Summer Intro LAr Neutrino Analysis Curriculum

M,F 10-noon, starting 21-June-2013
D0gHouse (portakamp in DAB parking lot)
85LARSW (8552779), dial 510-423-9220, to be replaced by ...
Readytalk 1-866-740-1260: 3277957, 5436 (Eric's Readytalk id/pwd)

- 21-June, Friday

- Set up students in Test Releases sitting around in a group

- Walkthrough Exercises for LArSoft Newcomer
  - https://cdcvs.fnal.gov/redmine/projects/larsoftsvn/wiki
  - larforum.org/uboone

No real textbook for this 21-June, Friday

- There's a new document from the ART guys at http://artdoc.fnal.gov/artsupport.shtml
  - I have barely looked at it.
  - It looks like it may be quite useful.
  - If people want to use it as this group's course guide, we could do that. Somebody would need to start walking through it and advocate for that position.
- Another thing this group could do is chuck this "curriculum" and instead, e.g., walk through a C ++ text together.
  - How fun would that be?

Terms, components

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- LArSoft is built on ART
  - ART is a state machine. The less said here, the better.
- We run the executable lar (“art” in the workbook)
- We write code in C++
- We write fcl files to control the flow of lar
  - job script fcl files
  - parameter set fcl files

Nuts and Bolts

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- We compile C++ into .o files, which are gathered together into .so's (shared object libraries).
- Basically, not precisely, the lay-LArSoft user writes C++ modules which are compiled into their own .so and those live in the user's area.
- Other .so's live in some public directory
- lar runs and finds the .o's it needs in the .so's on the fly. Environment variable $LD_LIBRARY_PATH does this.
- The compiler/linker is gcc;
- The (GNU)Makefiles detect what code is out of date wrt the .so of interest, and compiles/links it.

Build System 21-June, Friday

- The build system is basically a directory tree, with a Makefile at the top and in each branch all the way down. It sets all the environment variables to correctly force all needed building (compiling+linking) and set you up for subsequently running. $SRT_PUBLIC_CONTEXT, $SRT_PRIVATE_CONTEXT. We currently use SRT. Others are CMake, SCons.
- The code repository is almost entirely .cc, .cpp, .cxx files -- source code. We currently use svn for the LArSoft repository. Others are git, cvs, cleartool, perforce, ...

Software Project management tools: the big meta organizer 21-June, Friday

- Redmine
  - We use this
  - (1) https://cdcvs.fnal.gov/redmine/projects/uboonеoffline, (2) larsoftsvn
- Basecamp
- github

Interactive Development Environment (IDE) and editors

21–June, Friday,

- We don't have an IDE, regrettably.
  - It would aid all of us
  - editor w syntax highlighting, precompile hints, easy integration of all code
- Eclipse, NetBeans, ...
  - I have used Eclipse and think it's great
  - I have not ever wrestled with getting Eclipse set up, to understand SRT, redmine, etc.
  - If starting from scratch I'd do this.
- Editors
  - emacs: God's editor, 'nuff said
  - kate, vi, nedit, gedit, ...

debuggers and ancilary tools 21-June, Friday

- gdb, totalview
  - to drill down into problems

- grid
  - A “farm” of all FNAL’s computers
  - condor (our job submission tool), lsf, ...

The Whole Package 21-June, Friday

- So, you're being asked to learn (some of) all this at once.
  - Not just programming, but C++, repositories, build system, physics!, ...

- Also, you need to learn some ROOT !! In order to make/Fill/plot histograms, etc.
- We're sympathetic
  - if that counts for anything
- It's also why this "course" doesn't propose to go in linear order.

Now, start doing some coding

- At this point and hereafter, all interested parties sit together in a group, 2 hours a class, 2x/wk.

  - Jonathan, Andrzej, Mitch, Eric, Wes, Ben C, serve as the TA during these sessions, with less and less supervision as time goes on over the summer.
  - Someone however always sits in the room to get people unstuck.

- Next, learn to pull down AnalysisExample
  - build it, edit something, build it again
  - apply to muons from Walkthrough Exercises
  - fill histos, TTrees, make cuts, change parameters, compile, run again, go into ROOT and see your changes.

single particles -- Need (early, easiest) MC Challenge samples by this point

- Starting with AnalysisExample, create histogram and/or TTree branches to capture info there
  - Syracuse looks at single protons,Kaons from MC Challenge
  - Yale looks at single, some-stopping muons
  - University of Phoenix works with DeVry Institute to examine pi minuses
  - Etcetera, for other interested institutions (NMSU, MIT, VT, UC, Otterbein, any and all!!)

Tack on Modules

- Add your own or canned ana Module
  - add histograms
  - add a TTree!
  - (exclamation points somehow imply this would be fun, though it probably won't be!)
- Add a canned, or your own recon Module
  - Do a put(std::move(yourOwnObject)) on the event!!!
  - extra exclamation points!

Reconstruction

- stop and
  - walk through a Recon module
  - Ask how we pull in data that's necessary for the module
  - Ask how we grab up associated objects to another object of interest
  - Drill down into the while() or for() loops and ask just wtf is going on.
  - Field any and all C++ questions

- Stop roughly on July 8,12 have lectures on:

neutrinos (Flavio)

- generic neutrino interactions
  - CCQE, Resonant, Coherent, DIS
- FSI
- Liquid Argon TPC

neutrinos interaction in LArTPC (Ornella)

- topologies in LArTPC, ie:
  - how each physical channel can appear in different topologies
  - hints for topology identification (and for topology mis-Id).

GENIE evts (Jonathan, Andrzej, Ben C, Eric, …) : Back to LArSoft!

- Now we need full MC Challenge Genie events!
  - ETA: post-June 30

- Give whole group GENIE sample from MC Challenge, have them start looking in EVD at
  - only GENIE evts
  - Then GENIE + cosmic evts
- Spend considerable time just looking at events

Event Topologies, if we get this far

- Try to pick out topologies in EVD, pick a a handful of reasonably exctricable ones,
  - display the MC information in EVD thoroughly in order to make contact with the Neutrino lecture(s)
  - See if in EVD one can imagine how to pick the following out
    - CC Processes
      - $\nu_\mu + Ar \rightarrow 1\mu + 0\,\pi + (n_p\,\mathbf{p} + n_n\,\mathbf{n})$
      - $\nu_\mu + Ar \rightarrow 1\mu + 1\,\pi^{\pm} + (n_p\,\mathbf{p} + n_n\,\mathbf{n})$
      - $\nu_\mu + Ar \rightarrow 1\mu + 1\,\pi^{0} + (n_p\,\mathbf{p} + n_n\,\mathbf{n})$
    - NC Processes
      - $\nu + Ar \rightarrow 0\,\mathit{lept} + 0\,\pi + n_p\,\mathbf{p}$
      - $\nu + Ar \rightarrow 0\,\mathit{lept} + 1\,\pi^{0} + (n_p\,\mathbf{p} + n_n\,\mathbf{n})$

Now, advanced work

- Edit AnalysisExample Ana module
  - Add histos or TTree branches to fill energy, costh for all evts for the following, picked out at truth level
    - protons
    - muon
    - pions
- Turn this into a Filter to write out a desired topology to a stream

- Now, the real leap:
  - Can any of this slide be re-performed with truth level selection replaced by selection rules as gleaned from handscan experience?!