CSE 1325: Object-Oriented Programming

Lectures 16 and 17 – Chapter 16
(Using gtkmm)

More GUI and Drawing via CSE1325 Paint

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Based on material by Bjarne Stroustrup
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ERB 402
Office Hours:
Tuesday Thursday 11 - 12
Or by appointment

Lecture 15

Quick Review

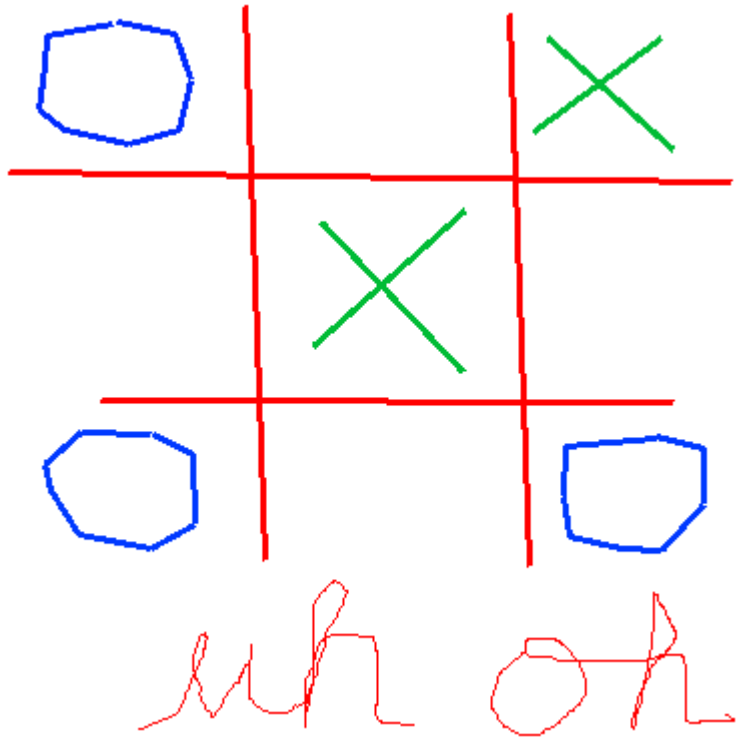
- A **class library** is a collection of prewritten classes, often designed as templates, that work together to facilitate writing applications.
  - Name some popular ones for C++. **.NET and FCL, iOS Frameworks, Oracle Class Libraries, gtkmm / Gtk+, Qt, WxWidgets, FLTK, Boost**
- **True** or False: Multiple namespace blocks with the same name are permitted.
- A **typedef** defines an alias for an (often complex) type, simplifying code and increasing readability.
- The **Adapter Pattern** implements a bridge between two classes with incompatible interfaces.
- The set of implementation elements and associated integration mechanisms necessary to meet the system requirements is called the system's **architecture**. The engineering role primarily responsible for it is the **architect**.
- **Generalization** is extracting shared characteristics from two or more classes, combining them into a generalized base class. The opposite, decomposing a general base class into specialized derived classes, is **specialization**.

Lecture 15
Quick Review

- An anonymous function object is called a **lambda**. They have a **capture clause** to determine which outer scope variables are visible, an optional parameter list, and a body.
- **True** or False: The parameter list of a lambda function, including the parentheses, are optional.
- True or **False**: By default, a lambda function can access all variables from the enclosing scope. None are visible by default.
- **True** or False: By default, a captured variable is copied. Prepend an *&* to capture the variable by reference.
- Describe how can all variables in the surrounding scope can be captured, first by reference, and then by access (copied). **[&], [=]**
- While the return type of a lambda function is usually inferred by the compiler, describe how to explicitly define the return type
  [ ] -> bool { };

Overview: GUI Widgets and Drawing

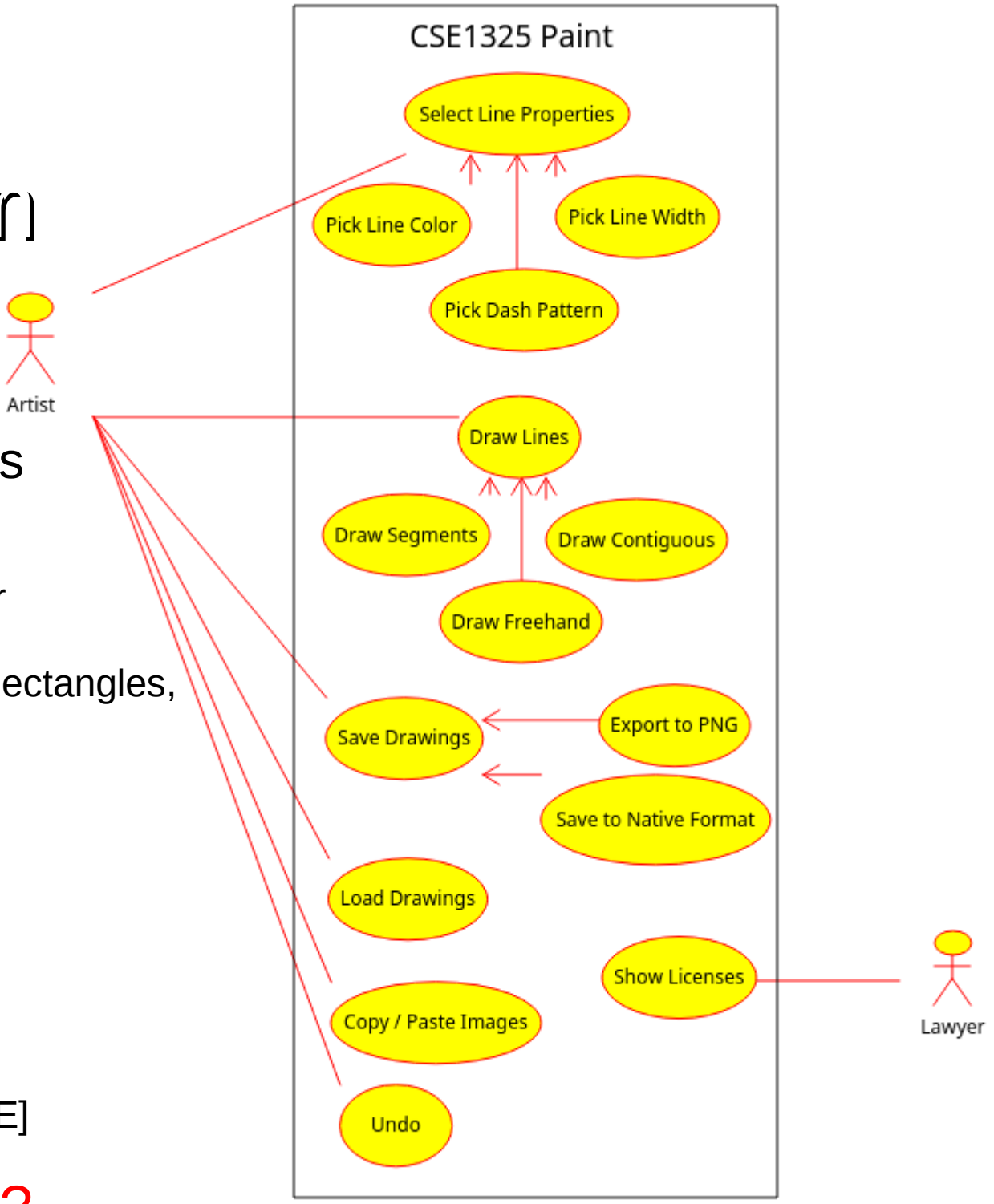
- A Simple GUI App
  - Exit with unsaved data warning
- Drawing Lines
  - Segments
  - Changing color and width
- Adding a Toolbar
- Adding File I/O
  - Save / Save As
  - Open / New
- Adding Draw Modes
  - Segments
  - Contiguous
  - Freehand
  - Dashed Lines
- Undo
- About



Building a Paint App with gtkmm

- To illustrate how widgets interact, let's build a very simple Paint application with C++ and gtkmm
  - We'll follow our Baby Steps philosophy
  - We'll analyze and design in the UML
  - We'll use Scrum for process management
  - We'll use git for version control
- So what's our first step?

Basic Use Case Diagram



Other Possible Use Cases

- Add Curved Lines
- Add Text
  - Select Font, Face, Size, Color
- Add Shapes
  - Circles / Ellipses, Squares / Rectangles, Triangles,
  - Fill with Color, Pattern, Image
  - Control Border as per Line
- Add Image
  - Bitmap, Vector
- Scripting
  - Turtle Graphics
  - Python
  - Public API
- [YOUR FAVORITE GOES HERE]

What's our next step?

SCRUM Product Backlog

Status	As an...	I want to...	So that I can...
	Artist	Exit via x – check for “dirty” bit and prompt to save given new data	Close the window
	Artist	Exit via File > Exit – creating a File > Exit menu item	Close the window independent of the OS
	Artist	Draw discrete lines – click for (x1, y1), drag to (x2, y2)	Create line art
	Artist	Change pen color – use a color selection dialog	Create colorful drawings
	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

The Use Cases and Feature Backlog document requirements.
What do we do after nailing down the *initial* requirements?

User Interface Design

Drop-Down Menu

File	**Edit**	**Pen**	**Turtles**	**Help**
New	Undo	Segment	Select Turtle	About
Open...	Copy	Contiguous		
Save	Paste	Freehand		
Save As...		---		
Export		Line Color		
Exit		Line Width		
		Dash Pattern		

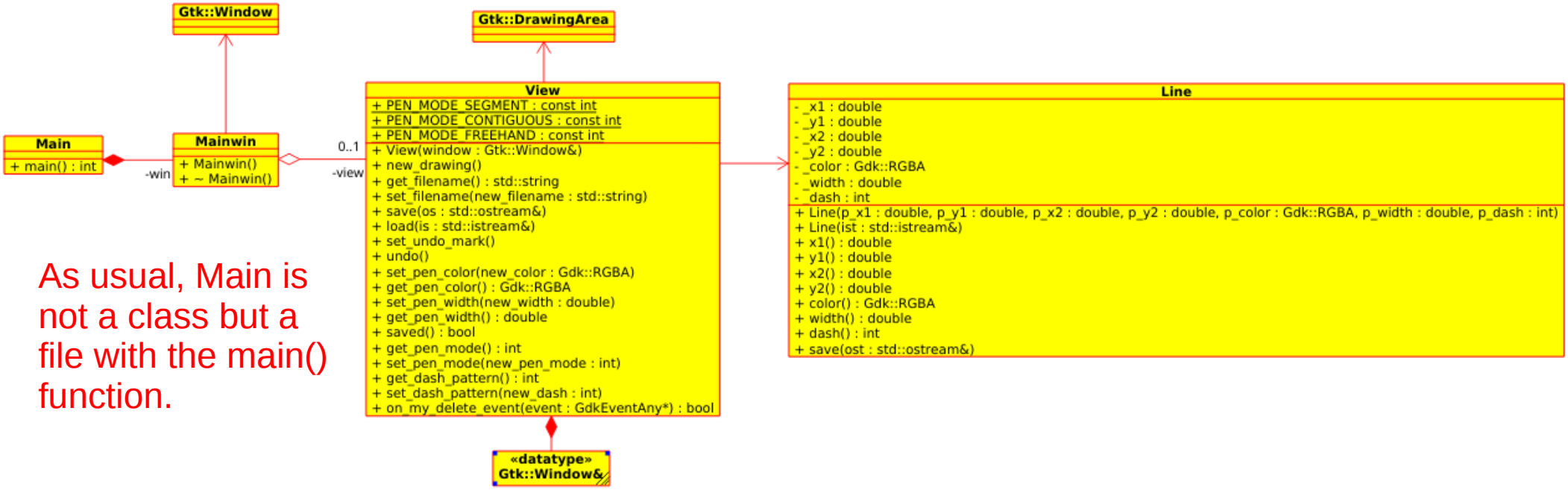
The User Interface Design is often codified in a document, with a paragraph or two providing details on the behavior triggered by each interface element.

Every use case should be able to be implemented using your user interface design (validation).

Toolbar (images may be selected later)

What other minimum artifacts comprise our design?

Our Class Diagram



As usual, Main is not a class but a file with the main() function.

We'll baseline the code from our Turtle Graphics demo, which included a Line class and basic drawing mechanisms, and implement our sprints from there.

(A **baseline** is a reference point in our version control system, usually indicating completion and formal approval of a product release, and sometimes used as a starting point for a branch or new product. I'm using the word somewhat loosely here.)

That's our bare-bones design. What's first for implementation?

Our Sprint #1 Backlog
(1 of 2)

Feature ID	Description	Status
XX	Observe signal_delete_event, implementing a dirty bool in View	
XFE	Derive a Mainwin class from Gtk::Window for customization	
XFE	Create File menu with Quit entry	
XFE	Initiate signal_delete_event when File > Quit is selected	
DDL	Add a DrawingArea to View	
DDL	Observe mouse clicks in the DrawingArea and create Line objects	
DDL	Override DrawingArea::on_draw and draw the line objects	
PC	Add set_pen_color method to View	
PC	Add Pen > Color menu item, display color chooser, and set in View	
PC	Add color attribute to Line	
PW	Add set_pen_width method to View	
PW	Add Pen > Width menu item	
PW	Create custom Set Pen Width dialog, set in View	
TB	Enable the toolbar	
TB	Add pen color button and connect signal	
TB	Add pen width button and connect signal	
SAV	Add Line::save to stream	
SAV	Add View::save to stream	
SAV	Add File > Save to menu	
SAV	Add save button to tool bar	
NEW	Add View::new	
NEW	Add File > New to menu	
NEW	Add new button to tool bar	
OP1	Add Line::Line(input stream)	
OP1	Add View::Open(filename)	
OP1	Add File > Open, passing default filename	
OP1	Add open button to tool bar	
SVA	Add Mainwin::on_save_as_click with file chooser dialog	
SVA	Add File > Save As to menu	
SVA	Save selected filename to view	
OPN	Add file chooser dialog to open	

Our Sprint #1 Backlog
(2 of 2)

DCL	Add View::set_draw_mode with constants
DCL	Add contiguous line drawing to mainwin
DCL	Add Pen > Contiguous and Pen > Segment to menu
DCL	Add contiguous and segment to tool bar
DFH	Add motion notify event handler to View
DFH	Add Pen > Freehand
DFH	Add freehand to tool bar
DSH	Add dash patterns, dash index, and getters / setters to View
DSH	Add dash index to Line
DSH	Update View::on_draw to use Line's dash setting
DSH	Add Pen > Dash with custom dialog to select dash pattern
UNDO	Add View::set_undo_mark and undo methods
UNDO	Set undo marks when a line segment is drawn
UNDO	Set undo marks when entering freehand mode
UNDO	Add Edit > Undo
UNDO	Add undo button to tool bar
TURT	Add Turtle base class from which programs will be derived
TURT	Add several common turtle graphics programs
TURT	Add View::new_turtle method to add lines to vector
TURT	Add Pen > Turtle
TURT	Add turtle button to toolbar
CP	Convert DrawingArea (View) to pixmap, then copy to buffer
CP	Add Edit > Copy
CP	Add copy to tool bar
PAS	Add Imager:Line type
PAS	Accept paste of pixmap
PAS	Convert pixmap to Imager object and add to vector
PAS	Add Edit > Paste
PAS	add paste to tool bar
EXP	Export pixmap (reused from CP) to PNG file
EXP	Add File > Export
ABT	Add About dialog
ABT	Add Help > About

The Accompanying Files

- As usual, this slide deck includes an attached ZIP archive of supporting files and source code
  - The actual Scrum spreadsheet used for planning and managing this code development is attached
  - The “dev” directory contains the git repository activity
  - Numbered directories are code corresponding to the Step numbers (not feature numbers!) in the slides that follow
- Each source code directory contains a Makefile
  - Type “make” to compile
    - “make rebuild” or “make clean ; make” rebuilds from scratch
    - “make debug” rebuilds from scratch for the ddd debugger
  - Type “./paint” to run
    - Type “ddd paint” to debug

Step 000 – Baseline

- This is the source code from our Turtle Graphics demo
  - The executable here is named ‘stars’
- We’re primarily interested in reusing the Line and View classes
  - We’ll rip out a little and add a LOT for our Paint!
- Add the baseline to git!

```
ee35027 Baseline from turtle graphics demo
```

Step 001 – Refactor

- We need to rip out a little
  - Remove Turtle Graphics class and code in main()
  - Add View::dirty and saved() getter (both bool)

view.h

```
#ifndef _VIEW_H
#define _VIEW_H

#include "line.h"
#include <vector>
#include <gtkmm/drawingarea.h>

using namespace std;

class View : public Gtk::DrawingArea {
  public:
     View(vector<Line> L);
     bool saved();
     bool on_draw(const Cairo::RefPtr<Cairo::Context>& cr) override;
  private:
     vector<Line> lines;
     bool dirty = false;  // True if any changes since last save
};
#endif
```

Step 001 – Refactor

```
// Draw the lines any time gtkmm needs to refresh the widget
bool View::on_draw(const Cairo::RefPtr<Cairo::Context>& cr) {
    // If nothing to draw, we're done
    if (lines.size() == 0) return true;

    // Create a Cairomm context to manage our drawing
    Gtk::Allocation allocation = get_allocation();

    // Center the drawing in the window
    const double width = allocation.get_width();
    const double height = allocation.get_height();
    cr->translate(width / 2, height / 2);

    // Use a 3 pixel wide red line
    cr->set_line_width(3.0);
    cr->set_source_rgb(0.8, 0.0, 0.0);

    // Draw the lines
    for(Line l : lines) {
        cr->move_to(l.x1(), l.y1());
        cr->line_to(l.x2(), l.y2());
    }
    // Apply the colors to the window
    cr->stroke();

    // Drawing was successful
    return true;
}
```

view.cpp

```
#include "view.h"
#include "line.h"
#include <vector>
#include <gtkmm/drawingarea.h>
#include <cairomm/context.h>

using namespace std;

View::View(vector<Line> L) : lines{L} { }

// True if all data has been written to disk
bool View::saved() {
    return !dirty;
}
```

