5281/zenodo.7038908	Aug 31, 2022
Version 1 10.5281/zenodo.6977663	Aug 9, 2022

References

1.C. Degrande, C. Duhr, B. Fuks, D. Grellscheid, O. Mattelaer, T. Reiter, UFO – the universal FeynRules output, Comput. Phys. Comm. 183 (6) (2012) 1201–1214, http://dx.doi.org/10.1016/j.cpc.2012.01.022.

2.M. Wilkinson, M. Dumontier, I. Aalbersberg, et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci Data 3, 160018 (2016). https://doi.org/10.1038/sdata.2016.18

3.FeynRules model database. https://feynrules.irmp.ucl.ac.be/wiki/ModelDatabaseMainPage

4. L. Panizzi, B. Fuks. Vector like quarks. FeynRules models to be used for NLO calculations with aMC@NLO (2016). https://feynrules.irmp.ucl.ac.be/wiki/NLOModels

Thank you for listening!

Any questions?