

UniDyn--Demo-01.nb

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Abstract: This demonstration notebook loads the **UniDyn** package and executes the package's unit tests.

Set the path to the package

Tell *Mathematica* the path to the directory containing the packages. For the `$NCPath` variable, put the directly where the `/NC` folder is installed; the `$NCPath` name should not end with `/NC`.

EDIT THE FOLLOWING PATH STRINGS:

```
In[1]:= $NCPath = "/Users/jam99/Dropbox";  
$UniDynPath =  
    "/Users/jam99/Dropbox/MarohnGroup__Software_Library/UniDyn/  
    unidyn";
```

YOU SHOULD NOT NEED TO EDIT ANYTHING FROM HERE ONWARDS.

Load the package

Append the package path to the system path. Before trying to load the package, ask *Mathematica* to find it. This is a test that we directed *Mathematica* to the correct directory. The output of this command should be the full system path to the `UniDyn.m` file.

```
In[3]:= $Path = AppendTo[$Path, $NCPath];  
$Path = AppendTo[$Path, $UniDynPath];  
FindFile["UniDyn`"]  
FindFile["NC`"]
```

```
Out[5]= /Users/jam99/Dropbox/MarohnGroup__Software_Library/UniDyn/unidyn/UniDyn.m
```

```
Out[6]= /Users/jam99/Dropbox/NC/init.m
```

Now that we are confident that the path is set correctly, load the package. Setting the global `$VerboseLoad` variable to `True` will print out the help strings for key commands in the package.

```
In[7]:= $VerboseLoad = True;  
Needs["UniDyn`"]
```

 **NC:** You are using the version of NCAgebra which is found in: " /Users /jam99 /Dropbox /NC/".

 NCAlgebra - Version 5.0.6
 Compatible with Mathematica Version 10 and above

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 Helton 2002
 Helton and Miller June 1991
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The program was written by the authors and by:

David Hurst, Daniel Lamm, Orlando Merino, Robert Obar,
 Henry Pfister, Mike Walker, John Wavrik, Lois Yu,
 J. Camino, J. Griffin, J. Oval, T. Shaheen, John Shopple.
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For NCAlgebra updates see:

www.github.com/NCAlgebra/NC
www.math.ucsd.edu/~ncalg

 ... **NCAlgebra** : All lower cap single letter symbols (e.g. a,b,c,...) were set as noncommutative.

... **CreateOperator** : CreateOperator [] is used to batch -define a bunch of operators. Example: CreateOperator [{{lx,
 ly, lz},{Sx,Sy,Sz}}] will create six operators; each of the operators in the first list is meant to commute with
 each of the operators in the second list.

- ... **CreateScalar** : CreateScalar [list] is used to batch —define a bunch of scalars. The parameter list can be a single scalar or a list of scalars. Example: CreateScalar [{w1,w2 }].
- ... **NCSort** : NCSort [list] sorts the operators in list into canonical order.
- ... **SortedMult** : SortedMult [list] returns Mult [list\$ordered], where list\$ordered are the elements of list sorted into canonical order.
- ... **MultSort** : MultSort [NonCommutativeMultiply [list]] returns returns NonCommutativeMultiply [list\$ordered], where list\$ordered are the elements of list sorted into canonical order.
- ... **Comm** : Comm [a,b] calculates the commutator of two operators.
- ... **SpinSingle\$CreateOperators** : SpinSingle\$CreateOperators [lx,ly,lz,L] creates lx, ly, and lz angular momentum operators and defines their commutation relations. When the total angular momentum L = 1/2, additional rules are defined to simplify products of the angular momentum operators. When the total angular momentum L is unspecified, no such simplification rules are defined.
- ... **OscSingle\$CreateOperators** : OscSingle\$CreateOperators [aL,aR] creates a raising operator aR and a lowering operator aL for single harmonic oscillator and defines the operator commutation relations.
- ... **Evolve** : Evolve [H, t, ρ] represents unitary evolution of the density operator ρ for a time t under the Hamiltonian H. This function expands according to simplification rules but leaves the evolution unevaluated.
- ... **Evolver** : Evolver [H, t, $\rho(0)$] calculates $\rho(t) = \text{Exp}[-i H t] \rho(0) \text{Exp}[+i H t]$, assuming that H is time independent, according to the commutation rules followed by $\rho(0)$ and H.