Step 001 – Refactor

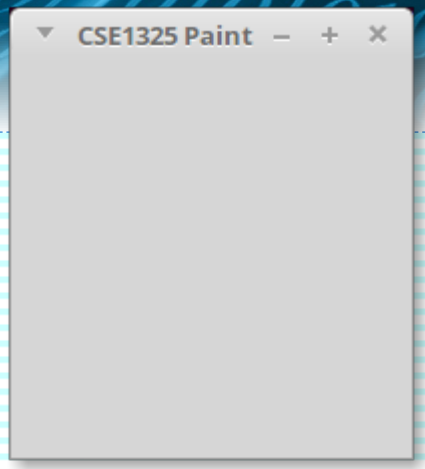
main.cpp

```
#include "view.h"
#include <gtkmm/application.h>
#include <gtkmm/window.h>

int main(int argc, char** argv)
{
   // Create the application
   auto app = Gtk::Application::create(argc, argv, "edu.uta.cse1325.paint");

   // Instance a window
   Gtk::Window win;
   win.set_title("CSE1325 Paint");

   // Instance a drawing surface
   // containing the lines and
   // add to the window
   View view{vector<Line>{}};
   win.add(view);
   view.show();

   return app->run(win);
}
```

line.h

```
#ifndef _LINE_H
#define _LINE_H

class Line {    // Define a line from (x1,
y1) to (x2, y2)
     double _x1, _y1, _x2, _y2;
   public:
     Line(double p_x1, double p_y1,double
p_x2, double p_y2);
     double x1();
     double y1();
     double x2();
     double y2();
};
#endif
```

Step 001 – Refactor



Makefile

```
CXXFLAGS = -std=c++11

all: main

debug: CXXFLAGS += -g
debug: rebuild

rebuild: clean main

main: main.o line.o view.o *.h
	$(CXX) $(CXXFLAGS) -o paint main.o line.o view.o
                                    `/usr/bin/pkg-config gtkmm-3.0 --cflags --libs`
main.o: main.cpp *.h
	$(CXX) $(CXXFLAGS) -c main.cpp `/usr/bin/pkg-config gtkmm-3.0 --cflags --libs`
line.o: line.cpp *.h
	$(CXX) $(CXXFLAGS) -c line.cpp
view.o: view.cpp *.h
	$(CXX) $(CXXFLAGS) -c view.cpp `/usr/bin/pkg-config gtkmm-3.0 --cflags --libs`
clean:
	-rm -f *.o paint
```

```
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

Feature 1

Step 002 – Dialog on “Dirty”

- Before erasing the user’s data (e.g., via exit), we should warn the user and give options
  - Discard the data
  - Save the data
  - Cancel the exit and continue editing
- This is often done with a “dirty bit”
  - True if unsaved data exists in the program
  - Set true when data is changed
  - Set false when data is saved
- Gtkmm exits when ‘x’ is clicked by default
  - We must intercept this to show our dialog using a signal

Product Backlog

Feature	Priority	Status	As an...	I want to...	So that I can...
XX	1		Artist	Exit via x – check for “dirty” bit and prompt to save given new data	Close the window

Sprint Backlog

Feature ID	Description	Status
XX	Observe signal_delete_event, implementing a dirty bool in View	

Feature 1

Step 002 – Dialog on “Dirty”

main.cpp

```
include "view.h"
#include <gtkmm/application.h>
#include <gtkmm/window.h>

int main(int argc, char** argv)
{
   // Create the application
   auto app = Gtk::Application::create(argc, argv, "edu.uta.cse1325.turtle1");

   // Instance a window
   Gtk::Window win;
   win.set_title("CSE1325 Paint");

   // Instance a drawing surface containing the lines and add to the window
   View view{win};
   win.add(view);
   view.show();

   // Allow view to determine if closing is permitted
   win.signal_delete_event().connect(sigc::mem_fun(view, &View::on_my_delete_event));

   // Return gtkmm's result code to the OS
   return app->run(win);
}
```

“When the main window signals a delete event, call View’s on_my_delete_event method.”

Feature 1

Step 002 – Dialog on “Dirty”

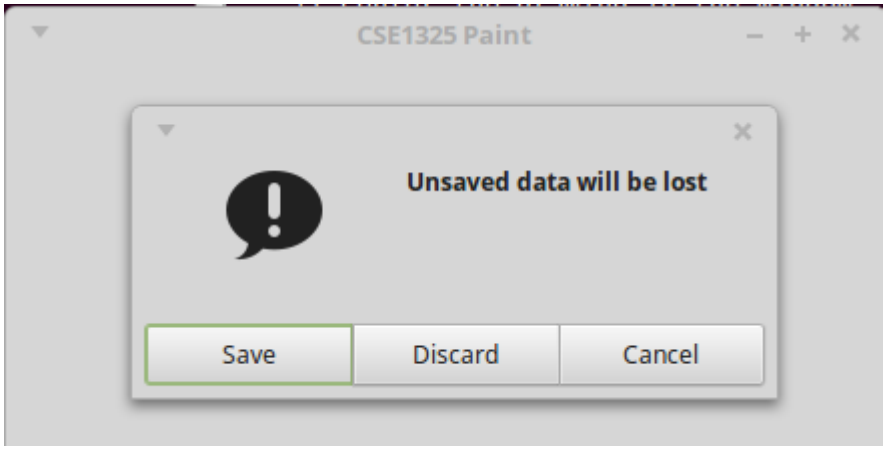
view.cpp

```
bool View::on_my_delete_event(GdkEventAny* event) {
  if (saved()) return false;
  Gtk::MessageDialog d{win, "Unsaved data will be lost", false,
                       Gtk::MESSAGE_WARNING, Gtk::BUTTONS_NONE};
  d.add_button("Save", 1);
  d.add_button("Discard", 2);
  d.add_button("Cancel", 3);
  int response = d.run();
  if (response == 1) {
    cout << "Saving data, then exit" << endl;
    return false;
  } else if (response == 2) {
    cout << "Discarding data and exiting" << endl;
    return false;
  } else {
    return true;
  }
}
```

“return true” means “the signal has been handled”.
Thus, no further handlers will be call and the application will NOT exit.

“return false” means “the signal hasn’t been handled”.
Thus, additional handlers may be called, and the application WILL exit.

Step 002 – Demonstrating Feature 1 Dialog on “Dirty”




```
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

SCRUM Product Backlog and Next Sprint Backlog Tasks

Status	As an...	I want to...	So that I can...
Finished in Sprint 1	Artist	Exit via x – check for “dirty” bit and prompt to save given new data	Close the window
	Artist	Exit via File > Exit – creating a File > Exit menu item	Close the window independent of the OS
	Artist	Draw discrete lines – click for (x1, y1), drag to (x2, y2)	Create line art
	Artist	Change pen color – use a color selection dialog	Create colorful drawings
	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status
XFE	Derive a Mainwin class from Gtk::Window for customization	
XFE	Create File menu with Quit entry	
XFE	Initiate signal_delete_event when File > Quit is selected	

Feature 2

Step 003 – Main Menu + Exit

mainwin.h

```
#ifndef MAIN_WINDOW_H
#define MAIN_WINDOW_H

#include <gtkmm.h>

class Mainwin : public Gtk::Window {
    public:
        Mainwin();
        virtual ~Mainwin();
    Protected:
        // Exit the program
        void on_quit_click();
};
#endif
```

"on_quit_click" is called by gtkmm when File > Quit is clicked.

We use close() instead of hide(), because the former generates the delete event, triggering our "dirty bit" warning dialog.

mainwin.cpp (1 of 2)

```
#include "mainwin.h"

Mainwin::~Mainwin() { }

void Mainwin::on_quit_click() {
    close();  // This is equivalent to clicking the 'x' in the window manager
              // (Otherwise, we would use hide() instead.)
}
```

Feature 2

Step 003 – Main Menu + Exit

mainwin.h

```
Mainwin::Mainwin() {
    set_default_size(640, 480);

    // Put a vertical box container as the Window contents
    Gtk::Box *vbox = Gtk::manage(new Gtk::Box{Gtk::ORIENTATION_VERTICAL, 0});
    add(*vbox);

    // ///////
    // M E N U
    // Add a menu bar as the top item in the vertical box
    Gtk::MenuBar *menubar = Gtk::manage(new Gtk::MenuBar{});
    vbox->pack_start(*menubar, Gtk::PACK_SHRINK, 0);

    //     F I L E
    // Create a File menu and add to the menu bar
    Gtk::MenuItem *menuitem_file = Gtk::manage(new Gtk::MenuItem{"_File", true});
    menubar->append(*menuitem_file);
    Gtk::Menu *filemenu = Gtk::manage(new Gtk::Menu{});
    menuitem_file->set_submenu(*filemenu);

    //         Q U I T
    // Append Quit to the File menu
    Gtk::MenuItem *menuitem_quit = Gtk::manage(new Gtk::MenuItem{"_Quit", true});
    menuitem_quit->signal_activate().connect(sigc::mem_fun(*this,
        &Mainwin::on_quit_click));
    filemenu->append(*menuitem_quit);

    vbox->show_all();
}
```

This code creates our main window and adds a File > Quit menu entry.
We'll continue to build our menu (and eventually, our toolbar) here.

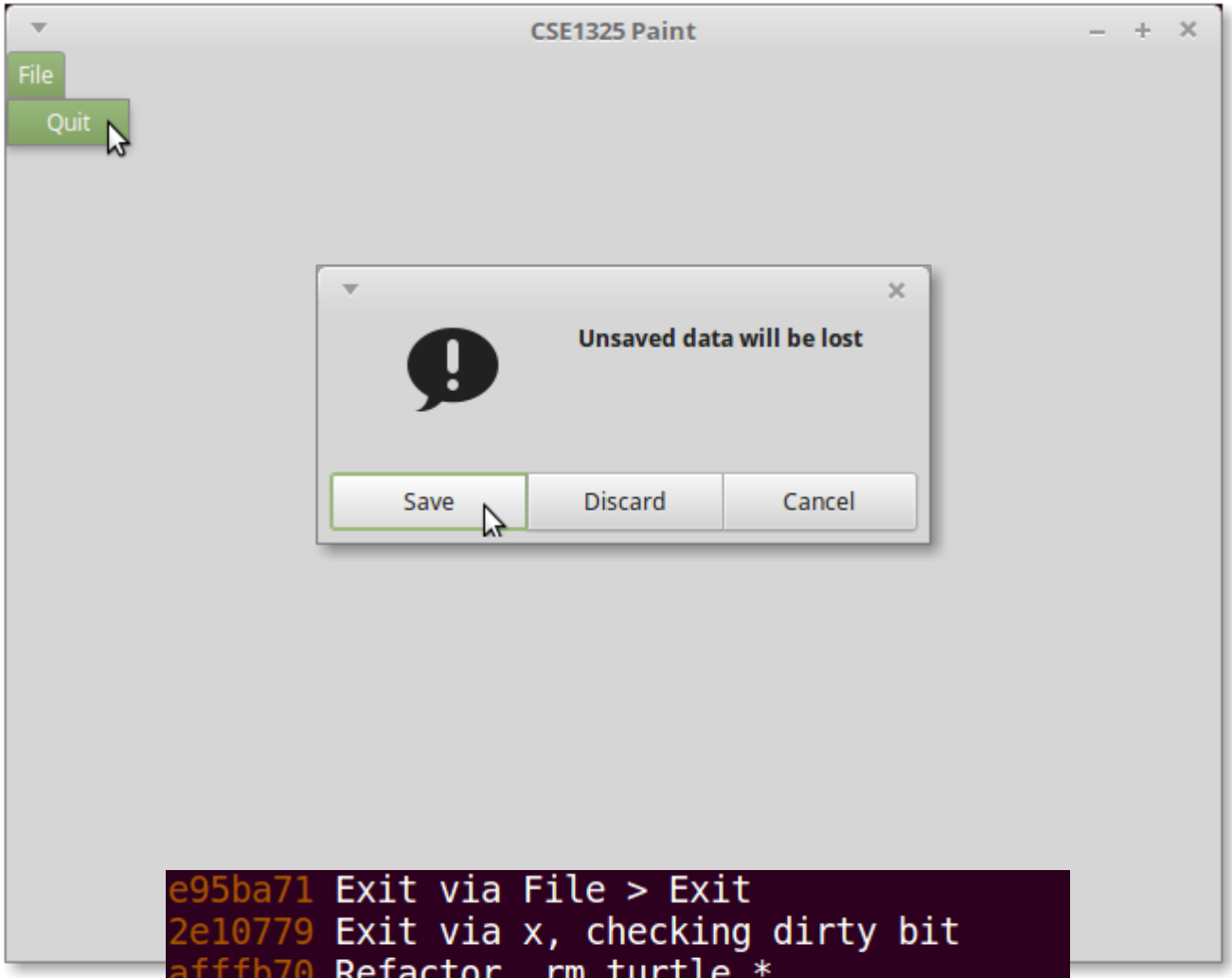
Feature 2

Step 003 – Main Menu + Exit

Makefile

```
rebuild: clean all

debug: CXXFLAGS += -g
debug: rebuild

main: main.o mainwin.o line.o view.o *.h
	$(CXX) $(CXXFLAGS) -o paint main.o mainwin.o line.o view.o `/usr/bin/pkg-config
gtkmm-3.0 --cflags --libs`
main.o: main.cpp *.h
	$(CXX) $(CXXFLAGS) -c main.cpp `/usr/bin/pkg-config gtkmm-3.0 --cflags --libs`
mainwin.o: mainwin.cpp *.h
	$(CXX) $(CXXFLAGS) -c mainwin.cpp `/usr/bin/pkg-config gtkmm-3.0 --cflags --libs`
view.o: view.cpp *.h
	$(CXX) $(CXXFLAGS) -c view.cpp `/usr/bin/pkg-config gtkmm-3.0 --cflags --libs`
line.o: line.cpp *.h
	$(CXX) $(CXXFLAGS) -c line.cpp `/usr/bin/pkg-config gtkmm-3.0 --cflags --libs`
clean:
	-rm -f *.o paint
div:
	@echo
	@echo 'X-X-X-X-X-X-X-X-X-X-X-X-X-X-X-X-'
	@echo '-X-X-X-X-X-X-X-X-X-X-X-X-X-X-X-X'
	@echo 'X-X-X-X-X-X-X-X-X-X-X-X-X-X-X-X-'
	@echo '-X-X-X-X-X-X-X-X-X-X-X-X-X-X-X-X'
	@echo
```

Step 003 – Demonstrating Feature 2 Main Menu + Exit




```
e95ba71 Exit via File > Exit
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

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	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
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	Artist	Copy Image	Place my drawings into e.g., Office documents
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	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status	Notes
DDL	Add a DrawingArea to View		Inherited from the baseline
DDL	Observe mouse clicks in the DrawingArea and create Line objects		
DDL	Override DrawingArea::on_draw and draw the line objects		Inherited from the baseline

Feature 3

Step 004 – Draw Discrete Lines

- We move the View instance and delete_event signal connection from main to Mainwin
  - Because it's a more natural fit
- In View's constructor, we enable the button_press_mask event so we can detect clicks
- We add a View::new_line method to add lines to our vector of Line objects representing our drawing
- We override the on_button_press_event method (which View inherited from DrawingArea) to collect data and call View::new_line as needed

Feature 3

Step 004 – Draw Discrete Lines

view.h

```
#ifndef _VIEW_H
#define _VIEW_H

#include "line.h"
#include <vector>
#include <gtkmm/drawingarea.h>

using namespace std;

class View : public Gtk::DrawingArea {
  public:
     View(Gtk::Window& window);
     bool saved();
     bool on_draw(const Cairo::RefPtr<Cairo::Context>& cr) override;  // Redraw screen
     bool on_my_delete_event(GdkEventAny* event);  // catch click on 'x' in title bar

  protected:
     // Response to a button press
     bool on_button_press_event(GdkEventButton * event) override;

  private:
     Gtk::Window& win;
     int x1, y1;
     vector<Line> lines;
     void new_line(int _x1, int _y1, int _x2, int _y2);
     bool dirty = false;
     bool click_in_progress = false; // distinguish 1st click from 2nd in line drawing
};
#endif
```

Feature 3
Step 004 – Draw Discrete Lines

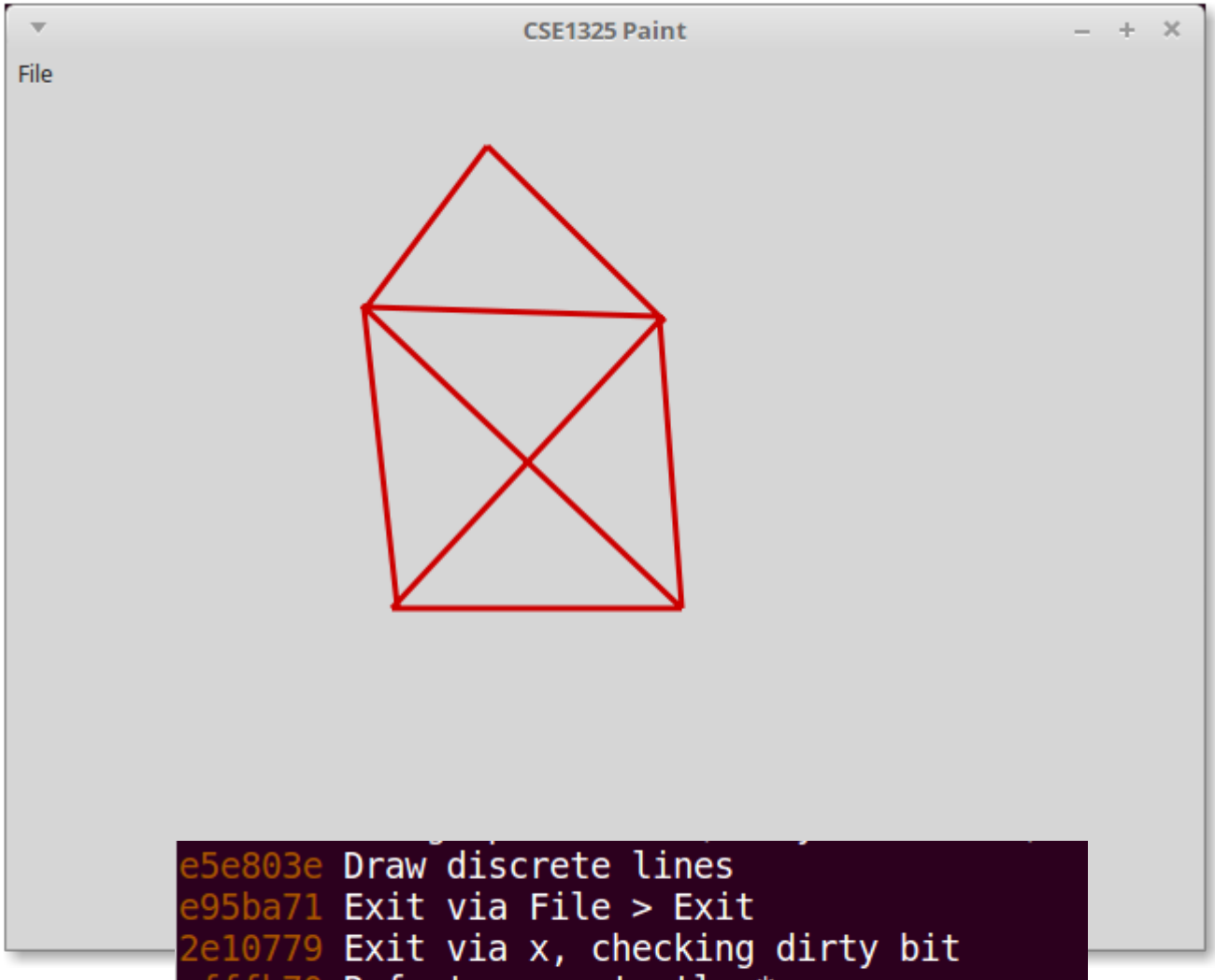
view.cpp

