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Chapter 1

Object Ownership

An object has ownership of another object if it has permission to delete it. Usually a collection or a parent object such as a pad holds ownership. To prevent memory leaks and multiple attempts to delete an object, you need to know which objects ROOT owns and which are owned by you.

The following rules apply to the ROOT classes.

- Histograms, trees, and event lists created by the user are owned by current directory (*gDirectory*). When the current directory is closed or deleted the objects it owns are deleted.
- The TROOT master object (*gROOT*) has several collections of objects. Objects that are members of these collections are owned by *gROOT* see “Ownership by the Master TROOT Object (*gROOT*)”.
- Objects created by another object, for example the function object (e.g. *TF1*) created by the *TH1::Fitmethod* is **owned by the histogram**.
- An object created by *DrawCopy* methods, is owned by the pad it is drawn in.

If an object fits none of these cases, the user has ownership. The next paragraphs describe each rule and user ownership in more detail.

1.1 Ownership by Current Directory (*gDirectory*)

When a histogram, tree, or event list (*TEventList*) is created, it is added to the list of objects in the current directory by default. You can get the list of objects in a directory and retrieve a pointer to a specific object with the *GetList* method. This example retrieves a histogram.

```
TH1F *h = (TH1F*)gDirectory->GetList()->FindObject("myHist");
```

The method *TDirectory::GetList()* returns a *TList* of objects in the directory. It looks in memory, and is implemented in all ROOT collections. You can change the directory of a histogram, tree, or event list with the *SetDirectory* method. Here we use a histogram for an example, but the same applies to trees and event lists.

```
h->SetDirectory(newDir);
```

You can also remove a histogram from a directory by using *SetDirectory(0)*. Once a histogram is removed from the directory, it will not be deleted when the directory is closed. It is now your responsibility to delete this histogram once you have finished with it. To change the default that automatically adds the histogram to the current directory, you can call the static function:

```
TH1::AddDirectory(kFALSE);
```

Not all histograms created here after will be added to the current directory. In this case, you own all histogram objects and you will need to delete them and clean up the references. You can still set the directory of a histogram by calling *SetDirectory* once it has been created as described above.

Note that, when a file goes out of scope or is closed all objects on its object list are deleted.

1.2 Ownership by the Master TROOT Object (gROOT)

The master object *gROOT*, maintains several collections of objects. For example, a canvas is added to the collection of canvases and it is owned by the canvas collection.

```
TSeqCollection* fFiles      List of TFile
TSeqCollection* fMappedFiles List of TMappedFile
TSeqCollection* fSockets    List of TSocket and TServerSocket
TSeqCollection* fCanvases   List of TCanvas
TSeqCollection* fStyles     List of TStyle
TSeqCollection* fFunctions  List of TF1, TF2, TF3
TSeqCollection* fTasks     List of TTask
TSeqCollection* fColors     List of TColor
TSeqCollection* fGeometries List of geometries
TSeqCollection* fBrowsers   List of TBrowser
TSeqCollection* fSpecials   List of special objects
TSeqCollection* fCleanups   List of recursiveRemove collections
```

These collections are also displayed in the root folder of the Object Browser. Most of these collections are self explanatory. The special cases are the collections of specials and cleanups.

1.2.1 The Collection of Specials

This collection contains objects of the following classes: *TCutG*, *TMultiDimFit*, *TPrincipal*, *TChains*. In addition it contains the *gHtml* object, *gMinuit* objects, and the array of contours graphs (*TGraph*) created when calling the Draw method of a histogram with the "CONT, LIST" option.

1.2.2 Access to the Collection Contents

The current content for a collection listed above can be accessed with the corresponding *gROOT->GetListOf* method (for example *gROOT->GetListOfCanvases*). In addition, *gROOT->GetListOfBrowsablees* returns a collection of all objects visible on the left side panel in the browser. See the image of the Object Browser in the next figure.

