A Simple CCA Component Application

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Module Overview

- What the example does: the math.
- From math to components: the architecture.
- The making of components: inheritance and ports.
- Framework-component interactions.
- Putting it all together: the CCafeine ways.
- The application in action.

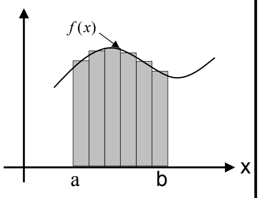
Goals

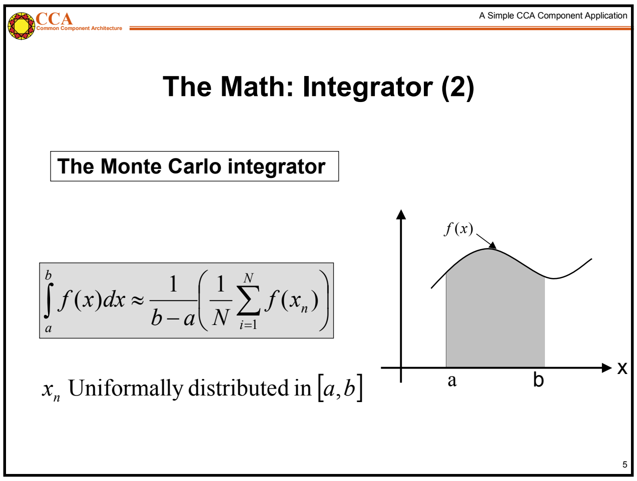
To show how CCA components are used to build an application to integrate numerically a continuous function using two different integration techniques.

The Math: Integrator (1)

The midpoint numerical integrator

$$\int_a^b f(x)dx \approx \frac{b-a}{n}\sum_{j=1}^{n} f\left(\frac{x_{j-1}+x_j}{2}\right)$$



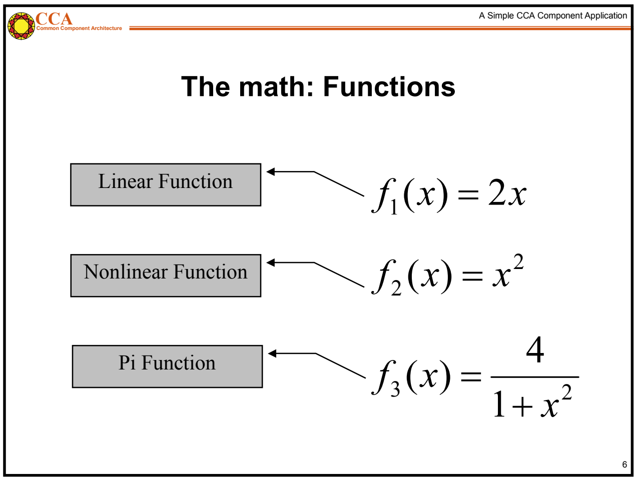


The Math: Integrator (2)

The Monte Carlo integrator

$$\int_a^b f(x)dx \approx \frac{1}{b-a}\left(\frac{1}{N}\sum_{i=1}^{N} f(x_n)\right)$$