```
View::View(Gtk::Window& window) : win{window} {
    add_events(Gdk::BUTTON_PRESS_MASK);
}

// Add a line to the vector
void View::new_line(int _x1, int _y1, int _x2, int _y2) {
    lines.push_back(Line(_x1, _y1, _x2, _y2));
    dirty = true;
}

bool View::on_button_press_event(GdkEventButton * event) {
    // If this is a left-mouse button press, we're interested!
    if( (event->type == GDK_BUTTON_PRESS) && (event->button == 1)) {

        // Just remember the coordinates on the first click, but
        // add a new line on the second click
        if (!click_in_progress) {
            x1 = event->x;
            y1 = event->y;
            click_in_progress = true;
        } else {
            new_line(x1, y1, event->x, event->y);
            click_in_progress = false;
            queue_draw();  // initiate screen refresh
        }
        return true; // We handled this event
    }
    return false;  // We did NOT handle this event
}
```

If button 1 (left) is pressed, we alternate between remembering (x1, y1) on first click, then adding a (x1,y1)-(x2,y2) line on second click.

DrawingArea::queue_draw requests that the drawing area be redrawn.

Step 004 – Demonstrating Feature 3
Draw Discrete Lines



SCRUM Product Backlog and Next Sprint Backlog Tasks

Status	As an...	I want to...	So that I can...
Finished in Sprint 1	Artist	Exit via x – check for “dirty” bit and prompt to save given new data	Close the window
Finished in Sprint 1	Artist	Exit via File > Exit – creating a File > Exit menu item	Close the window independent of the OS
Finished in Sprint 1	Artist	Draw discrete lines – click for (x1, y1), drag to (x2, y2)	Create line art
	Artist	Change pen color – use a color selection dialog	Create colorful drawings
	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status
PC	Add set_pen_color method to View	
PC	Add Pen > Color menu item, display color chooser, and set in View	
PC	Add color attribute to Line	

Feature 4

Step 005 – Change Pen Color

- Gtkmm has a color selection dialog for this
- We'll need to store the currently selected color with each Line stored in our lines vector

line.h

```
#ifndef _LINE_H
#define _LINE_H
#include <gdkmm/rgba.h>

class Line {    // Define a line from (x1, y1) to (x2, y2)
     double _x1, _y1, _x2, _y2;
     Gdk::RGBA _color;
   public:
     Line(double p_x1, double p_y1,double p_x2, double p_y2, Gdk::RGBA p_color);
     double x1();
     double y1();
     double x2();
     double y2();
     Gdk::RGBA color();
};
#endif
```

Some GUI class libraries (ahem, FLTK) store a color as a simple int. But gtkmm uses a class – RGBA (for Red, Green, Blue, Alpha).

Alpha sets a level of transparency.

Feature 4

Step 005 – Change Pen Color

- Use Line's pen color to update the screen

view.cpp

```
// Draw the lines any time gtkmm needs to refresh the widget
bool View::on_draw(const Cairo::RefPtr<Cairo::Context>& cr) {
    // If nothing to draw, we're done
    if (lines.size() == 0) return true;

    // Create a Cairomm context to manage our drawing
    Gtk::Allocation allocation = get_allocation();

    // Use a 3 pixel wide line of the user-selected color
    cr->set_line_width(3.0);

    // Draw the lines
    for(Line l : lines) {
        Gdk::Cairo::set_source_rgba(cr, l.color());
        cr->move_to(l.x1(), l.y1());
        cr->line_to(l.x2(), l.y2());
        cr->stroke();
    }

    // Drawing was successful
    return true;
}
```

Feature 4

Step 005 – Change Pen Color

- Add Pen > Color to the menu after File > Quit

mainwin.cpp

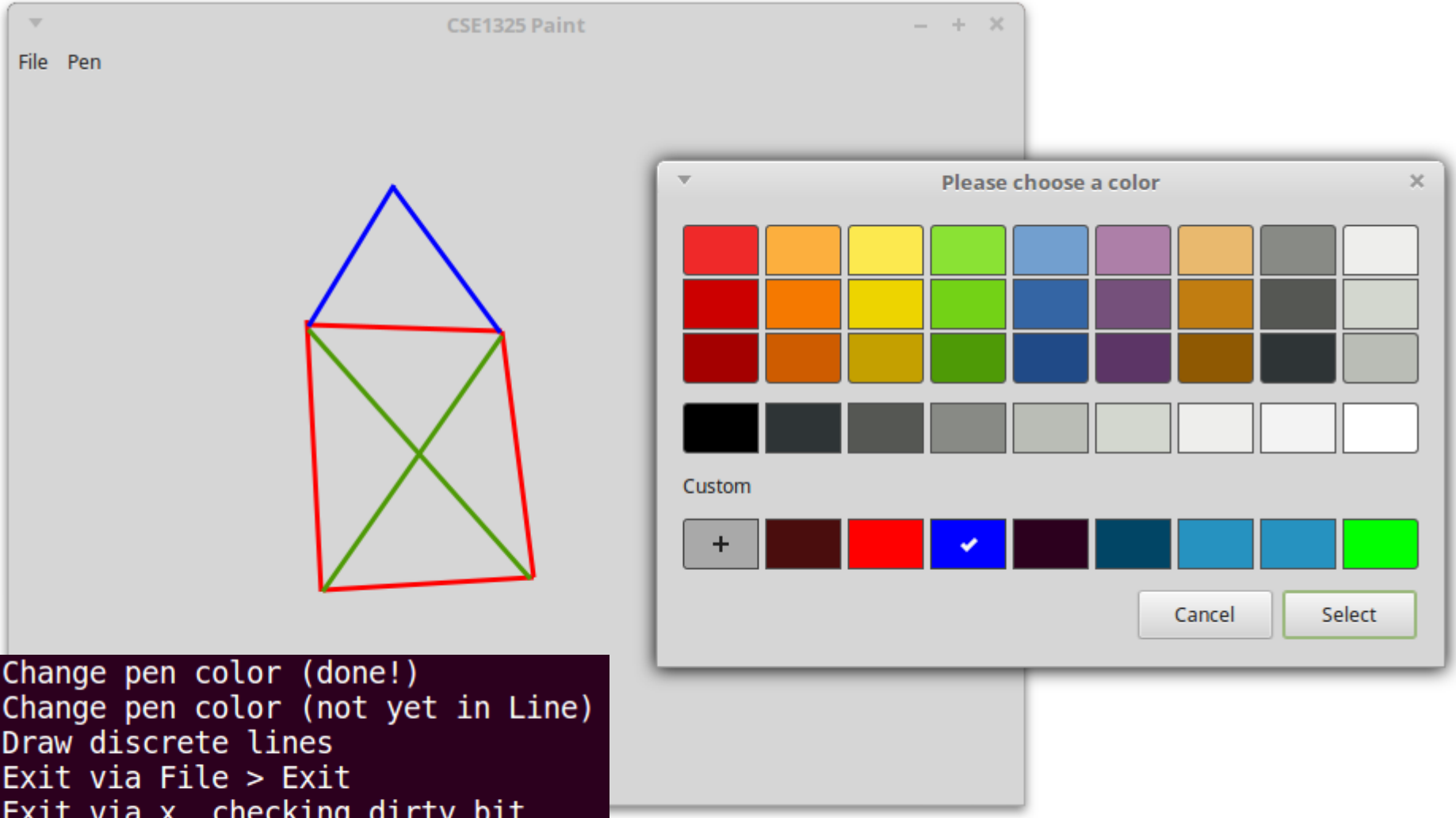
```
    //     P E N
    // Create a Pen menu and add to the menu bar
    Gtk::MenuItem *menuitem_pen = Gtk::manage(new Gtk::MenuItem{"_Pen", true});
    menubar->append(*menuitem_pen);
    Gtk::Menu *penmenu = Gtk::manage(new Gtk::Menu{});
    menuitem_pen->set_submenu(*penmenu);

    //         C O L O R
    // Append Color to the Pen menu
    Gtk::MenuItem *menuitem_color = Gtk::manage(new Gtk::MenuItem{"_Color", true});
    menuitem_color->signal_activate().connect(sigc::mem_fun(*this,
        &Mainwin::on_color_click));
    penmenu->append(*menuitem_color);
```

Only added code is shown.

Code may not be contiguous in file!

```
void Mainwin::on_color_click() {
  Gtk::ColorChooserDialog dialog("Please choose a color");
  dialog.set_transient_for(*this);  // Avoid the “discouraging” warning

  dialog.set_rgba(view->get_pen_color());  // Set the current color as default

  int result = dialog.run();

  if (result == Gtk::RESPONSE_OK)
     view->set_pen_color(dialog.get_rgba());
}
```

Step 005 – Demonstrating Feature 4 Change Pen Color




```
033a45d Change pen color (done!)
5699aec Change pen color (not yet in Line)
e5e803e Draw discrete lines
e95ba71 Exit via File > Exit
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

SCRUM Product Backlog and Next Sprint Backlog Tasks

Status	As an...	I want to...	So that I can...
Finished in Sprint 1	Artist	Exit via x – check for “dirty” bit and prompt to save given new data	Close the window
Finished in Sprint 1	Artist	Exit via File > Exit – creating a File > Exit menu item	Close the window independent of the OS
Finished in Sprint 1	Artist	Draw discrete lines – click for (x1, y1), drag to (x2, y2)	Create line art
Finished in Sprint 1	Artist	Change pen color – use a color selection dialog	Create colorful drawings
	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status
PW	Add set_pen_width method to View	
PW	Add Pen > Width menu item	
PW	Create custom Set Pen Width dialog, set in View	

Feature 5

Step 006 – Change Pen Width

- Gtkmm has no pre-defined dialog for this – had planned to use text, but why not a slider?
- We'll need to store the currently selected color with each Line stored in our lines vector

line.h

```
#ifndef _LINE_H
#define _LINE_H
#include <gdkmm/rgba.h>

class Line {    // Define a line from (x1, y1) to (x2, y2)
     double _x1, _y1, _x2, _y2;
     Gdk::RGBA _color;
     double _width;
   public:
     Line(double p_x1, double p_y1,double p_x2, double p_y2,
          Gdk::RGBA p_color, double p_width);
     double x1();
     double y1();
     double x2();
     double y2();
     Gdk::RGBA color();
     double width();
};
#endif
```

Feature 5

Step 006 – Change Pen Width

mainwin.cpp

```
    //        W I D T H
    // Append Width to the Pen menu
    Gtk::MenuItem *menuitem_width = Gtk::manage(new Gtk::MenuItem{"_Width", true});
    menuitem_width->signal_activate().connect(sigc::mem_fun(*this,
        &Mainwin::on_width_click));
    penmenu->append(*menuitem_width);

void Mainwin::on_width_click() {
    // Create a custom dialog for setting line width
    Gtk::Dialog dialog{"Select Pen Width", *this};

    // The lower widget is a slider (Gtk "scale"), so the user can mouse the new width
    Gtk::Scale scale{};
    scale.set_range(1.0,10.0);
    scale.set_value(view->get_pen_width());  // Preset scale to current width
    scale.show();
    dialog.get_vbox()->pack_start(scale);

    // OK and Cancel buttons
    dialog.add_button("Cancel", 0);
    dialog.add_button("OK", 1);
    dialog.set_default_response(1);

    // Show the dialog, get the button pressed
    dialog.show_all();
    int result = dialog.run();
    if (result == 1) view->set_pen_width(scale.get_value());
    dialog.close();
}
```

A text box in the upper area would be nice, so the user can type in a width as well. It's in the next version! (Old programmers' joke)

Feature 4

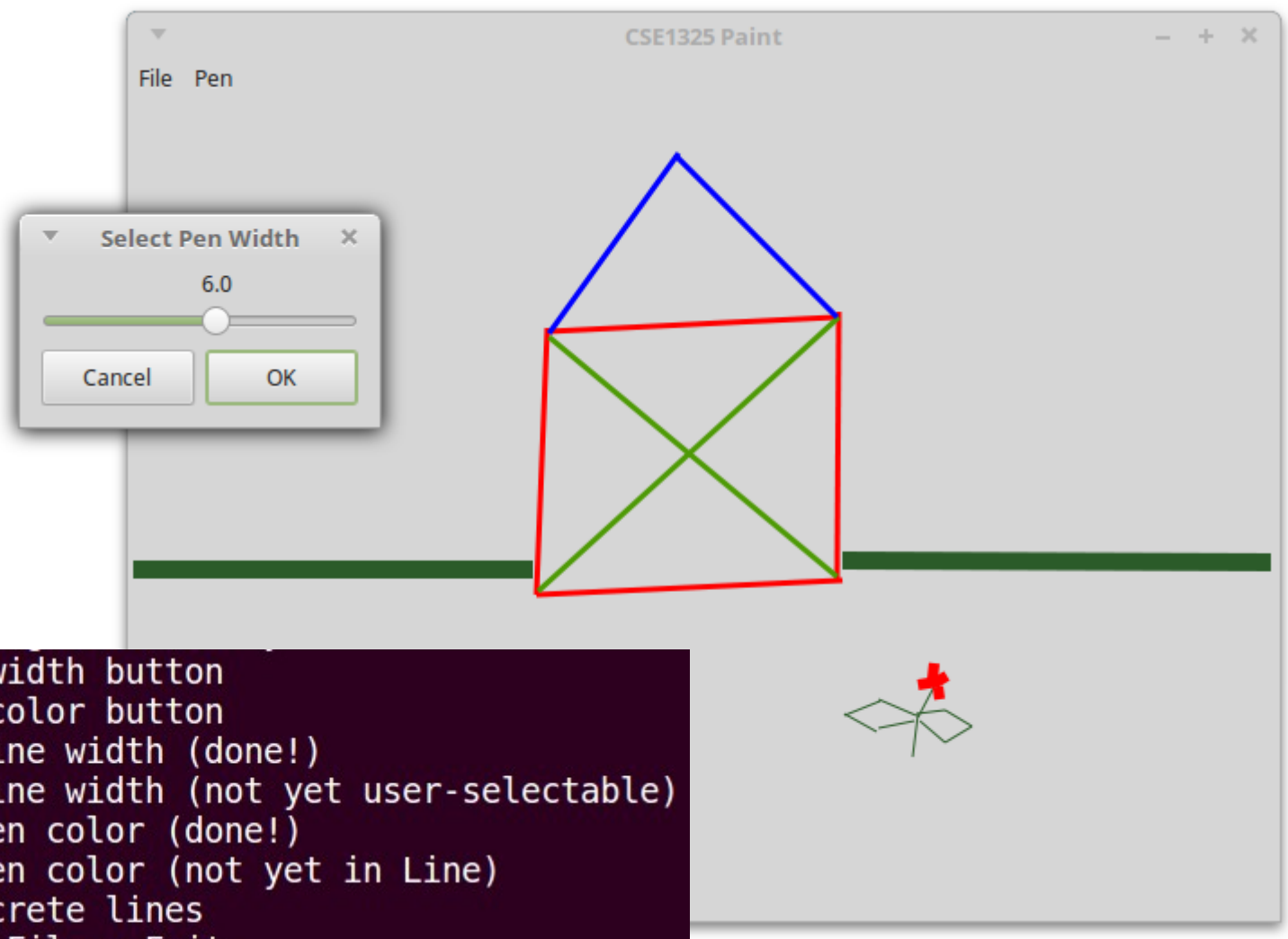
Step 005 – Change Pen Color

- Use Line's pen color to update the screen

view.cpp

```
// Draw the lines any time gtkmm needs to refresh the widget
bool View::on_draw(const Cairo::RefPtr<Cairo::Context>& cr) {
    // If nothing to draw, we're done
    if (lines.size() == 0) return true;

    // Create a Cairomm context to manage our drawing
    Gtk::Allocation allocation = get_allocation();

    // Draw the lines
    for(Line l : lines) {
        Gdk::Cairo::set_source_rgba(cr, l.color());
        cr->set_line_width(l.width());
        cr->move_to(l.x1(), l.y1());
        cr->line_to(l.x2(), l.y2());
        cr->stroke();
    }

    // Drawing was successful
    return true;
}
```

