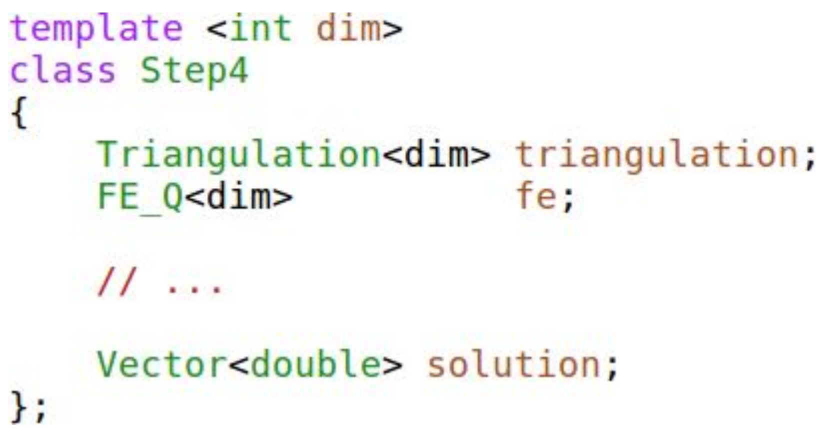
C++ Templates and usage in deal.II

Templates in C++

- “blueprints” to generate functions and/or classes
- Template arguments are either numbers or types
- No performance penalty!
- Very powerful feature of C++ but difficult syntax, ugly error messages, slow compilation
- More info:
  http://www.cplusplus.com/doc/tutorial/templates/
  http://www.math.tamu.edu/~bangerth/videos.676.12.html



```
template <int dim>
class Step4
{
    Triangulation<dim> triangulation;
    FE_Q<dim>          fe;

    // ...

    Vector<double> solution;
};
```

Usage in deal.II

- Step-4 works in 2d and 3d:

```
template <int dim>
void make_grid (Triangulation<dim> &triangulation) {...}
```

- In deal.II so that we have Vector<double> and Vector<float>:

```
template<typename number>
class Vector< number > { number [] elements; ...};
```

- Default values (embed dim-dimensional object in spacedim):

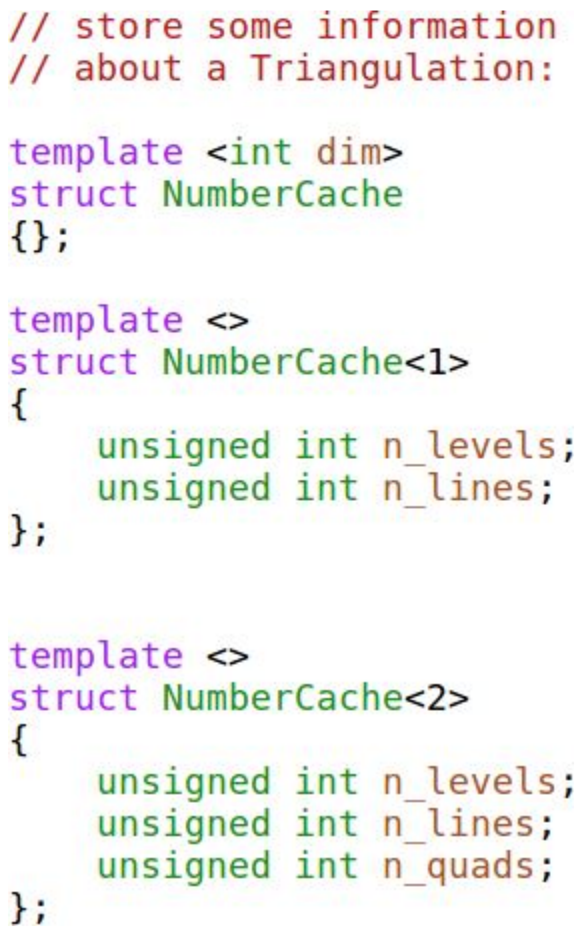
```
template<int dim, int spacedim=dim>
class Triangulation< dim, spacedim > { ... };
```

- Already familiar:

```
template<int dim, int spacedim>
void GridGenerator::hyper_cube  (Triangulation< dim, spacedim > &       tria,
                                  const double left,
                                  const double right)
{...}
```

Explicit Specialization

- different blueprint for a specific type T or value



```
// store some information
// about a Triangulation:

template <int dim>
struct NumberCache
{};

template <>
struct NumberCache<1>
{
    unsigned int n_levels;
    unsigned int n_lines;
};


template <>
struct NumberCache<2>
{
    unsigned int n_levels;
    unsigned int n_lines;
    unsigned int n_quads;
};
```

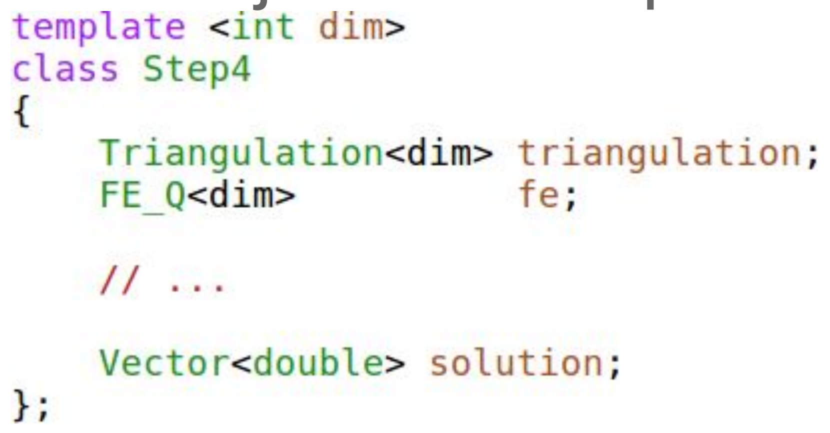
step-3 vs step-4

- step4: dimension independent version of step-3
- replace

  Triangulation<2>, DoFHandler<2>, …

  by

  Triangulation<dim>, DoFHandler<dim>, …
- main object is a template class:



```
template <int dim>
class Step4
{
    Triangulation<dim> triangulation;
    FE_Q<dim>          fe;

    // ...

    Vector<double> solution;
};
```

- also see the difference in main()