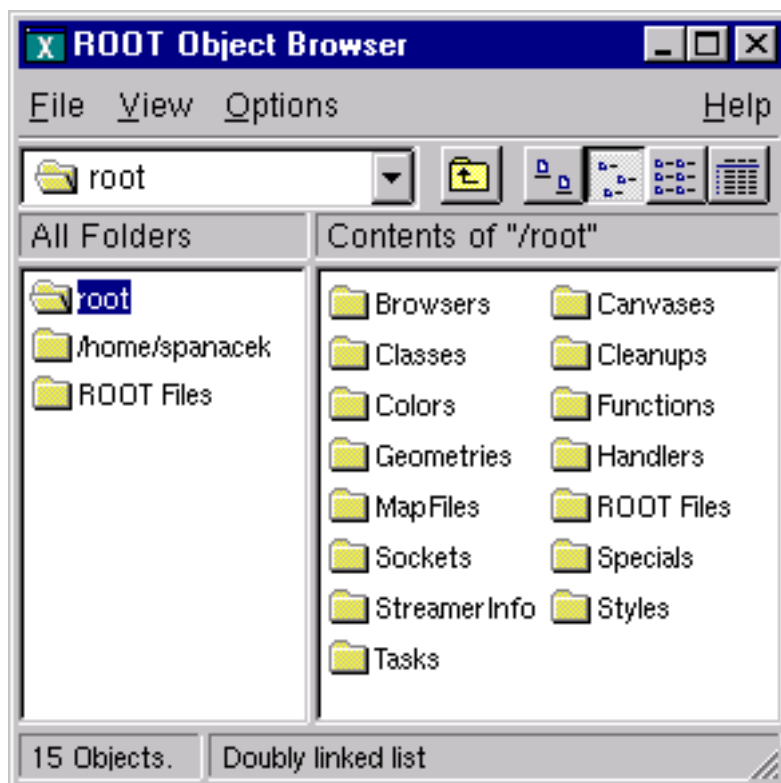


Figure 1.1: The ROOT Object Browser

1.3 Ownership by Other Objects

When an object creates another, the creating object is the owner of the created one. For example:

```
myHisto->Fit("gaus")
```

The call to `Fit` copies the global `TF1` Gaussian function and attaches the copy to the histogram. When the histogram is deleted, the copy is deleted also.

When a pad is deleted or cleared, all objects in the pad with the `kCanDelete` bit set are deleted automatically. Currently the objects created by the `DrawCopy` methods, have the `kCanDelete` bit set and are therefore owned by the pad.

1.4 Ownership by the User

The user owns all objects not described in one of the above cases. `TObject` has two bits, `kCanDelete` and `kMustCleanup`, that influence how an object is managed (in `TObject::fBits`). These are in an enumeration in `TObject.h`. To set these bits do:

```
MyObject->SetBit(kCanDelete)
MyObject->SetBit(kMustCleanup)
```

The bits can be reset and tested with the `TObject::ResetBit` and `TObject::TestBit` methods.

1.4.1 The `kCanDelete` Bit

The `gROOT` collections (see above) own their members and will delete them regardless of the `kCanDelete` bit. In all other collections, when the collection `Clear` method is called (i.e. `TList::Clear()`), members with the `kCanDelete` bit set, are deleted and removed from the collection. If the `kCanDelete` bit is not set, the object is only removed from the collection but not deleted.

If a collection `Delete` (`TList::Delete()`) method is called, all objects in the collection are deleted without considering the `kCanDelete` bit. It is important to realize that deleting the collection (i.e. `delete MyCollection`), DOES NOT delete the members of the collection.

If the user specified `MyCollection->SetOwner()` the collection owns the objects and `delete MyCollection` will delete all its members. Otherwise, you need to:

```
// delete all member objects in the collection
MyCollection->Delete();

// and delete the collection object
delete MyCollection;
```

Note that `kCanDelete` is automatically set by the `DrawCopy` method and the user can set it for any object. For example, the user must manage all graphics primitives. If you want `TCanvas` to delete the primitive you created you have to set the `kCanDelete` bit.

The `kCanDelete` bit setting is displayed with `TObject::ls()`. The last number is either 1 or 0 and is the `kCanDelete` bit.

```
root[] TCanvas MyCanvas("MyCanvas")
root[] MyCanvas.Divide(2,1)
root[] MyCanvas->cd(MyCanvas_1)
root[] hstat.Draw()           // hstat is an existing TH1F
root[] MyCanvas->cd(MyCanvas_2)
root[] hstat.DrawCopy()      // DrawCopy sets the kCanDelete bit
(class TH1*)0x88e73f8
root[] MyCanvas.ls()
Canvas Name=MyCanvas ...
TCanvas ... Name= MyCanvas ...
TPad ... Name= MyCanvas_1 ...
TFrame ...
OBJ: TH1F hstat Event Histogram : 0
TPaveText ... title
TPaveStats ... stats
TPad ... Name= MyCanvas_2 ...
```

```

TFrame ...
OBJ: TH1F      hstat   Event Histogram : 1
TPaveText ... title
TPaveStats ... stats

```

1.4.2 The kMustCleanup Bit

When the `kMustCleanup` bit is set, the object destructor will remove the object and its references from all collections in the clean up collection (`gROOT::fCleanups`). An object can be in several collections, for example if an object is in a browser and on two canvases. If the `kMustCleanup` bit is set, it will be removed automatically from the browser and both canvases when the destructor of the object is called.

The `kMustCleanup` bit is set:

- When an object is added to a pad (or canvas) in `TObject::AppendPad`.
- When an object is added to a `TBrowser` with `TBrowser::Add`.
- When an object is added to a `TFolder` with `TFolder::Add`.
- When creating an inspector canvas with `TInspectCanvas::Inspector`.
- When creating a `TCanvas`.
- When painting a frame for a pad, the frame's `kMustCleanup` is set in `TPad::PaintPadFrame`

The user can add their own collection to the collection of clean ups, to take advantage of the automatic garbage collection. For example:

```

// create two list
TList *myList1, *myList2;

// add both to of clean ups
gROOT->GetListOfCleanUps()->Add(myList1);
gROOT->GetListOfCleanUps()->Add(myList2);

// assuming myObject is in myList1 and myList2, when calling:
delete myObject;

// the object is deleted from both lists

```