Step 006 – Demonstrating Feature 5 Change Pen Width




```
2a390f4 Add pen width button
4be73a9 Add pen color button
38ba644 Change line width (done!)
cd6bdfb Change line width (not yet user-selectable)
033a45d Change pen color (done!)
5699aec Change pen color (not yet in Line)
e5e803e Draw discrete lines
e95ba71 Exit via File > Exit
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

SCRUM Product Backlog and Next Sprint Backlog Tasks

Status	As an...	I want to...	So that I can...
Finished in Sprint 1	Artist	Exit via x – check for "dirty" bit and prompt to save given new data	Close the window
Finished in Sprint 1	Artist	Exit via File > Exit – creating a File > Exit menu item	Close the window independent of the OS
Finished in Sprint 1	Artist	Draw discrete lines – click for (x1, y1), drag to (x2, y2)	Create line art
Finished in Sprint 1	Artist	Change pen color – use a color selection dialog	Create colorful drawings
Finished in Sprint 1	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status	Notes
TB	Enable the toolbar		Inherited from baseline
TB	Add pen color button and connect signal		
TB	Add pen width button and connect signal		

Feature 6

Step 007 – Add Toolbar

- Just as we did with the Nim example
- We need icons: Pen color  and width 
  though I considered this: 

Feature 6

Step 007 – Add Toolbar

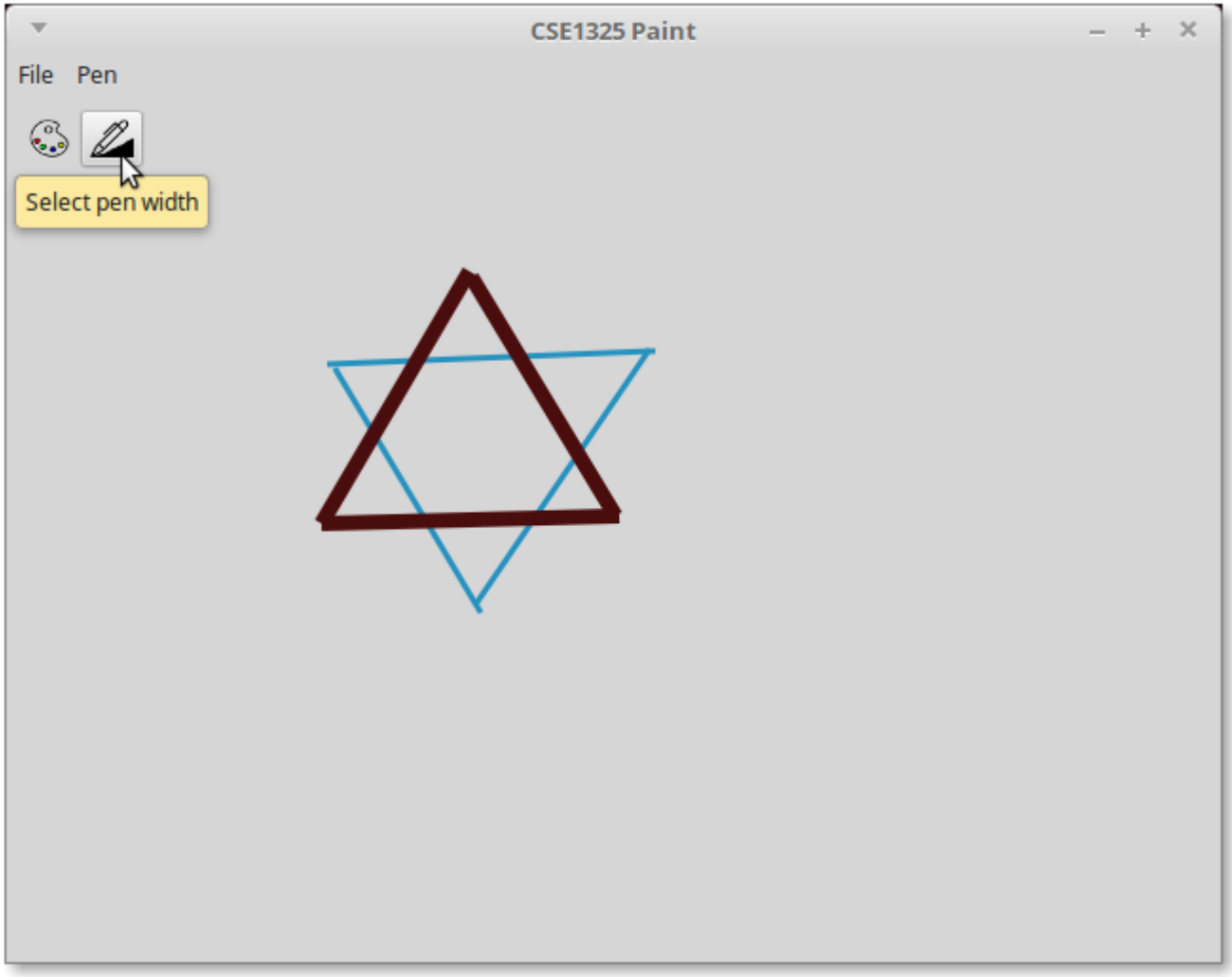
mainwin.cpp

```
// ////////////
// T O O L B A R -- Add a toolbar to the vertical box below the menu
//
Gtk::Toolbar *toolbar = Gtk::manage(new Gtk::Toolbar);
vbox->add(*toolbar);

//     P E N   C O L O R
// Add a new pen color icon
Gtk::Image *button_pen_color_image =
    Gtk::manage(new Gtk::Image("select_pen_color.png"));
Gtk::ToolButton *button_pen_color =
    Gtk::manage(new Gtk::ToolButton(*button_pen_color_image));
button_pen_color->set_tooltip_markup("Select pen color");
button_pen_color->signal_clicked().connect(
    sigc::mem_fun(*this, &Mainwin::on_color_click));
toolbar->append(*button_pen_color);

//     P E N   W I D T H
// Add a set pen width icon
Gtk::Image *button_pen_width_image =
    Gtk::manage(new Gtk::Image("select_pen_width.png"));
Gtk::ToolButton *button_pen_width =
    Gtk::manage(new Gtk::ToolButton(*button_pen_width_image));
button_pen_width->set_tooltip_markup("Select pen width");
button_pen_width->signal_clicked().connect(
    sigc::mem_fun(*this, &Mainwin::on_width_click));
toolbar->append(*button_pen_width);
```

Right below the menu code.

We use exactly the same handlers for buttons as for menu selections.

Step 007 – Demonstrating Feature 6
Add Toolbar



And I forgot to commit this version to git... *sigh*

SCRUM Product Backlog and Next Sprint Backlog Tasks

Status	As an...	I want to...	So that I can...
Finished in Sprint 1	Artist	Exit via x – check for "dirty" bit and prompt to save given new data	Close the window
Finished in Sprint 1	Artist	Exit via File > Exit – creating a File > Exit menu item	Close the window independent of the OS
Finished in Sprint 1	Artist	Draw discrete lines – click for (x1, y1), drag to (x2, y2)	Create line art
Finished in Sprint 1	Artist	Change pen color – use a color selection dialog	Create colorful drawings
Finished in Sprint 1	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
Finished in Sprint 1	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status
SAV	Add Line::save to stream	
SAV	Add View::save to stream	
SAV	Add File > Save to menu	
SAV	Add save button to tool bar	

Review

Reading and Writing Files

- Remember that text files are superior to binary files
- For our purposes, reading and writing files is *exactly like reading and writing cin and cout*
  - Streams are streams
- We create a new output stream (aka cout) by instancing ofstream, with the filename as parameter
  - ostream is its base class, and is used for referencing an ofstream
- We create a new input stream (aka cin) by instancing ifstream, with the filename as parameter
  - istream is its base class, and is used for referencing an ifstream

We Need a Data Format

- Each Line contains 6 objects
  - Given the 6 objects, we can recreate each line and push it back on the lines vector

```
class Line {
// ...
  private:
     double _x1, _y1, _x2, _y2;
     Gdk::RGBA _color;
     double _width;
};
```

- The question mark is _color – how to convert Gdk::RGBA objects to and from a string?
  - RGBA does NOT implement operator<< or operator>>
    - But we could! (Isn't extensibility nice?)
  - But it DOES offer to_string (e.g., _color.to_string)
    - This results in the string "rgb(255,0,0)" for red
  - And it DOES include a reverse constructor, e.g., Gdk::RBGA{"rgb(255,0,0)"}

We Need a Data Format

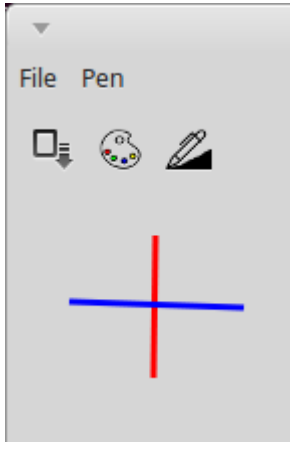
- cin specializes in reading whitespace-separated values from a stream
  - No parsing required
  - Highly reliable *for known data*

```
class Line {
// ...
  private:
     double _x1, _y1, _x2, _y2;
     Gdk::RGBA _color;
     double _width;
};
```

- Simplest is often best – just stream the 6 space-separated strings out to a file
  - We can then just stream them back as batches of 6, creating each line object on the vector, until we reach the end of the file

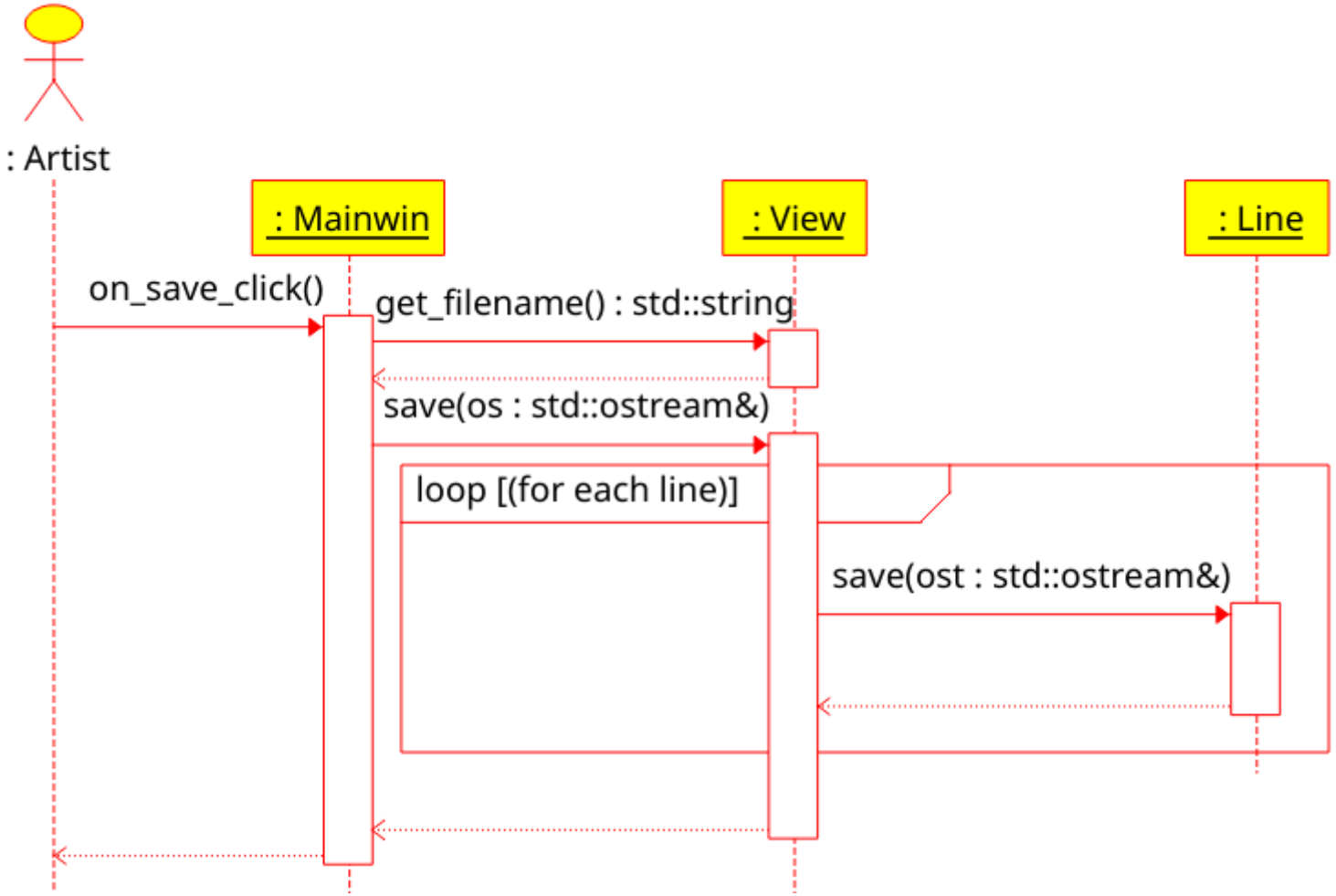
(X1,Y1) (X2,Y2) W Color
74 20 73 91 3 rgb(255,0,0)

(X1,Y1) (X2,Y2) W Color
31 53 118 56 3 rgb(0,0,255)



Feature 6 – Saving to a File

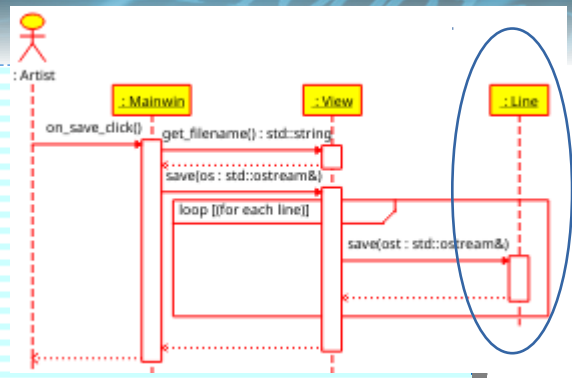
Sequence Diagram



We'll implement this design from right to left

Feature 7

Step 008 – Save



line.h

```
#ifndef _LINE_H
#define _LINE_H
#include <gdkmm/rgba.h>
#include <iostream>

class Line {    // Define a line from (x1, y1) to (x2, y2)
   public:
     Line(double p_x1, double p_y1,double p_x2, double p_y2,
         Gdk::RGBA p_color, double p_width);
     double x1();
     double y1();
     double x2();
     double y2();
     Gdk::RGBA color();
     double width();
     void save(std::ostream& ost);
  private:
     double _x1, _y1, _x2, _y2;
     Gdk::RGBA _color;
     double _width;
};
#endif
```

line.cpp

```
void Line::save(std::ostream& ost) {
    ost << _x1 << ' ' << _y1 << ' '
        << _x2 << ' ' << _y2 << ' '
        << _width << ' '
        << _color.to_string() << ' ';
}
```

We add a “save” method that sends the line as space-separated strings to a stream.
We’ll reconstruct the line later using a constructor:

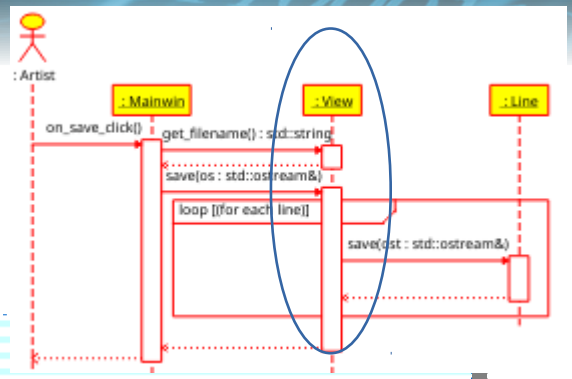
```
Line::Line(std::istream& ist) {
      std::string rgba_color;
      ist >> _x1 >> _y1 >> _x2 >> _y2
          >> _width >> _dash >> rgba_color;
      _color = Gdk::RGBA{rgba_color};
    }
```

Feature 7

Step 008 – Save

```
private:

    // Filename of the current drawing
    string filename = "untitled.ctp";
```

view.h




```
void View::save(ostream& os) {
    for(Line l : lines)
        l.save(os);
    dirty = false;
}
```

view.cpp

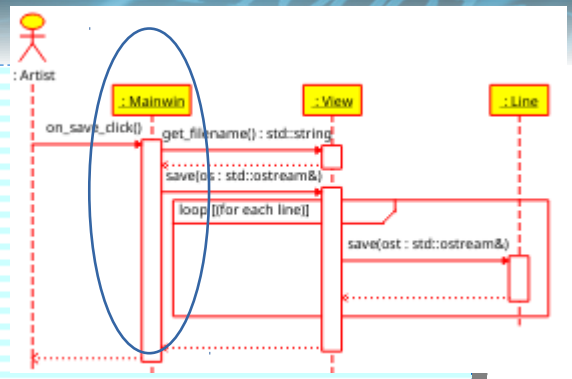
We also add a “save” method to View that calls the save method of every line in our vector.
We’ll reconstruct the vector later using this:

```
// Add a line to the vector
void View::new_line(std::istream& is) {
    lines.push_back(Line(is));
}

void View::load(std::istream& is) {
    dirty = (lines.size() > 0);
    while(is) new_line(is);
}
```

Feature 7

Step 008 – Save

mainwin.cpp



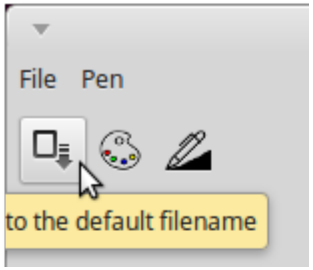

