Feynman diagrams package for python 3

Python II project

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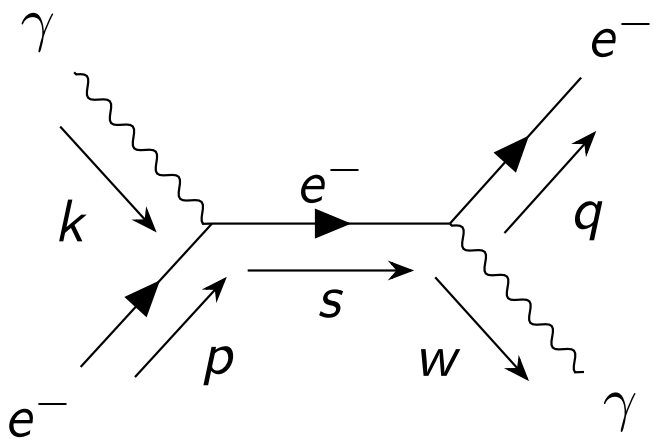
Basis idea and introduction to Feynman diagrams

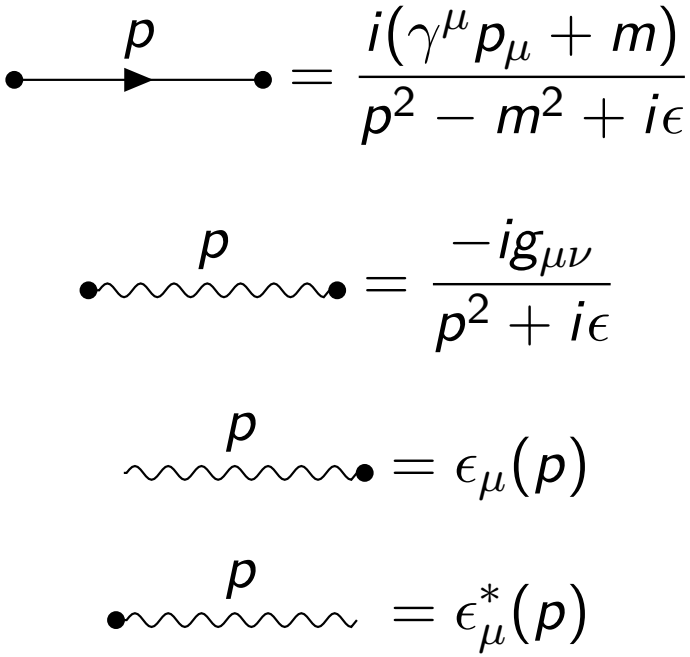
"A Feynman diagram is a pictorial representation of the mathematical expressions describing the behavior and interaction of subatomic particles." Wikipedia

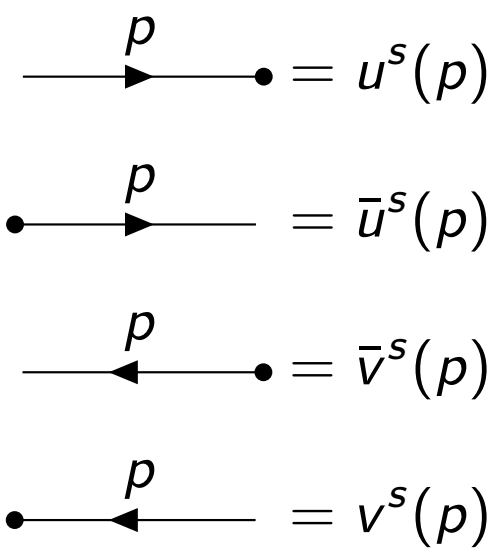


$$\int \frac{\mathrm{d}^4 p}{(2\pi)^4} \epsilon_\mu(k) iQe\gamma^\mu u^s(p) \left[\frac{i(\gamma^\mu s_\mu + m)}{s^2 - m^2 + i\epsilon} iQe\gamma^\mu \right] \bar{u}^s(q) iQe\gamma^\mu \epsilon^*_\mu(w)$$

