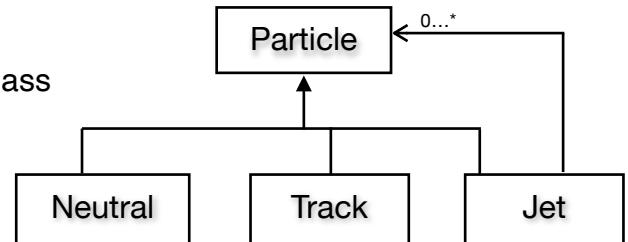


You must submit your exam by **Tuesday, Jun 22, at 13:00** following the instruction at <http://www.roma1.infn.it/people/rahatlou/index.php?link=Didattica&sublink=cmp/exams>

### Jets and Particles with Composite Pattern

The goal of the exercise is to implement the composite pattern for jets with tracks and neutrals. You need to implement the classes depicted in the figure below.

- **Particle** must be an abstract class
- Implement appropriate constructor(s) for each class
- **Particle** must have the following methods
  - **mass()** returning the invariant mass of the object properly implemented for each class
  - **p4()** returning the 4-momentum
    - You can use your own 4-vector class or use the ROOT `TLorentzVector`
  - **pt()** returning the transverse momentum of the object
  - make sure the methods behave properly for each sub-class
- **Jet** must have the proper function **add()** to behave as a composite object



Additional classes and methods are not necessary but if implemented will be evaluated.

You can test your code by creating

- A **Jet** object `j1` made of 2 **Track** objects `t1` and `t2`
- A **Jet** object `j2` made of a **Track** `t3`, a **Neutral** `n1`, and `j1`

I recommend choosing the momenta for the objects in such a way that you can easily compute the invariant mass and transverse momentum and compare with the implemented functions.

Evaluation will be based on: successful compilation, separation of the code in header and source files, correct use of C++ syntax, return type and arguments of functions, choice of data members and interface for each class, unnecessary void functions, use of unnecessary C features, and correct mathematical and physical operations.

You have to submit the implementation for the four classes in the diagram as well as a test application (`app.cc`).