```
    //         S A V E
    // Append Save to the File menu
    Gtk::MenuItem *menuitem_save =
        Gtk::manage(new Gtk::MenuItem{"_Save", true});
    menuitem_save->signal_activate().connect(
        sigc::mem_fun(*this, &Mainwin::on_save_click));
    filemenu->append(*menuitem_save);

    //     S A V E   D R A W I N G
    // Save a drawing to the default filename
    Gtk::ToolButton *save_button =
        Gtk::manage(new Gtk::ToolButton(Gtk::Stock::SAVE));
    save_button->set_tooltip_markup("Save drawing to the default filename");
    save_button->signal_clicked().connect(
        sigc::mem_fun(*this, &Mainwin::on_save_click));
    toolbar->append(*save_button);

// The user wants to save the current drawing to the default filename
void Mainwin::on_save_click() {
    ofstream ofs{view->get_filename(), std::ofstream::out};
    view->save(ofs);
}
```

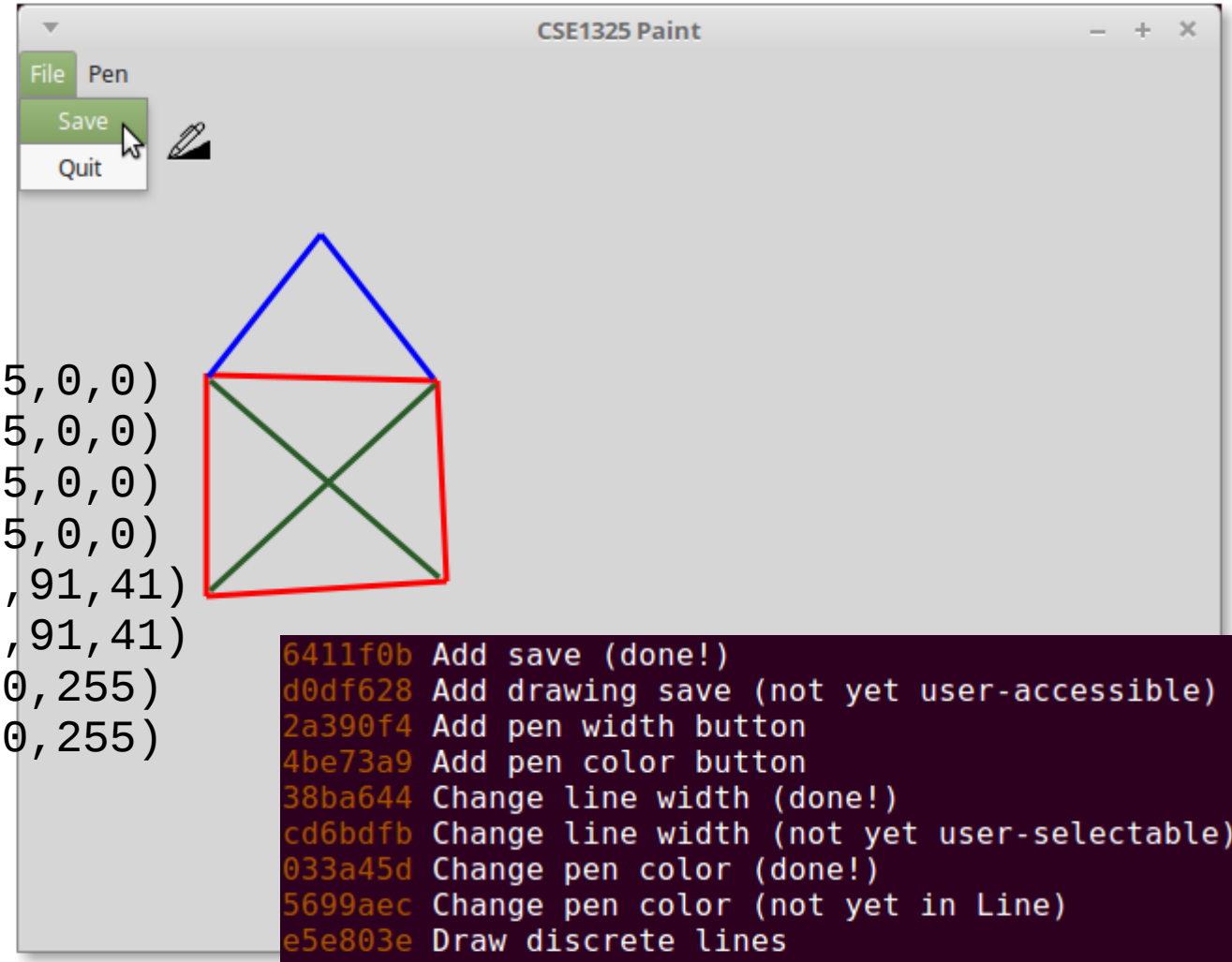
Remember: In C++, we open a file for writing by instancing a new output file stream (class ofstream).

- Parameter #1 is the filename.
- Parameter #2 is the mode, in this case, output.

Then we use the object just as if it were cout.

Step 008 – Demonstrating Feature 7 Saving a File






```
100 101 100 220 3 rgb(255,0,0)
100 220 228 212 3 rgb(255,0,0)
228 212 223 105 3 rgb(255,0,0)
223 105 102 102 3 rgb(255,0,0)
102 105 224 210 3 rgb(43,91,41)
222 107 102 217 3 rgb(43,91,41)
101 103 161  27 3 rgb(0,0,255)
161  27 221 104 3 rgb(0,0,255)
```

(Note, newlines added for clarity.
The actual data file is one
long string of characters -
though I added newlines in cleanup
because it makes it much more legible!)

```
6411f0b Add save (done!)
d0df628 Add drawing save (not yet user-accessible)
2a390f4 Add pen width button
4be73a9 Add pen color button
38ba644 Change line width (done!)
cd6bdfb Change line width (not yet user-selectable)
033a45d Change pen color (done!)
5699aec Change pen color (not yet in Line)
e5e803e Draw discrete lines
e95ba71 Exit via File > Exit
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

SCRUM Product Backlog and Next Sprint Backlog Tasks

Status	As an...	I want to...	So that I can...
Finished in Sprint 1	Artist	Exit via x – check for “dirty” bit and prompt to save given new data	Close the window
Finished in Sprint 1	Artist	Exit via File > Exit – creating a File > Exit menu item	Close the window independent of the OS
Finished in Sprint 1	Artist	Draw discrete lines – click for (x1, y1), drag to (x2, y2)	Create line art
Finished in Sprint 1	Artist	Change pen color – use a color selection dialog	Create colorful drawings
Finished in Sprint 1	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
Finished in Sprint 1	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
Finished in Sprint 1	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status
NEW	Add View::new	
NEW	Add File > New to menu	
NEW	Add new button to tool bar	

Feature 8
Step 009 – New

view.cpp

```
bool View::on_my_delete_event(GdkEventAny* event) {
    return drawing_is_unsaved();
}

bool View::drawing_is_unsaved() {
    if (saved()) return false;
    Gtk::MessageDialog d{win, "Unsaved data will be lost", false,
                         Gtk::MESSAGE_WARNING, Gtk::BUTTONS_NONE};
    d.add_button("Save", 1);
    d.add_button("Discard", 2);
    d.add_button("Cancel", 3);
    int response = d.run();
    if (response == 1) {
        ofstream ofs{filename, std::ofstream::out};
        save(ofs);
        return false;
    } else if (response == 2) {
        return false;
    } else {
        return true;
    }
}

void View::new_drawing() {
    if (drawing_is_unsaved()) return;
    lines.clear();
    dirty = false;
}
```

"New" is another risk of losing data.
Unlike File > Quit, no delete event is generated.

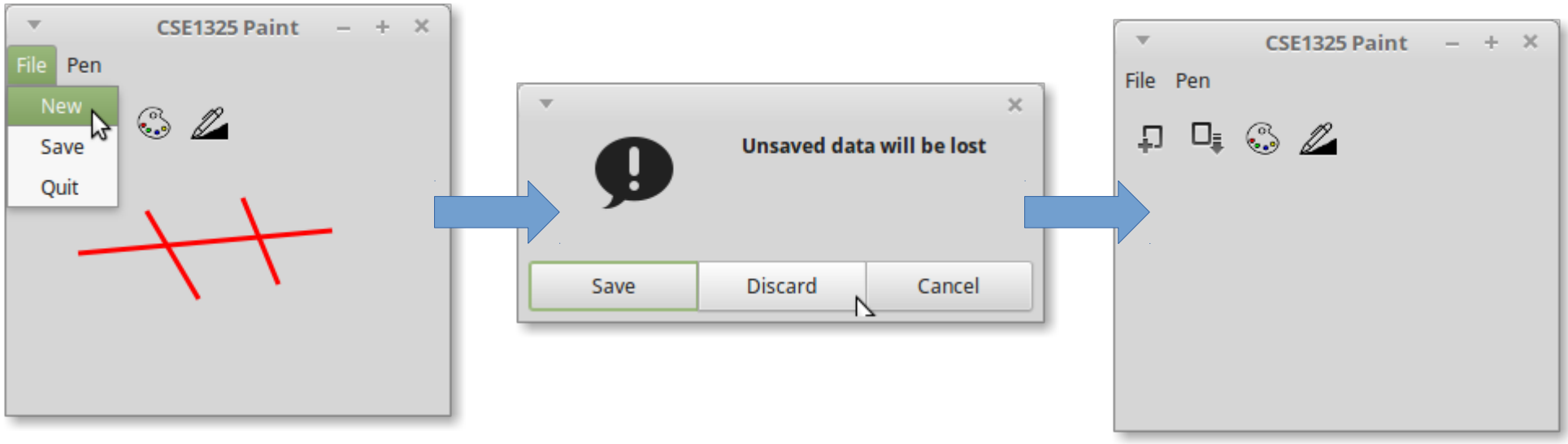
Therefore, we refactor on_my_delete_event to create a private drawing_is_unsaved method for use by new_drawing and on_my_delete_event.

Feature 8
Step 009 – New

mainwin.cpp

```
    //         N E W
    // Append New to the File menu
    Gtk::MenuItem *menuitem_new = Gtk::manage(new Gtk::MenuItem{"_New", true});
    menuitem_new->signal_activate().connect(sigc::mem_fun(*this,
        &Mainwin::on_new_click));
    filemenu->append(*menuitem_new);

    //     N E W   D R A W I N G
    // Start a new drawing
    Gtk::ToolButton *new_button = Gtk::manage(
        new Gtk::ToolButton(Gtk::Stock::NEW));
    new_button->set_tooltip_markup("Start a new drawing");
    new_button->signal_clicked().connect(
        sigc::mem_fun(*this, &Mainwin::on_new_click));
    toolbar->append(*new_button);

//
// The user wants a new, empty drawing
//
void Mainwin::on_new_click() {
    view->new_drawing();
}
```

Step 009 – Demonstrating Feature 8 New




```
02c64d0 Add new (not yet user-accessible)
6411f0b Add save (done!)
d0df628 Add drawing save (not yet user-accessible)
2a390f4 Add pen width button
4be73a9 Add pen color button
38ba644 Change line width (done!)
cd6bdfb Change line width (not yet user-selectable)
033a45d Change pen color (done!)
5699aec Change pen color (not yet in Line)
e5e803e Draw discrete lines
e95ba71 Exit via File > Exit
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

SCRUM Product Backlog and Next Sprint Backlog Tasks

Status	As an...	I want to...	So that I can...
Finished in Sprint 1	Artist	Exit via x – check for “dirty” bit and prompt to save given new data	Close the window
Finished in Sprint 1	Artist	Exit via File > Exit – creating a File > Exit menu item	Close the window independent of the OS
Finished in Sprint 1	Artist	Draw discrete lines – click for (x1, y1), drag to (x2, y2)	Create line art
Finished in Sprint 1	Artist	Change pen color – use a color selection dialog	Create colorful drawings
Finished in Sprint 1	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
Finished in Sprint 1	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
Finished in Sprint 1	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
Finished in Sprint 1	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status
OP1	Add Line::Line(input stream)	
OP1	Add View::Open(filename)	
OP1	Add File > Open, passing default filename	
OP1	Add open button to tool bar	

Feature 9

Step 010 – Open Default

line.cpp

```
Line::Line(std::istream& ist) {
        std::string rgba_color;
        ist >> _x1 >> _y1 >> _x2 >> _y2 >> _width >> rgba_color;
        _color = Gdk::RGBA{rgba_color};
}
```

view.cpp

```
void View::load(std::istream& is) {
    dirty = (lines.size() > 0);
    while(is) new_line(is);
}
```

As promised...

Feature 9

Step 010 – Open Default

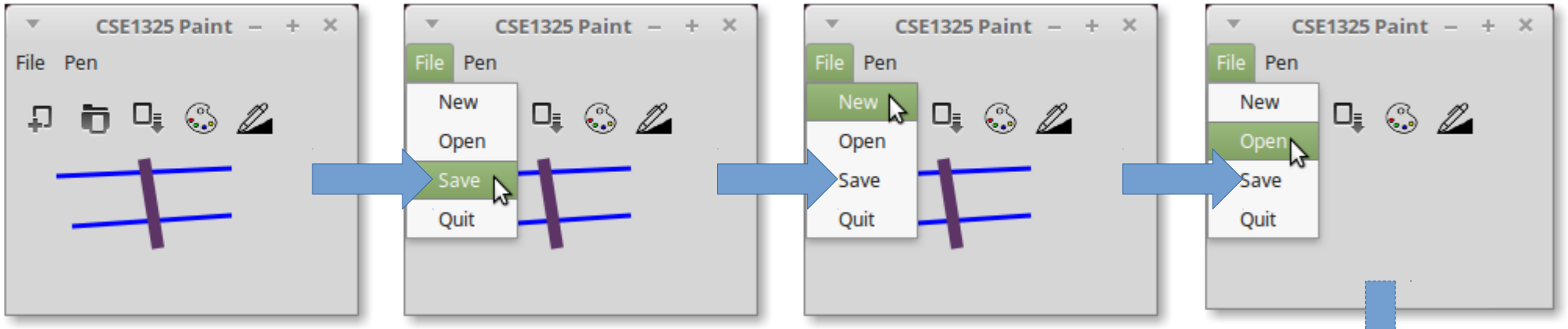
mainwin.cpp

```
    //         O P E N
    // Append Open to the File menu
    Gtk::MenuItem *menuitem_open =
        Gtk::manage(new Gtk::MenuItem{"_Open", true});
    menuitem_open->signal_activate().connect(
        sigc::mem_fun(*this, &Mainwin::on_open_click));
    filemenu->append(*menuitem_open);

    //     O P E N   D R A W I N G
    // Open a drawing from disk
    Gtk::ToolButton *open_button =
        Gtk::manage(new Gtk::ToolButton(Gtk::Stock::OPEN));
    open_button->set_tooltip_markup("Open a drawing");
    open_button->signal_clicked().connect(
        sigc::mem_fun(*this, &Mainwin::on_open_click));
    toolbar->append(*open_button);

//
// The user wants to open a drawing from the filesystem
//
void Mainwin::on_open_click() {
    std::ifstream ifs{view->get_filename(), std::ifstream::in};
    view->load(ifs);
    view->queue_draw(); // refresh the DrawingArea with loaded drawing
}
```

Just to review:
As with output streams in C++, instance ifstream with filename and mode. The resulting object works very much like cin.

Don’t forget to tell the system to redraw the window!

Step 010 – Demonstrating Feature 9 Open Default




```
8e0d17c Add load from default (done!)
c74196c Add load (not yet user-accessible)
02c64d0 Add new (not yet user-accessible)
6411f0b Add save (done!)
d0df628 Add drawing save (not yet user-accessible)
2a390f4 Add pen width button
4be73a9 Add pen color button
38ba644 Change line width (done!)
cd6bdfb Change line width (not yet user-selectable)
033a45d Change pen color (done!)
5699aec Change pen color (not yet in Line)
e5e803e Draw discrete lines
e95ba71 Exit via File > Exit
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

SCRUM Product Backlog and Next Sprint Backlog Tasks

Status	As an...	I want to...	So that I can...
Finished in Sprint 1	Artist	Exit via x – check for “dirty” bit and prompt to save given new data	Close the window
Finished in Sprint 1	Artist	Exit via File > Exit – creating a File > Exit menu item	Close the window independent of the OS
Finished in Sprint 1	Artist	Draw discrete lines – click for (x1, y1), drag to (x2, y2)	Create line art
Finished in Sprint 1	Artist	Change pen color – use a color selection dialog	Create colorful drawings
Finished in Sprint 1	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
Finished in Sprint 1	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
Finished in Sprint 1	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
Finished in Sprint 1	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
Finished in Sprint 1	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status
SVA	Add Mainwin::on_save_as_click with file chooser dialog	
SVA	Add File > Save As to menu	
SVA	Save selected filename to view	