Execute the units tests in batch

Included with the package are a number of files, ending in “-tests.m”, that contain tests of the package’s functions -- so-called unit tests. Set the working directory to the package directory and pretty-print the directory name.

```
In[9]:= SetDirectory[$UniDynPath];
```

```
TableForm[{{$UniDynPath}}, TableHeadings -> {None, {"Directory"}}]
```

```
Out[10]//TableForm=
```

```
Directory
```

```
/Users/jam99/Dropbox/MarohnGroup__Software_Library/UniDyn/unidyn
```







Get the names of all the unit-testing files included with the package (following my convention that the unit testing file end in “-tests.m”). Pretty-print the names of the unit-test files included with the package.

```
In[11]:= fn = FileNames["*-tests.m"];
TableForm[{{fn}}, TableHeadings → {None, {"Test files found"}}]
```

```
Out[12]//TableForm=
Test files found
Comm-tests.m
Evolve-tests.m
Mult-tests.m
OpCreate-tests.m
Osc-tests.m
Spins-tests.m
```

Finally, carry out the unit tests.

```
In[13]:= test$report = TestReport /@ fn;
TableForm[Table[test$report [[k]], {k, 1, Length[test$report]}]]
```

```
Out[14]//TableForm=
TestReportObject [ +  Title: Test Report: Comm -tests.m
Success rate: 100% Tests run: 12 ]
TestReportObject [ +  Title: Test Report: Evolve -tests.m
Success rate: 100% Tests run: 27 ]
TestReportObject [ +  Title: Test Report: Mult -tests.m
Success rate: 100% Tests run: 20 ]
TestReportObject [ +  Title: Test Report: OpCreate -tests.m
Success rate: 100% Tests run: 23 ]
TestReportObject [ +  Title: Test Report: Osc -tests.m
Success rate: 100% Tests run: 20 ]
TestReportObject [ +  Title: Test Report: Spins -tests.m
Success rate: 100% Tests run: 14 ]
```

Make a report.

```
In[15]:= tests$passed$total = Plus @@ (test$report[[#]]["TestsSucceededCount"] & /@
List @@ Table[k, {k, 1, Length[test$report]}]);
tests$failed$total = Plus @@ (test$report[[#]]["TestsFailedCount"] & /@
List @@ Table[k, {k, 1, Length[test$report]}]);

Print[Style[ToString[tests$passed$total] <> " tests passed",
FontWeight → Bold, FontSize → 18, FontColor → Blue]]
Print[Style[ToString[tests$failed$total] <> " tests failed",
FontWeight → Bold, FontSize → 18, FontColor → Red]]
```

116 tests passed**0 tests failed**

Execute the units tests one-by-one

Re-execute the tests in an order determined by us. This is useful for debugging. Running the *Evolve-test.m* file takes a minute.

```
In[19]:= SetDirectory[$UniDynPath];
TableForm[{{$UniDynPath}}, TableHeadings -> {None, {"Directory"}}]
```



```
Out[20]//TableForm=
Directory
/Users/jam99/Dropbox/MarohnGroup__Software_Library/UniDyn/unidyn
```

```
In[21]:= $VerboseLoad = False;
Needs["UniDyn`"]
```



```
In[23]:= TestReport[FileNames["OpCreate-tests.m"]][[1]]
```

```
Out[23]= TestReportObject[  Title: Test Report: OpCreate -tests.m
Success rate: 100% Tests run: 23
```

```
In[24]:= TestReport[FileNames["Mult-tests.m"]][[1]]
```

```
Out[24]= TestReportObject[  Title: Test Report: Mult -tests.m
Success rate: 100% Tests run: 20
```



```
In[25]:= TestReport[FileNames["Comm-tests.m"]][[1]]
```

```
Out[25]= TestReportObject[  Title: Test Report: Comm -tests.m
Success rate: 100% Tests run: 12
```

```
In[26]:= TestReport[FileNames["Spins-tests.m"]][[1]]
```

```
Out[26]= TestReportObject[  Title: Test Report: Spins -tests.m
Success rate: 100% Tests run: 14
```

```
In[27]:= TestReport[FileNames["Evolve-tests.m"]][[1]]
```

```
Out[27]= TestReportObject[  Title: Test Report: Evolve -tests.m
Success rate: 100% Tests run: 27
```

Congratulations

At this point you should have

- (1) loaded the NCAlgebra and UniDyn packages and
- (2) run the UniDyn units tests demonstrating that UniDyn is working as expected.