Focus on QED

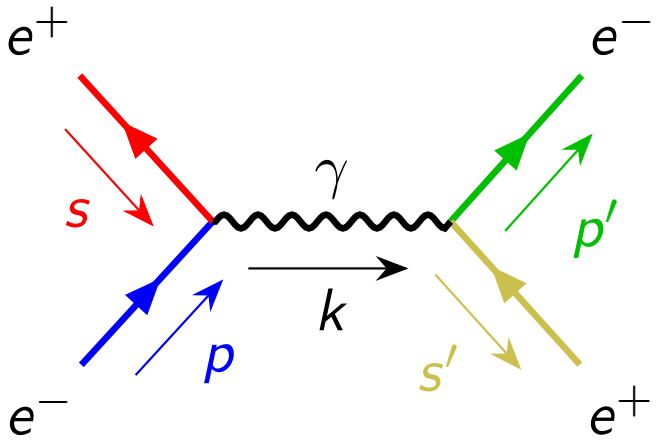
Each QFT is described by a set of rules. Here are the ones for QED (the value of the QED vertex is $iQe\gamma^{\mu}$):





From diagram to integral

- Time ordered integral
- Feynman's rules



$$\int \frac{\mathrm{d}^4 p}{(2\pi)^4} \bar{v}^s(s) iQe\gamma^\mu u^s(p) \left[\frac{-ig_{\mu\nu}}{k^2 + i\epsilon}\right] \bar{u}^s(p') iQe\gamma^\mu v^s(s')$$

Goals

The package has two goals :

- Create and display a Feynman diagram with Tikz-feynman LaTeXpackage
- Display the integral associated to a Feynman diagram

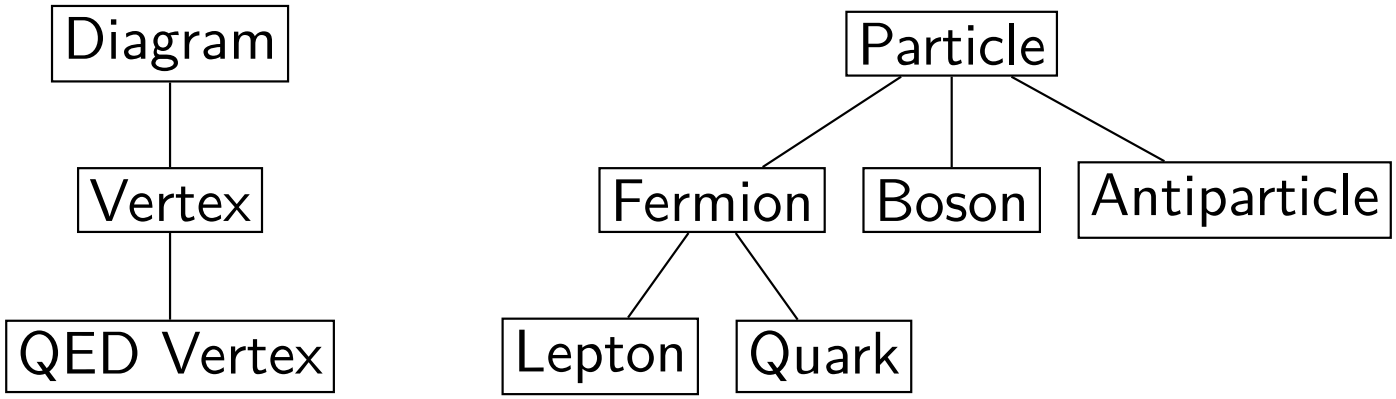
Does it work ? Yes !

How does it work then ?

Package organisation

Only QED is implemented at the moment, but the other interactions can be added easily.

Inheritance diagram :



Package organisation

The diagram is seen as a tree structure with nodes (vertices), leaves and edges (particles and propagators).

Examples

```
A = QED_Vertex("A", diagram=d)
B = QED_Vertex("B", d)
e1 = Electron(name="e1", momentum='p')
e2 = Electron("e2", 's')
e3 = Electron("e3", 'q')
gamma1 = Photon("gamma1", 'k')
gamma2 = Photon("gamma2", 'w')
A.connect_particle_in(e1, gamma1)
A.connect_vertex_out(B, e2)
B.connect_particle_out(e3, gamma2)
```

Creation of a diagram image

- Creation of the diagram, vertices, particles...
- Creation of a LaTeXcode for tikz-feynman
- Creation and compilation of a .tex file
- Convert the .pdf to a .png
- Display the .png file in the jupyter notebook

Warning ! The .tex file is compiled with LuaLaTeX (mandatory for tikz-feynman)

Creation of a diagram integral

- Creation of the diagram, vertices, particles...
- Creation of LaTeX code for each particle and vertex with respect to the time ordering
- Display the integral in the jupyter notebook

In practice

Now, let's see what it looks like in practice !