Feature 10

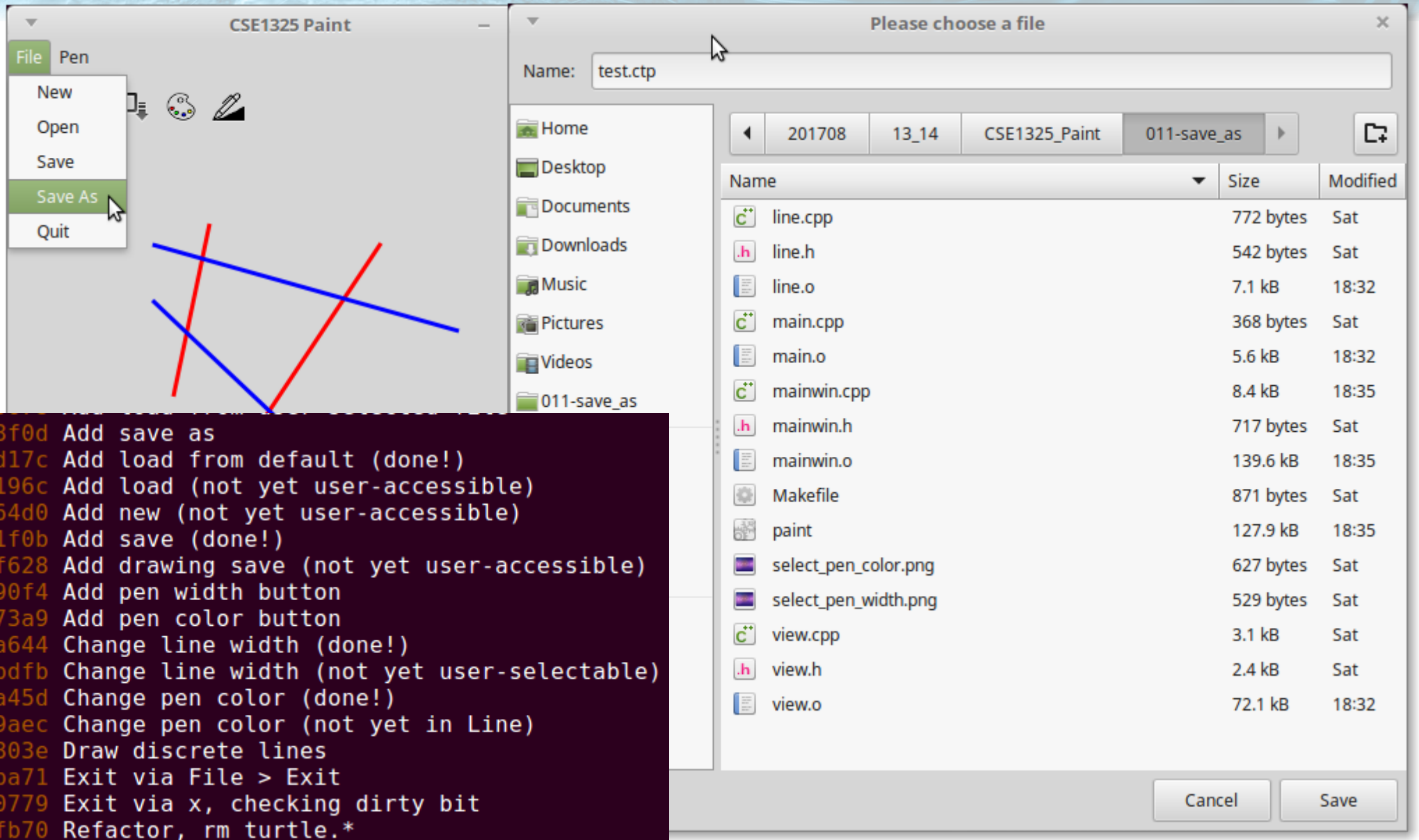
Step 011 – Save As

mainwin.cpp

```
    //          S A V E   A S
    // Append Save As to the File menu
    Gtk::MenuItem *menuitem_save_as =
        Gtk::manage(new Gtk::MenuItem{"Save _As", true});
    menuitem_save_as->signal_activate().connect(
        sigc::mem_fun(*this, &Mainwin::on_save_as_click));
    filemenu->append(*menuitem_save_as);

//
// The user wants to save the current drawing to a new filename
//
void Mainwin::on_save_as_click() {
  Gtk::FileChooserDialog dialog("Please choose a file",
          Gtk::FileChooserAction::FILE_CHOOSER_ACTION_SAVE);
  dialog.set_transient_for(*this);

  //Add response buttons the the dialog:
  dialog.add_button("_Cancel", 0);
  dialog.add_button("_Save", 1);

  int result = dialog.run();

  //Handle the response:
  if (result == 1) {
      std::ofstream ofs{dialog.get_filename(), std::ofstream::out};
      view->save(ofs);
  }
}
```

gtkmm provides a pre-defined file chooser dialog to select a new filename for saving.

Step 011 – Demonstrating Feature 10 Save As




```
7c28f0d Add save as
8e0d17c Add load from default (done!)
c74196c Add load (not yet user-accessible)
02c64d0 Add new (not yet user-accessible)
6411f0b Add save (done!)
d0df628 Add drawing save (not yet user-accessible)
2a390f4 Add pen width button
4be73a9 Add pen color button
38ba644 Change line width (done!)
cd6bdfb Change line width (not yet user-selectable)
033a45d Change pen color (done!)
5699aec Change pen color (not yet in Line)
e5e803e Draw discrete lines
e95ba71 Exit via File > Exit
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

SCRUM Product Backlog and Next Sprint Backlog Tasks

Status	As an...	I want to...	So that I can...
Finished in Sprint 1	Artist	Exit via x – check for “dirty” bit and prompt to save given new data	Close the window
Finished in Sprint 1	Artist	Exit via File > Exit – creating a File > Exit menu item	Close the window independent of the OS
Finished in Sprint 1	Artist	Draw discrete lines – click for (x1, y1), drag to (x2, y2)	Create line art
Finished in Sprint 1	Artist	Change pen color – use a color selection dialog	Create colorful drawings
Finished in Sprint 1	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
Finished in Sprint 1	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
Finished in Sprint 1	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
Finished in Sprint 1	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
Finished in Sprint 1	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
Finished in Sprint 1	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status
OPN	Add file chooser dialog to open	

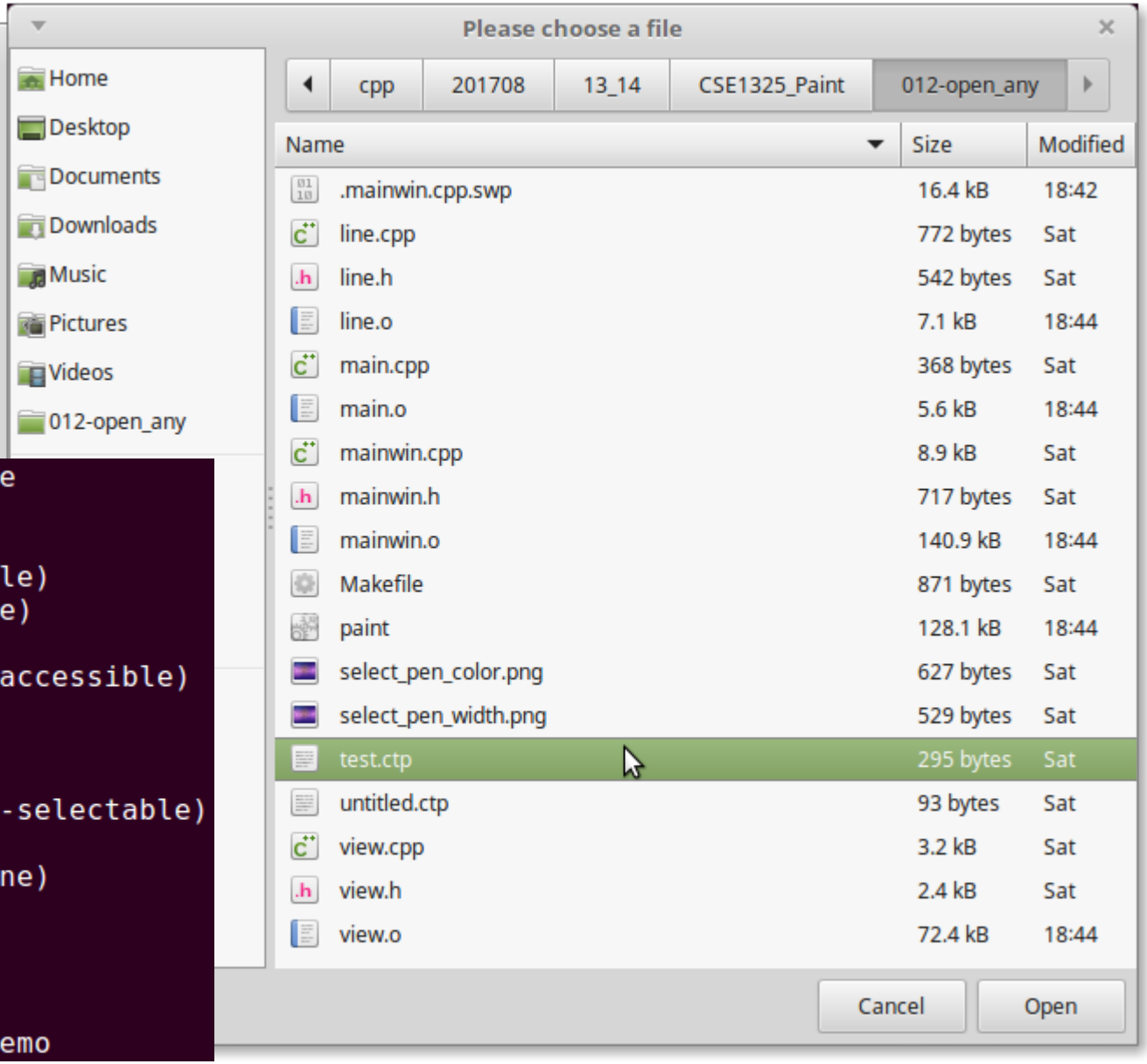
Feature 11
Step 012 – Open

mainwin.cpp

```
//
// The user wants to open a drawing from the filesystem
//
void Mainwin::on_open_click() {
    Gtk::FileChooserDialog dialog("Please choose a file",
          Gtk::FileChooserAction::FILE_CHOOSER_ACTION_OPEN);
    dialog.set_transient_for(*this);

    //Add response buttons the the dialog:
    dialog.add_button("_Cancel", 0);
    dialog.add_button("_Open", 1);

    int result = dialog.run();

    //Handle the response:
    if (result == 1) {
        std::ifstream ifs{dialog.get_filename(), std::ifstream::in};
        view->load(ifs);
        view->queue_draw(); // refresh the DrawingArea with loaded drawing
        view->set_filename(dialog.get_filename());
    }
}
```

The same file chooser dialog may be used to select an existing filename for opening.

Step 012 – Demonstrating Feature 11 Open




```
a760678 Add load from user-selected file
7c28f0d Add save as
8e0d17c Add load from default (done!)
c74196c Add load (not yet user-accessible)
02c64d0 Add new (not yet user-accessible)
6411f0b Add save (done!)
d0df628 Add drawing save (not yet user-accessible)
2a390f4 Add pen width button
4be73a9 Add pen color button
38ba644 Change line width (done!)
cd6bdfb Change line width (not yet user-selectable)
033a45d Change pen color (done!)
5699aec Change pen color (not yet in Line)
e5e803e Draw discrete lines
e95ba71 Exit via File > Exit
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

SCRUM Product Backlog and Next Sprint Backlog Tasks

Status	As an...	I want to...	So that I can...
Finished in Sprint 1	Artist	Exit via x – check for “dirty” bit and prompt to save given new data	Close the window
Finished in Sprint 1	Artist	Exit via File > Exit – creating a File > Exit menu item	Close the window independent of the OS
Finished in Sprint 1	Artist	Draw discrete lines – click for (x1, y1), drag to (x2, y2)	Create line art
Finished in Sprint 1	Artist	Change pen color – use a color selection dialog	Create colorful drawings
Finished in Sprint 1	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
Finished in Sprint 1	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
Finished in Sprint 1	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
Finished in Sprint 1	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
Finished in Sprint 1	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
Finished in Sprint 1	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status
DCL	Add View::set_draw_mode with constants	
DCL	Add contiguous line drawing to mainwin	
DCL	Add Pen > Contiguous and Pen > Segment to menu	
DCL	Add contiguous and segment to tool bar	

Feature 12

Step 013 – Contiguous Mode

- Adding contiguous mode (a new line every click from the previous point of click) means we also need a way to select segment mode (two clicks per line segment)
- We definitely want tool bar buttons for these!
- Then we need to adjust our click handler to manage contiguous line creation

Feature 12

Step 013 – Contiguous Mode

mainwin.cpp

```
    //         P E N   M O D E : S E G M E N T
     // Append Segment to the Pen menu
     Gtk::MenuItem *menuitem_pen_mode_segment =
         Gtk::manage(new Gtk::MenuItem{"Line _Segments", true});
     menuitem_pen_mode_segment->signal_activate().connect(
         sigc::mem_fun(*this, &Mainwin::on_pen_mode_segment_click));
     penmenu->append(*menuitem_pen_mode_segment);

     //         P E N   M O D E : C O N T I G U O U S
     // Append Contiguous to the Pen menu
     Gtk::MenuItem *menuitem_pen_mode_contiguous =
         Gtk::manage(new Gtk::MenuItem{"_Contiguous Lines", true});
     menuitem_pen_mode_contiguous->signal_activate().connect(
         sigc::mem_fun(*this,&Mainwin::on_pen_mode_contiguous_click));
     penmenu->append(*menuitem_pen_mode_contiguous);

    // Set for segment mode initially
    on_pen_mode_segment_click();
}

void Mainwin::on_pen_mode_segment_click() {
    view->set_pen_mode(View::PEN_MODE_SEGMENT);
}

void Mainwin::on_pen_mode_contiguous_click() {
    view->set_pen_mode(View::PEN_MODE_CONTIGUOUS);
}
```

Feature 12

Step 013 – Contiguous Mode

mainwin.cpp

```
//     P E N   M O D E : S E G M E N T
// Add a toggle button to enable segment pen mode
Gtk::Image *segment_image = Gtk::manage(new Gtk::Image("segment.png"));
button_segment = Gtk::manage(new Gtk::RadioToolButton(*segment_image));
button_segment->set_tooltip_markup("Draw line segments");
auto group = button_segment->get_group();
button_segment->signal_clicked().connect(
    sigc::mem_fun(*this, &Mainwin::on_pen_mode_segment_click));
toolbar->append(*button_segment);

//     P E N   M O D E : C O N T I G U O U S
// Add a toggle button to enable contiguous pen mode
Gtk::Image *contiguous_image =
    Gtk::manage(new Gtk::Image("contiguous.png"));
button_contiguous =
    Gtk::manage(new Gtk::RadioToolButton(*contiguous_image));
button_contiguous->set_tooltip_markup("Draw contiguous lines");
button_contiguous->set_group(group);
button_contiguous->signal_clicked().connect(
    sigc::mem_fun(*this, &Mainwin::on_pen_mode_contiguous_click));
toolbar->append(*button_contiguous);
```

A RadioToolButton is click-on, click-off.
Only one button may be on within a group.
This provides a good visual indication of which pen mode is active.

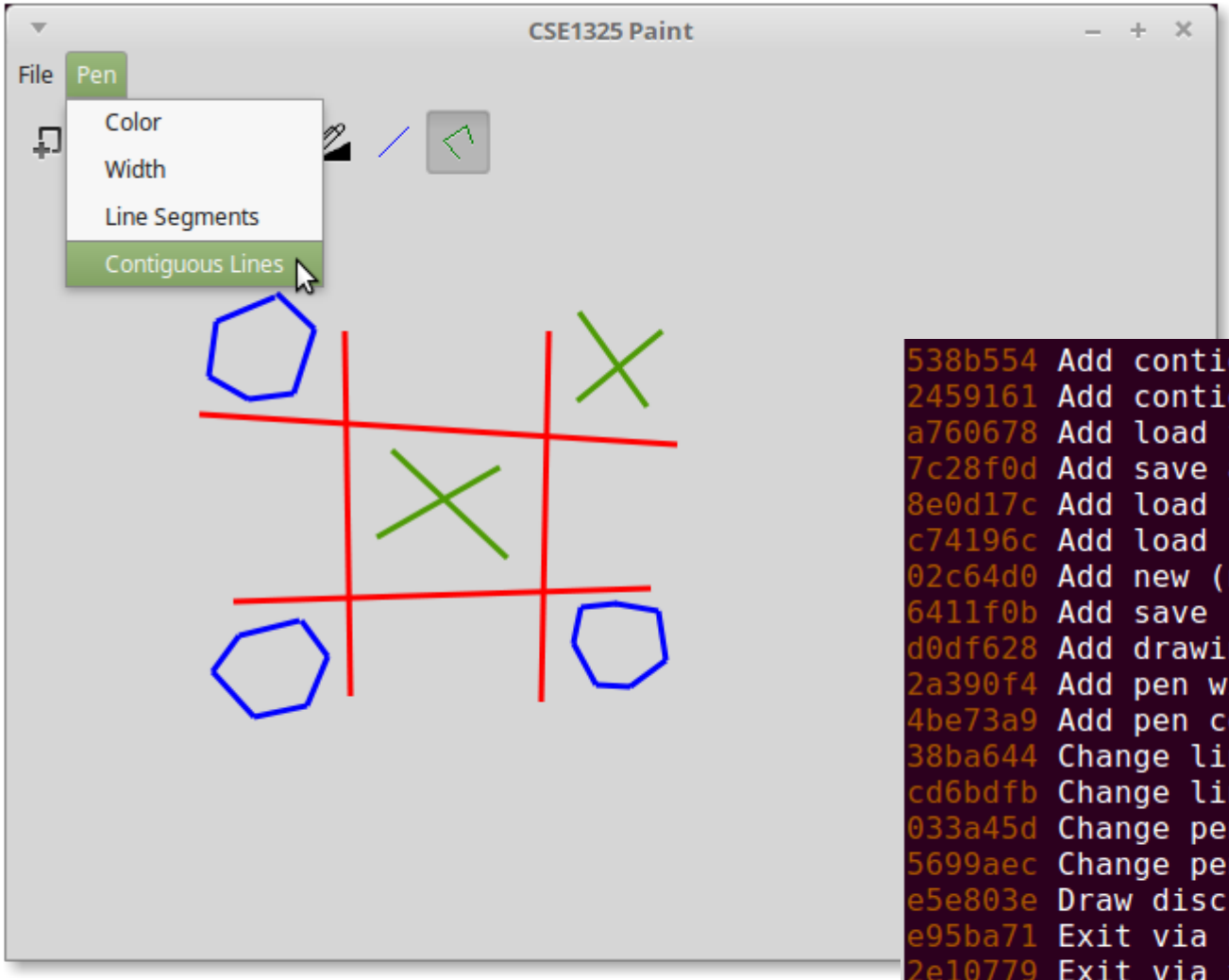
Feature 12

Step 013 – Contiguous Mode

view.cpp

```
bool View::on_button_press_event(GdkEventButton * event) {
    static int previous_pen_mode;
    if( (event->type == GDK_BUTTON_PRESS) && (event->button == 1)) {

        // If the pen mode changed, clear any clicks in progress
        if (pen_mode != previous_pen_mode) click_in_progress = false;

        // Just remember the coordinates on the first click, but add a new line
        // on the second click (and subsequent clicks in contiguous mode)

        if (!click_in_progress) {
            x1 = event->x;
            y1 = event->y;
            click_in_progress = true;
        } else {
            int x2 = event->x;
            int y2 = event->y;
            new_line(x1, y1, x2, y2, color, width);
            queue_draw();  // initiate screen refresh
            x1 = x2;       // to support contiguous mode
            y1 = y2;
            if (pen_mode == PEN_MODE_SEGMENT) click_in_progress = false;
        }
        previous_pen_mode = pen_mode;
        return true; // We handled this event
    }
    return false;  // We did NOT handle this event
}
```

