DESIGNING NEW INTERFACES FOR ROOT DATA PROCESSING

EP - SFT
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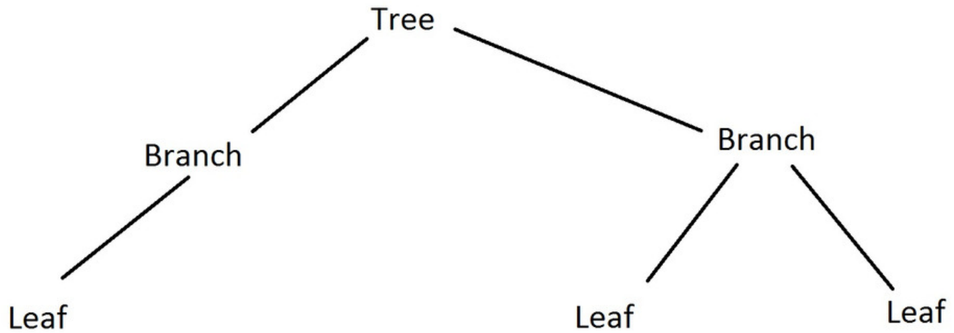
ROOT
Data Analysis Framework

BACKGROUND

Tree

- Tree is an (ADT) abstracted data type
- Trees have branches and branches have leaves
- Widely used
  - Also at LHC: ROOT TTrees



BACKGROUND

Usage of TTree

In [ ]:

```
TFile f('data.root')
TTree t = f.Get('T')
t->Draw(">>myEntryList",func1 & func2 & func3,"LEGO");
TEntryList* myEntryList;
gDirectory->GetObject("myEntryList",myEntryList);
t->SetEntryList(myEntryList);
t->Draw("Var1:Var2", func4, "LEGO");
```

CHAINS OF FUNCTIONAL PRIMITIVES

```
In [ ]: (roottree.tree('data.root', 'T')
        .filter(func1)
        .map(func2)
        .filter(func3)
        .cache()
        .filter(func4)
        .histo('Var1:Var2')
        .Draw('LEGO'))
```

func can be any callable object,
a usual function, a callable of a class or a lambda.

TDATAFRAME

- New class to ROOT

- Works as a dataset class
    - Describes a TTree

- Possibility to use functional chains

- Possibility to cache

t.filter(func1).filter(func2).cache()

Identifies if the functions stay the same or not

t.filter(func2).filter(func1).cache()

Caches the values again, because the order has changed

func can be any callable object,
a usual function, a callable of a class or a lambda.

FUNCTION TYPES

Transformations

Lazy functions, in that they do not compute their results right away. Instead, they just remember the transformations applied to some base dataset

- Filter(): Filter out all the elements of the dataset
- Map(): Returns a new dataset with the elements changed by function
- FlatMap():Map a function over a dataset and flatten the result with one level

FUNCTION TYPES

Actions

Functions, that return a value to the driver program after running a computation on the dataset

- Draw(): Draws the histogram according its options
- Histo(): Creates histogram and fills it with the results
- Cache(): Caches the result for later use.

CACHING

```
DataFrame.filter(function).map(function).cache()
```

Caches the filtered and mapped result
-> Allows the usage of the cached result to be a lot faster the next time you call for it