x_n Uniformally distributed in $[a,b]$

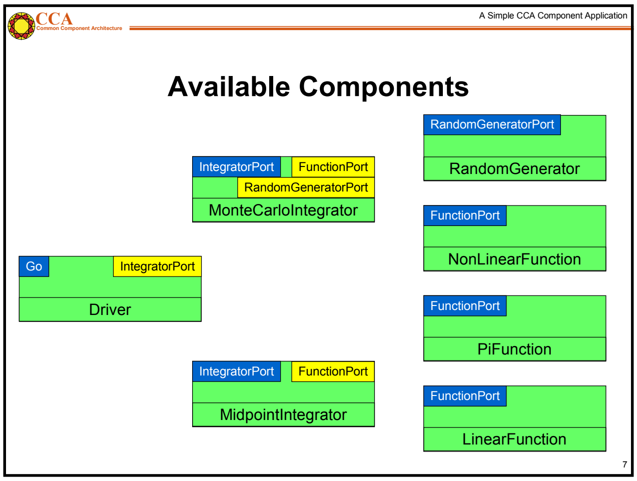


The math: Functions

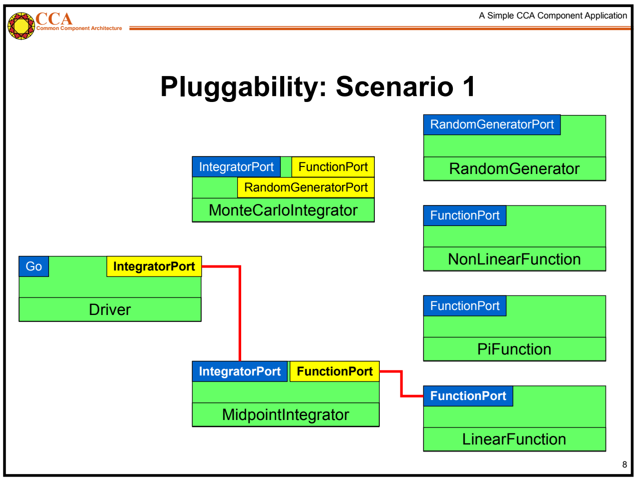
Linear Function ← $f_1(x) = 2x$

Nonlinear Function ← $f_2(x) = x^2$

Pi Function ← $f_3(x) = \frac{4}{1+x^2}$

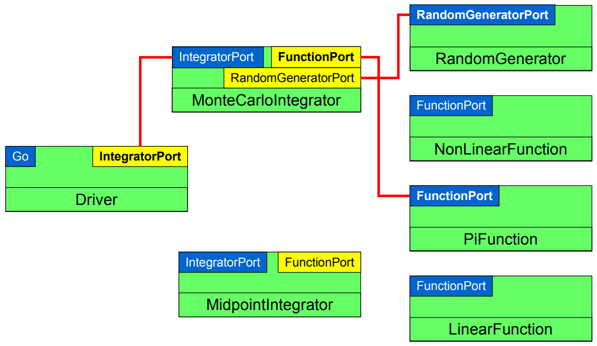


Available Components

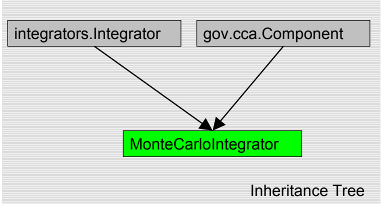


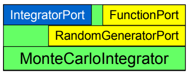
Pluggability: Scenario 1

Pluggability: Scenario 2



MonteCarloIntegrator in Details





Relevant files:
integrator.sidl
function.sidl
random.sidl

What makes it a component?
Inheritance from ***gov.cca.Component***

Where does **IntegratorPort** come from?
Inheritance from ***integrators.Integrator***

Saying it in SIDL

```
package integrators version 1.0 {

  interface Integrator
       extends gov.cca.Port
  {
   double integrate(in double lowBound,
             in double upBound, in int count);
  }
  class MonteCarloIntegrator
       implements-all Integrator,
                      gov.cca.Component
  {
  }
………
}
```

Notes

- Inheritance from ***gov.cca.Component*** furnishes the only method known to the framework: ***setServices()***
- “**Provides**” ports are interfaces that need to inherit from ***gov.cca.Port*** (***Integrator*** in this case)

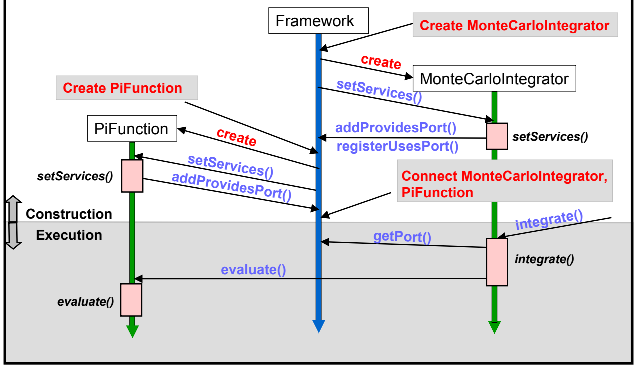
The Framework Role

- Framework-to-Component: ***setServices()***
  - Called after the component is constructed.
  - The component's chance to identify:
    - Ports it provides – ***addProvidesPort()***
    - Ports it uses – ***registerUsesPort()***
  - Component should not acquire the port here – Reason: it may not be there yet !!!!
  - Also used to "shutdown" the component.

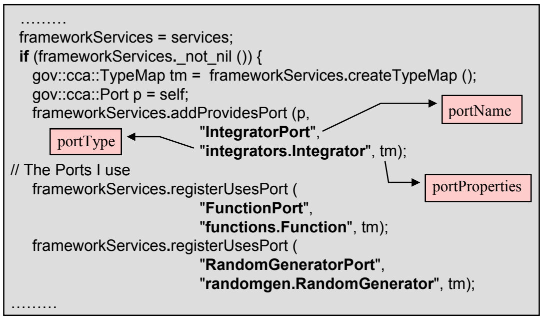
Component-to-Framework

- Mainly through ***Services*** object passed through ***setServices().***
- ***addProvidesPort()***, ***registerUsesPort()***:
  - Component "*pointer*", PortName, PortType, PortProperties.
- ***getPort():***
  - Called by the using component.
  - Matching using portType (not name).
- ***releasePort(), removeProvidesPort()***:
  - When all is done.