Step 013 – Demonstrating Feature 12 Contiguous Mode




```
538b554 Add contiguous mode (done!)
2459161 Add contiguous mode (sans buttons)
a760678 Add load from user-selected file
7c28f0d Add save as
8e0d17c Add load from default (done!)
c74196c Add load (not yet user-accessible)
02c64d0 Add new (not yet user-accessible)
6411f0b Add save (done!)
d0df628 Add drawing save (not yet user-accessible)
2a390f4 Add pen width button
4be73a9 Add pen color button
38ba644 Change line width (done!)
cd6bdfb Change line width (not yet user-selectable)
033a45d Change pen color (done!)
5699aec Change pen color (not yet in Line)
e5e803e Draw discrete lines
e95ba71 Exit via File > Exit
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

SCRUM Product Backlog and Next Sprint Backlog Tasks

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Finished in Sprint 1	Artist	Change pen color – use a color selection dialog	Create colorful drawings
Finished in Sprint 1	Artist	Change pen width – use a text input dialog and atoi	Provide more texture and movement
Finished in Sprint 1	Artist	Select pen properties from a toolbar	Switch pen properties more quickly
Finished in Sprint 1	Artist	Save – write the lines vector to a default filename	Reload, reuse, and share drawings
Finished in Sprint 1	Artist	New canvas (vector) – toss drawing (prompt to save) and start new	Start a new drawing without closing the program
Finished in Sprint 1	Artist	Open – load the lines vector for the default file	Reload, reuse, and share drawings
Finished in Sprint 1	Artist	Save as – write the lines vector to a user-specified file	Manage my drawing files with less work
Finished in Sprint 1	Artist	Open – load the lines vector from a user-selected file	Reload, reuse, and share drawings
Finished in Sprint 1	Artist	Draw contiguous straight lines – sequence of clicks	Create polygons
	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

Feature ID	Description	Status
DFH	Add motion notify event handler to View	
DFH	Add Pen > Freehand	
DFH	Add freehand to tool bar	

Feature 13

Step 014 – Freehand Mode

- Freehand (or “scribble”) mode requires a new event handler
  - Button Press only responds to *buttons*, not *movement*
  - Pointer Motion is just the ticket!
- When the mouse moves with the button down, we’ll create a stream of line segments, just as if the artist is rapidly clicking the mouse button as she goes
- We also need to add a 3rd radio button to our group (and a menu item) to select Freehand mode

Feature 13

Step 014 – Freehand Mode

view.cpp

```
View::View(Gtk::Window& window) : win{window} {
    add_events(Gdk::BUTTON_PRESS_MASK);
    add_events(Gdk::POINTER_MOTION_MASK);
}

// Drag mouse event handler (for scribbling)
bool View::on_motion_notify_event(GdkEventMotion * event) {

    if (pen_mode != PEN_MODE_FREEHAND) return false;

    int x2, y2;
    guint state;

    x2 = (int)event->x;
    y2 = (int)event->y;
    state = event->state;

    if (state & Gdk::BUTTON1_MASK) {
        new_line(x1, y1, x2, y2, color, width);
        queue_draw();  // initiate screen refresh
        x1 = x2;
        y1 = y2;
    }

    click_in_progress = false;
    return true;
}
```

Although we could allow freehand drawing any time, we choose to only allow it when in Freehand mode to avoid confusion.

– The Architect

Feature 13

Step 014 – Freehand Mode

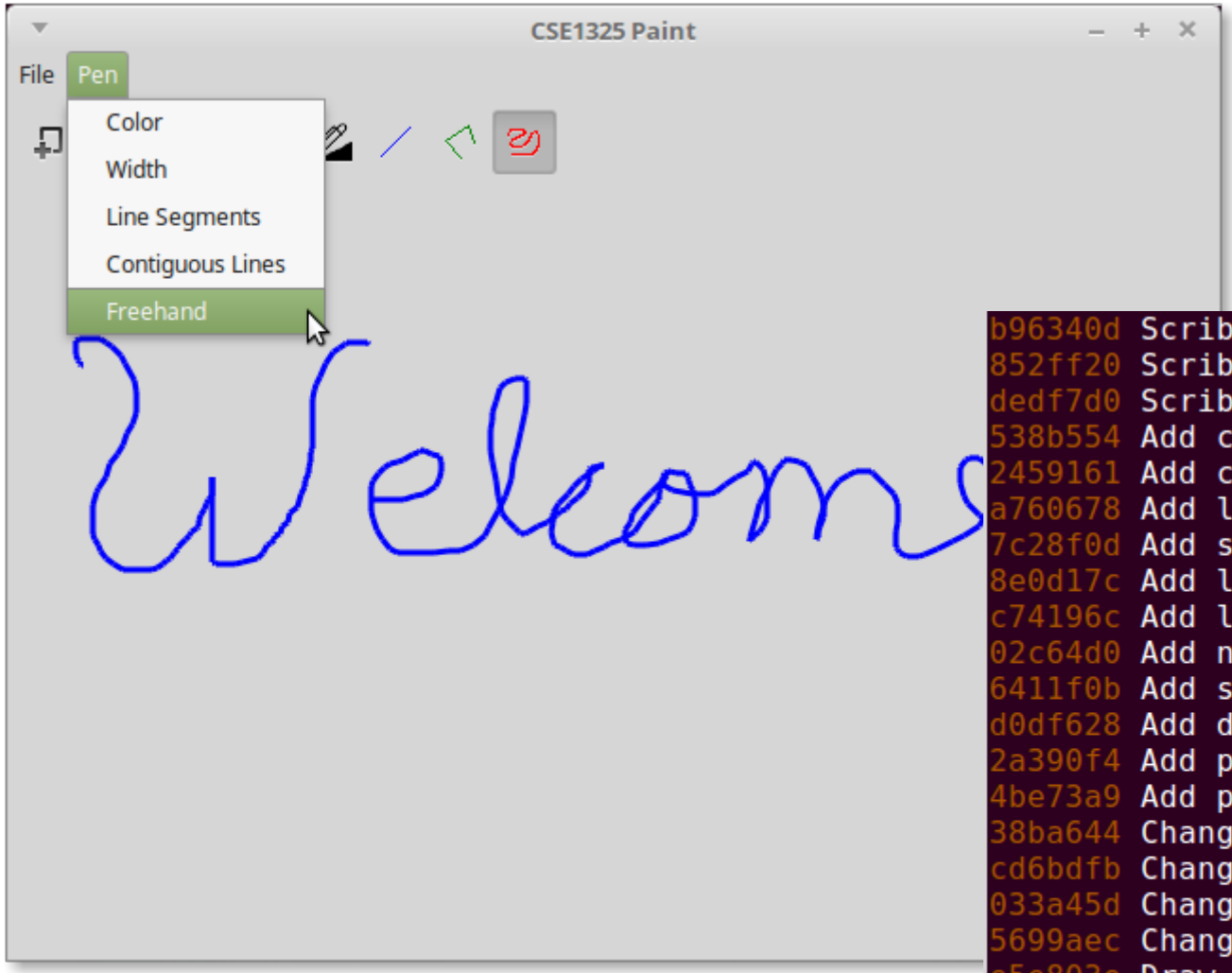
mainwin.cpp

```
    //         P E N   M O D E : F R E E H A N D
    // Append Freehand to the Pen menu
    Gtk::MenuItem *menuitem_pen_mode_freehand =
        Gtk::manage(new Gtk::MenuItem{"_Freehand", true});
    menuitem_pen_mode_freehand->signal_activate().connect(
        sigc::mem_fun(*this, &Mainwin::on_pen_mode_freehand_click));
    penmenu->append(*menuitem_pen_mode_freehand);

    //     P E N   M O D E : F R E E H A N D
    // Add a toggle button to enable freehand pen mode
    Gtk::Image *freehand_image = Gtk::manage(new Gtk::Image("freehand.png"));
    Gtk::RadioToolButton *button_freehand =
        Gtk::manage(new Gtk::RadioToolButton(*freehand_image));
    button_freehand->set_tooltip_markup("Scribble");
    button_freehand->set_group(group);
    button_freehand->signal_clicked().connect(
        sigc::mem_fun(*this, &Mainwin::on_pen_mode_freehand_click));
    toolbar->append(*button_freehand);

void Mainwin::on_pen_mode_freehand_click() {
    view->set_pen_mode(View::PEN_MODE_FREEHAND);
}
```

Step 014 – Demonstrating Feature 13 Draw Freehand




```
b96340d Scribble (done!)
852ff20 Scribble works
dedf7d0 Scribble works (almost)
538b554 Add contiguous mode (done!)
2459161 Add contiguous mode (sans buttons)
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8e0d17c Add load from default (done!)
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2a390f4 Add pen width button
4be73a9 Add pen color button
38ba644 Change line width (done!)
cd6bdfb Change line width (not yet user-selectable)
033a45d Change pen color (done!)
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e95ba71 Exit via File > Exit
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

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	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

DSH	Add dash patterns, dash index, and getters / setters to View
DSH	Add dash index to Line
DSH	Update View::on_draw to use Line's dash setting
DSH	Add Pen > Dash with custom dialog to select dash pattern

Feature 14

Step 015 – Dashed Lines

line.cpp

```
#include "line.h"
#include <gtkmm.h>

Line::Line(double p_x1, double p_y1,double p_x2, double p_y2,
        Gdk::RGBA p_color, double p_width, int p_dash)
    : _x1{p_x1}, _y1{p_y1}, _x2{p_x2}, _y2{p_y2},
       _color{p_color}, _width{p_width}, _dash{p_dash}  { }
Line::Line(std::istream& ist) {
      std::string rgba_color;
      ist >> _x1 >> _y1 >> _x2 >> _y2 >> _width >> _dash >> rgba_color;
      _color = Gdk::RGBA{rgba_color};
    }
double Line::x1() {return _x1;}
double Line::y1() {return _y1;}
double Line::x2() {return _x2;}
double Line::y2() {return _y2;}
Gdk::RGBA Line::color() {return _color;}
double Line::width() {return _width;}
int Line::dash() {return _dash;}
void Line::save(std::ostream& ost) {
    ost << _x1    << ' ' << _y1    << ' ' << _x2 << ' ' << _y2  << ' '
        << _width << ' ' << _dash  << ' ' << _color.to_string() << ' ';
}
```

A Word about File Compatibility

- ctp files written by earlier program iterations will fail for this iteration
  - And files written by this iteration will fail with earlier iterations as well
- How can we maximize file compatibility?

A Word about File Compatibility

- Linux uses heuristics to identify file types
  - See ‘man file’ for details
- Some standard formats, e.g., XML, are inherently extensible
- Executable & Linkable Format (ELF) uses a “magic number”
  - The first 32-bit word is 07F, ‘E’, ‘L’, ‘F’
  - Subsequent byte is e_version of file format
- By prepending a text identifier (e.g, “CTPF”) and version (e.g., “1.0.0”), additional code could provide backward compatibility (e.g., set dash to ‘0’)
  - Forward compatibility is a bit more challenging...

Feature 14

Step 015 – Dashed Lines

view.h

```
// Current dash pattern (a vector index)
int dash = 0;

// Supported dashed lines
typedef std::vector<double> dash_pattern;
std::vector<dash_pattern> dashes = {
    {8.0, 0.0},
    {8.0, 8.0},
    {8.0, 4.0},
    {8.0, 4.0, 2.0, 4.0},
};
```

- A dash pattern is a vector of doubles
  - Even indexes are number of “on” pixels
  - Odd indexes are number of “off” pixels
- For initial release, just predefine a few and name them
  - Long term, we’d want to enable user to create their own and select based on a dynamically generated visual representation

Feature 14

Step 015 – Dashed Lines

view.cpp

```
// Draw the lines any time gtkmm needs to refresh the widget
bool View::on_draw(const Cairo::RefPtr<Cairo::Context>& cr) {
    // If nothing to draw, we're done
    if (lines.size() == 0) return true;

    // Create a Cairomm context to manage our drawing
    Gtk::Allocation allocation = get_allocation();

    // Draw the lines
    for(Line l : lines) {
        Gdk::Cairo::set_source_rgba(cr, l.color());
        cr->set_line_width(l.width());
        cr->set_dash(dashes[l.dash()], 0.0);
        cr->move_to(l.x1(), l.y1());
        cr->line_to(l.x2(), l.y2());
        cr->stroke();
    }

    // Drawing was successful
    return true;
}
```

```
void    set_dash (std::vector< double >& dashes, double offset)
        Sets the dash pattern to be used by stroke().
```

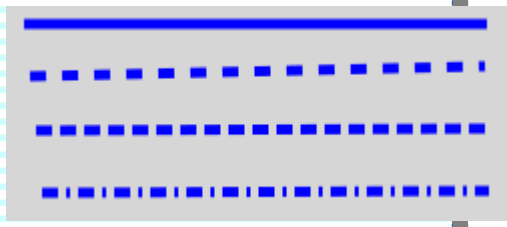
https://www.cairographics.org/documentation/cairomm/reference/classCairo_1_1Context.html

Feature 14

Step 015 – Dashed Lines

mainwin.cpp

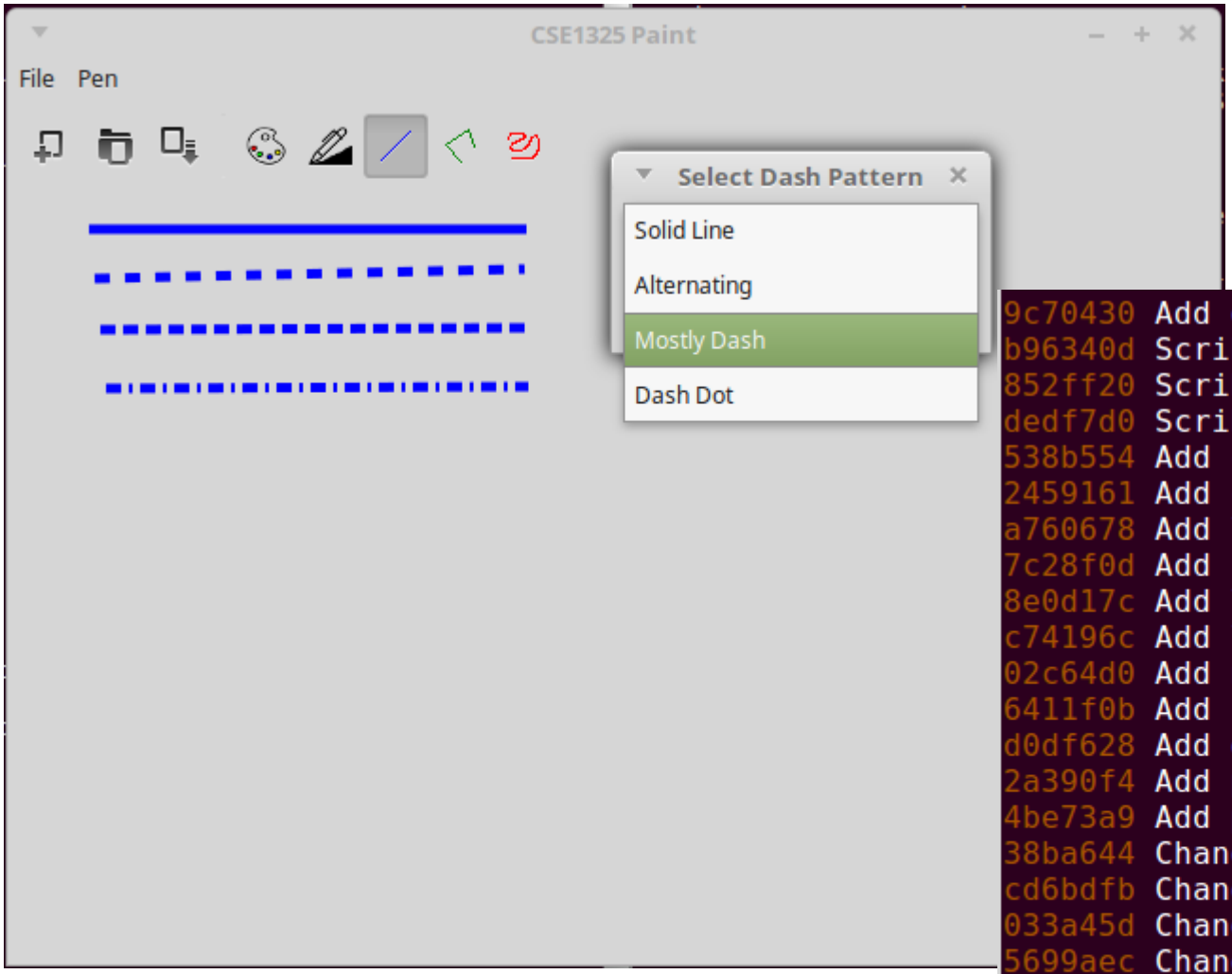
```
    //        D A S H   P A T T E R N S
    // Append dash patterns to the Pen menu
    Gtk::MenuItem *menuitem_dash_pattern =
        Gtk::manage(new Gtk::MenuItem{"_Dash Pattern", true});
    menuitem_dash_pattern->signal_activate().connect(
        sigc::mem_fun(*this, &Mainwin::on_dash_pattern_click));
    penmenu->append(*menuitem_dash_pattern);

void Mainwin::on_dash_pattern_click() {
    Gtk::Dialog dialog{"Select Dash Pattern", *this};

    Gtk::ComboBoxText c_dash;
    c_dash.set_size_request(160);
    c_dash.append("Solid Line");
    c_dash.append("Alternating");
    c_dash.append("Mostly Dash");
    c_dash.append("Dash Dot");
    dialog.get_vbox()->pack_start(c_dash, Gtk::PACK_SHRINK);

    // Show dialog
    dialog.add_button("Cancel", 0);
    dialog.add_button("OK", 1);
    dialog.show_all();
    int result = dialog.run();

    if (result == 1) view->set_dash_pattern(c_dash.get_active_row_number());
    dialog.close();
}
```



The lower widget is a drop-down list of patterns. The patterns are actually defined as View::dashes (in the header file). This list MUST match that vector exactly!