DataFrame = dataset, for example a TTree

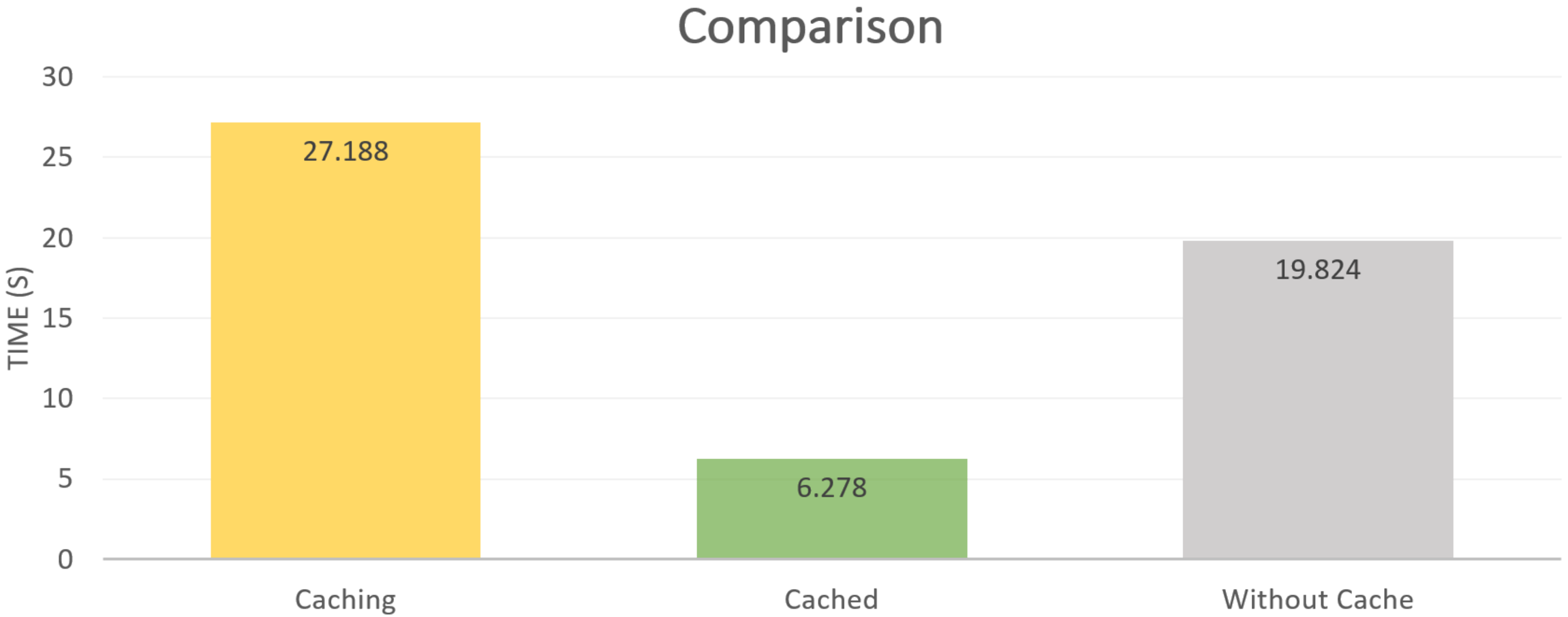
USING CACHE

```
DataFrame.filter(function).map(function).cache().filter(function)
.Draw('LEGO')
```

Uses the cached values and filters that once and then draws it.
-> We save time by having a cache of the first results

DataFrame = dataset, for example a TTree

TEST RESULTS



- data.root, 4 293 120 entries

STATUS OF THE PROJECT

Python implementation

Python implementation is almost ready
- Needs more transformations and actions

C++ implementation

C++ implementation in in progress
- Waiting the identifying of all the needed transformations and actions

THANK YOU !

Oulu

65°01′N 025°28′E

Temperature: +30 celsius to -30 celsius

Population: ~200’000

BACKUP SLIDES

APACHE SPARK

Transformation	Meaning
map(*func*)	Return a new distributed dataset formed by passing each element of the source through a function *func*.
filter(*func*)	Return a new dataset formed by selecting those elements of the source on which *func* returns true.
flatMap(*func*)	Similar to map, but each input item can be mapped to 0 or more output items (so *func* should return a Seq rather than a single item).
mapPartitions(*func*)	Similar to map, but runs separately on each partition (block) of the RDD, so *func* must be of type Iterator<T> => Iterator<U> when running on an RDD of type T.
mapPartitionsWithIndex(*func*)	Similar to mapPartitions, but also provides *func* with an integer value representing the index of the partition, so *func* must be of type (Int, Iterator<T>) => Iterator<U> when running on an RDD of type T.
sample(*withReplacement*, *fraction*, *seed*)	Sample a fraction *fraction* of the data, with or without replacement, using a given random number generator seed.
union(*otherDataset*)	Return a new dataset that contains the union of the elements in the source dataset and the argument.

APACHE SPARK

Action	Meaning
reduce(*func*)	Aggregate the elements of the dataset using a function *func* (which takes two arguments and returns one). The function should be commutative and associative so that it can be computed correctly in parallel.
collect()	Return all the elements of the dataset as an array at the driver program. This is usually useful after a filter or other operation that returns a sufficiently small subset of the data.
count()	Return the number of elements in the dataset.
first()	Return the first element of the dataset (similar to take(1)).
take(*n*)	Return an array with the first *n* elements of the dataset.

MORE COMPLEX EXAMPLE

In [ ]:

```
TFile f('data.root')
TTree t = f.Get('T')
t->Draw(">>myEntryList",func1 & func2 & func3,"LEGO");
TEntryList* myEntryList;
gDirectory->GetObject("myEntryList",myEntryList);
int nEntries = myEntryList->GetN();
t->SetEntryList(myEntryList);
int treenum, iEntry, chainEntry;
treenum = iEntry = chainEntry = -1;
for(Long64_t i=0 ; i<nEntries ; i++){
    iEntry = myEntryList->GetEntryAndTree(i, treenum);
    t->LoadTree(treenum);
    chainEntry = IEntry + (t->GetTreeOffset())[treenum];
    t->GetEntry(chainEntry);

    [... compute and filter func4 and fill a histogram ...]
}
```