The Life Cycle Revisited



Example: *setservices()* in MonteCarloIntegrator (C++)



```
 ………
 frameworkServices = services;
 if (frameworkServices._not_nil ()) {
    gov::cca::TypeMap tm =  frameworkServices.createTypeMap ();
    gov::cca::Port p = self;
    frameworkServices.addProvidesPort (p,
                              "IntegratorPort",
                              "integrators.Integrator", tm);
// The Ports I use
    frameworkServices.registerUsesPort (
                              "FunctionPort",
                              "functions.Function", tm);
    frameworkServices.registerUsesPort (
                              "RandomGeneratorPort",
                              "randomgen.RandomGenerator", tm);
………
```

Notes

- ***setServices()*** mainly used to inform the framework which ports the current component provides and/or uses.
- No actual connections between ports are established in ***setServices()***, since the “other” port may not yet exist !!!
- ***portName*** is unique per component.
- ***portType*** identifies the “*interface*” that the port implements (used to match user and provider).
- ***portProperties*** : list of port-specific key-value pairs.

Example: *integrate()* in MonteCarloIntegrator (C++)

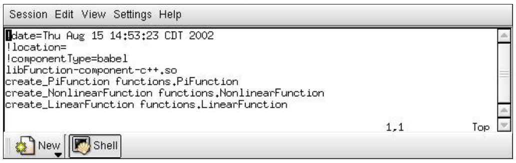
```
………
functions::Function functionPort;
randomgen::RandomGenerator randomPort;
double sum = 0.0;
randomPort = frameworkServices.getPort ("RandomGeneratorPort");
functionPort = frameworkServices.getPort ("FunctionPort");
for (int i = 0; i < count; i++){
   double x = lowBound + (upBound - lowBound) *
                randomPort.getRandomNumber();
   sum = sum + functionPort.evaluate(x);
}
frameworkServices.releasePort ("FunctionPort");
frameworkServices.releasePort ("RandomGeneratorPort");
return (upBound - lowBound) * sum / count;

………
```

Putting it all together

- Getting the application to do something:
  - Assembling the components into an app.
  - Launching the Application.
- App assembly:
  - Framework need to be told what components to use, and where to find them.
  - Framework need to be told which ***uses*** port connects to which ***provides*** port.
- App execution: the ***GO*** port:
  - Special ***provides*** port used to launch the application (after connections are established).
  - Has one method, ***go(),*** that is called by the framework to get the application going.

Oh Component , where art thou?.

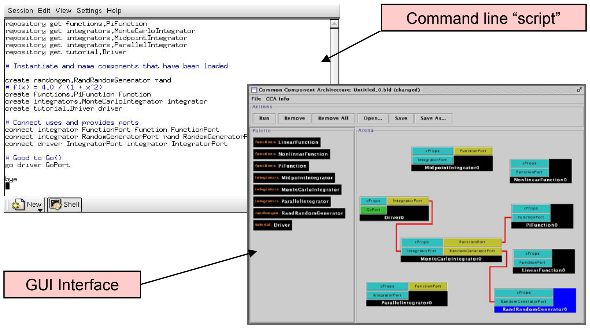
Which components, and how to create them



```
!date=Thu Aug 15 14:53:23 CDT 2002
!location=
!componentType=babel
libFunction-component-c++.so
create_PiFunction functions.PiFunction
create_NonlinearFunction functions.NonlinearFunction
create_LinearFunction functions.LinearFunction
                                                  1,1          Top
```

More details in the Ccaffeine Module

App. Assembly The Ccafeine way



```
repository get functions.PiFunction
repository get integrators.MonteCarloIntegrator
repository get integrators.MidpointIntegrator
repository get integrators.ParallelIntegrator
repository get tutorial.Driver

# Instantiate and name components that have been loaded

create randomgen.RandRandomGenerator rand
# f(x) = 4.0 / (1 + x^2)
create functions.PiFunction function
create integrators.MonteCarloIntegrator integrator
create tutorial.Driver driver

# Connect uses and provides ports
connect integrator FunctionPort function FunctionPort
connect integrator RandomGeneratorPort rand RandomGeneratorP
connect driver IntegratorPort integrator IntegratorPort

# Good to Go()
go driver GoPort

bye
```

Command line “script”

GUI Interface

Next: Babel