A dynamically constructed list of pattern images would be better, given time. Definitely next release! :-D

Step 015 – Demonstrating Feature 14 Dashed Lines




```
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e95ba71 Exit via File > Exit
2e10779 Exit via x, checking dirty bit
afffb70 Refactor, rm turtle.*
ee35027 Baseline from turtle graphics demo
```

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Feature ID	Description	Status
UNDO	Add View::set_undo_mark and undo methods	
UNDO	Set undo marks when a line segment is drawn	
UNDO	Set undo marks when entering freehand mode	
UNDO	Add Edit > Undo	
UNDO	Add undo button to tool bar	

Feature 15

Step 016 – Undo

- The user will expect to “undo” the last “thing” they drew
  - How would you implement this feature?

Feature 15
Step 016 – Undo

- Our drawing is a *time-ordered* list of vectors
  - Removing the last Line object from the lines vector is effectively an undo
- But what about Freehand (“scribble”) mode
  - This generates perhaps hundreds of vector entries
  - The user will expect an undo to delete the entire scribble, not one pixel or short line segment of it at a time
  - So we implement to the user's expectations (what is this called?)
- Keep a second vector of “undo marks”
  - Before an undoable drawing operation, set a mark – just push_back the size of the lines array onto the undo_marks vector
  - To undo, just delete lines from the end of the vector back to what is indicated in the last undo marks vector entry (back()), then delete the last undo marks entry

Feature 15
Step 016 – Undo

view.h

```
    // Mark the current line as the last before a new undo event
    void set_undo_mark();

    // Undo drawings back to the most recent undo mark
    void undo();

    // List of indices into lines for undo implementation
    std::vector<int> undo_marks = {0};
```

view.cpp

```
void View::set_undo_mark() {
    if (undo_marks.size() == 0 || undo_marks.back() != lines.size())
        undo_marks.push_back(lines.size());
}

void View::undo() {
    while (lines.size() > undo_marks.back()) {
        lines.pop_back();
    }
    if (undo_marks.size() > 1) undo_marks.pop_back();
}
```

Feature 15

Step 016 – Undo

view.cpp

```
// Normal button press event handler
bool View::on_button_press_event(GdkEventButton * event) {
    static int previous_pen_mode;

    // If this is a left-mouse button press, we're interested!
    if( (event->type == GDK_BUTTON_PRESS) && (event->button == 1)) {

        // If the pen mode changed, clear any clicks in progress
        if (pen_mode != previous_pen_mode) click_in_progress = false;

        if (!click_in_progress) {
            x1 = event->x;
            y1 = event->y;
            click_in_progress = true;
        } else {
            set_undo_mark();
            int x2 = event->x;
            int y2 = event->y;
            new_line(x1, y1, x2, y2, color, width, dash);
            queue_draw();  // initiate screen refresh
            x1 = x2;       // to support contiguous mode
            y1 = y2;
            if (pen_mode == PEN_MODE_SEGMENT) click_in_progress = false;
        }
        previous_pen_mode = pen_mode;
        return true; // We handled this event
    }
    return false;  // We did NOT handle this event
}
```

Feature 15

Step 016 – Undo

mainwin.cpp

```
    //     E D I T
    // Create an Edit menu and add to the menu bar
    Gtk::MenuItem *menuitem_edit =
        Gtk::manage(new Gtk::MenuItem{"_Edit", true});
    menubar->append(*menuitem_edit);
    Gtk::Menu *editmenu = Gtk::manage(new Gtk::Menu{});
    menuitem_edit->set_submenu(*editmenu);

    //         U N D O
    // Append Undo to the Edit menu
    Gtk::MenuItem *menuitem_undo = Gtk::manage(new Gtk::MenuItem{"_Undo", true});
    menuitem_undo->signal_activate().connect(
        sigc::mem_fun(*this, &Mainwin::on_undo_click));
    editmenu->append(*menuitem_undo);

//
// The user wants to undo the last operation
//
void Mainwin::on_undo_click() {
    view->undo();
    view->queue_draw();
}
```

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Finished in Sprint 1	Artist	Draw freehand – hold down the mouse and scribble	Create complex shapes
Finished in Sprint 1	Artist	Draw dashed lines in all modes	Make my drawings more interesting and attractive
Finished in Sprint 1	Artist	Undo	Make mistakes without having to start over
	Artist	Run Turtle Graphics file	Create reusable complex shapes
	Artist	Copy Image	Place my drawings into e.g., Office documents
	Artist	Paste Image	Insert drawings from e.g., Gnome Screenshot
	Artist	Export to PNG format	Save my drawings in an industry standard format
	Lawyer	Acknowledge license obligations	Avoid litigation

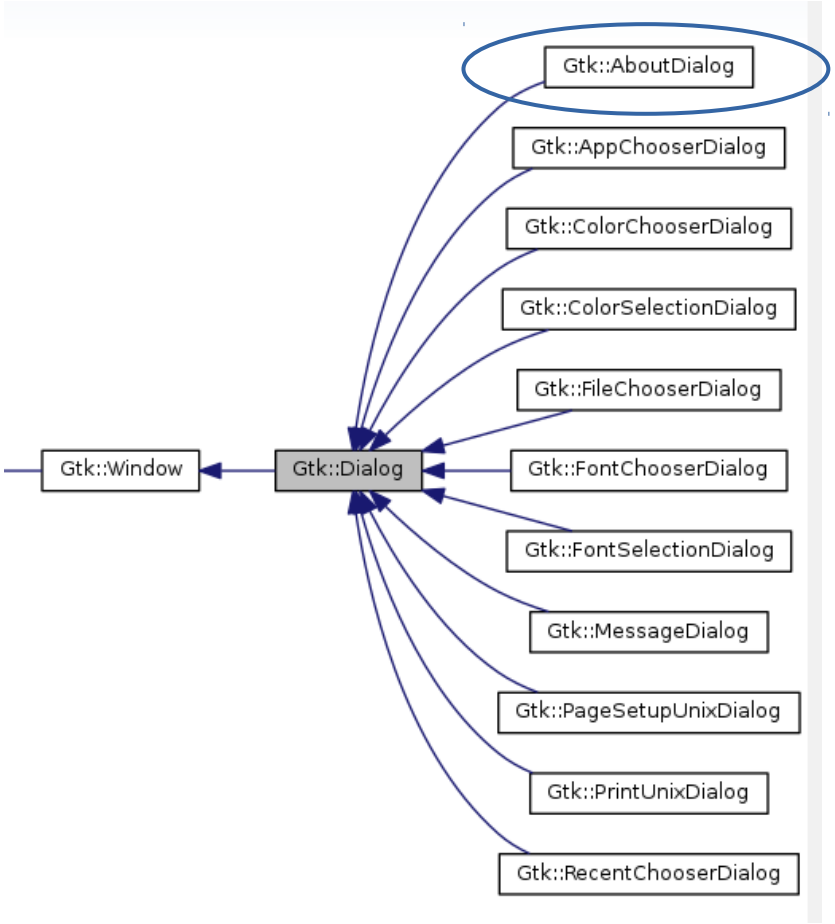
With Sprint 1 almost over, the lawyers manage to bump their feature enough to fit it into the current plan. Need to give credit where due, anyway.

ABT	Add About dialog
ABT	Add Help > About

Feature 20

Step 017 – About

- For Nim, we used a MessageDialog with Pango enabled for our About dialog
- But gtkmm has a predefined class, AboutMessage, specifically for this purpose



Feature 20

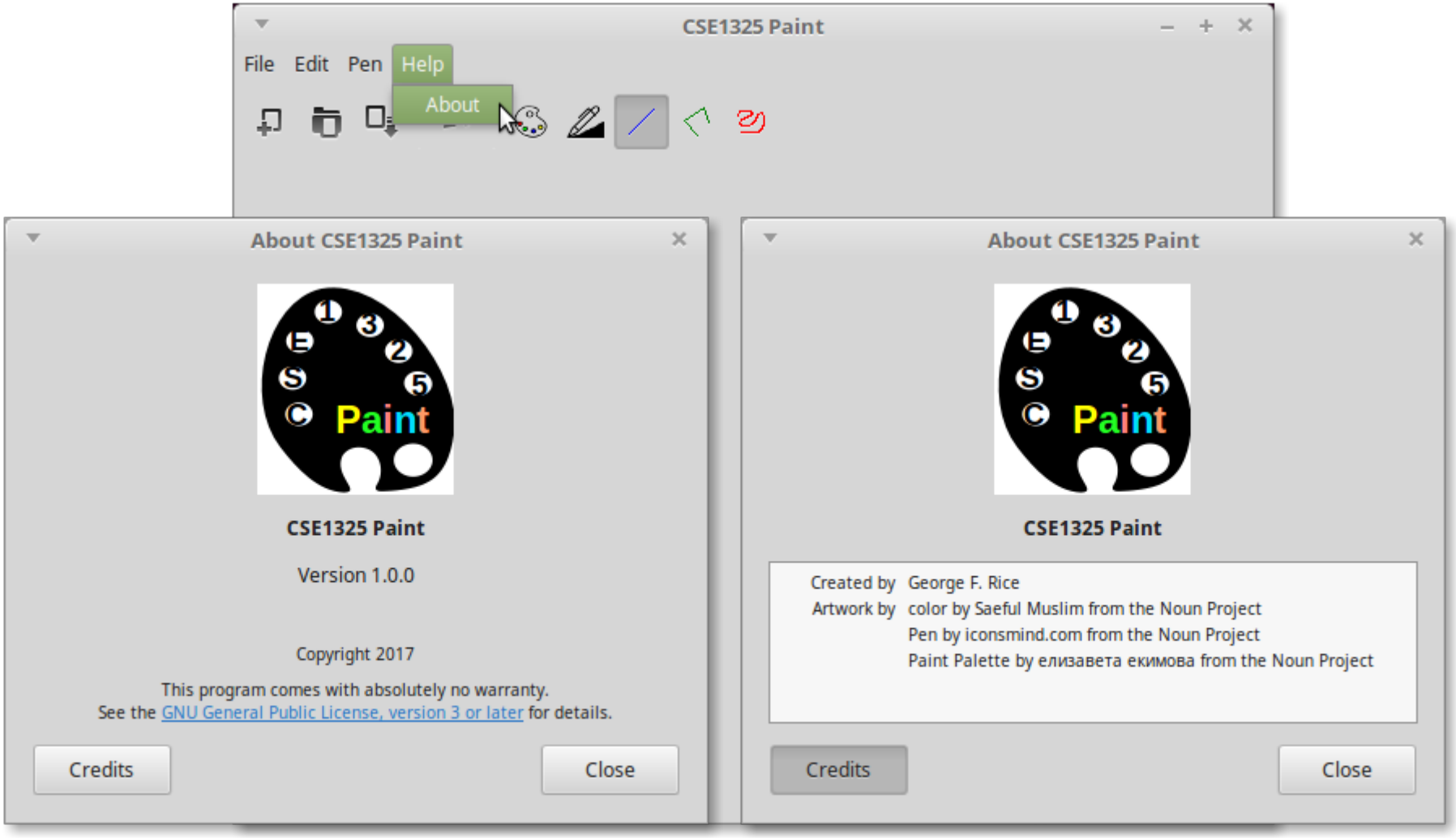
Step 017 – About

mainwin.cpp

```
    //     H E L P
    // Create a Help menu and add to the menu bar
    Gtk::MenuItem *menuitem_help =
        Gtk::manage(new Gtk::MenuItem("_Help", true));
    menubar->append(*menuitem_help);
    Gtk::Menu *helpmenu = Gtk::manage(new Gtk::Menu());
    menuitem_help->set_submenu(*helpmenu);
    //           A B O U T
    // Append About to the Help menu
    Gtk::MenuItem *menuitem_about = Gtk::manage(new Gtk::MenuItem("About", true));
    menuitem_about->signal_activate().connect(
        sigc::mem_fun(*this, &Mainwin::on_about_click));
    helpmenu->append(*menuitem_about);

void Mainwin::on_about_click() {
    Gtk::AboutDialog dialog{};
    dialog.set_transient_for(*this);
    dialog.set_program_name("CSE1325 Paint");
    auto logo = Gdk::Pixbuf::create_from_file("logo.png");
    dialog.set_logo(logo);
    dialog.set_version("Version 1.0.0");
    dialog.set_copyright("Copyright 2017");
    dialog.set_license_type(Gtk::License::LICENSE_GPL_3_0);
    std::vector< Glib::ustring > authors = {"George F. Rice"};
    dialog.set_authors(authors);
    std::vector< Glib::ustring > artists = {...}; // vector redacted for space
    dialog.set_artists(artists);
    dialog.run();
}
```

Step 017 – Demonstrating Feature 20 About



Feature 20 – About

```
ricegf@pluto:~/dev/cpp/201708/13_14/CSE1325_Paint/dev$ gitl
* 6618ef2 Final tweaks for release (4 seconds ago)
* 5dfdacb Official About dialog (23 hours ago)
* 8ca5534 Basic About dialog (23 hours ago)
* e5d43b8 Add undo (done!) (24 hours ago)
* 9c70430 Add dashed lines (done!) (24 hours ago)
* b96340d Scribble (done!) (25 hours ago)
* 852ff20 Scribble works (26 hours ago)
* dedf7d0 Scribble works (almost) (27 hours ago)
* 538b554 Add contiguous mode (done!) (2 days ago)
* 2459161 Add contiguous mode (sans buttons) (2 days ago)
* a760678 Add load from user-selected file (2 days ago)
* 7c28f0d Add save as (2 days ago)
* 8e0d17c Add load from default (done!) (2 days ago)
* c74196c Add load (not yet user-accessible) (2 days ago)
* 02c64d0 Add new (not yet user-accessible) (2 days ago)
* 6411f0b Add save (done!) (2 days ago)
* d0df628 Add drawing save (not yet user-accessible) (2 days ago)
* 2a390f4 Add pen width button (2 days ago)
* 4be73a9 Add pen color button (2 days ago)
* 38ba644 Change line width (done!) (2 days ago)
* cd6bdfb Change line width (not yet user-selectable) (3 days ago)
* 033a45d Change pen color (done!) (10 days ago)
* 5699aec Change pen color (not yet in Line) (10 days ago)
* e5e803e Draw discrete lines (10 days ago)
* e95ba71 Exit via File > Exit (10 days ago)
* 2e10779 Exit via x, checking dirty bit (10 days ago)
* afffb70 Refactor, rm turtle.* (10 days ago)
* ee35027 Baseline from turtle graphics demo (10 days ago)
```

Quick Review

- What artifacts are commonly used to document:
  - Requirements? – Design? – Implementation Plan?
- A _____ is a reference point in the version control system. What are some of its uses?
- What is the “dirty bit”?
- How does gtkmm model color? Dashes?
- Which are predefined gtkmm dialogs?
  (1) ColorChooserDialog (2) PenChooserDialog
  (3) DashChooserDialog (4) FileChooserDialog

Quick Review

- What is a good object-oriented approach to saving a large collection of objects to a file?
- What is the purpose of queue_draw()?
- What is a RadioToolButton? How is it added to a group?
- What precaution(s) in your initial design will simplify backward file compatibility later?
- Suggest a general algorithm for an unlimited depth undo feature.

Lecture 16 and 17
Quick Review

- What artifacts are commonly used to document:
  - Requirements? **(1) Use case diagram backed by Activity, State, or Sequence diagrams or text (2) Scrum Feature Backlog with additional descriptive text for each feaure**
  - Design? **(1) A user interface document that describes the behavior(s) initiated by every widget with which the user will be able to interact, and (2) (at least) a UML class diagram with fields and public methods (other than getters, setters, and default constructors / destructors) identified**
  - Implementation Plan? **(1) A Sprint (or Task) Backlog of tasks that must be completed to implement each feature**
- A **baseline** is a reference point in the version control system. What are some of its uses? **(1) Mark a delivered version (2) Transfer code to a new project**
- What is the “dirty bit”? **Set when unsaved data exists in the program**
- How does gtkmm model color? **RGBA class** Dashes? **Vector, with even subscripts the number of “on” pixels and odd subscripts the number of “off” pixels**
- Which are predefined gtkmm dialogs?
  (1) ColorChooserDialog (2) PenChooserDialog
  (3) DashChooserDialog **(4) FileChooserDialog**

Lecture 16 and 17

Quick Review

- What is a good object-oriented approach to saving a large collection of objects to a file? **Provide a save(ostream) method per class to convert its data to a string, and a *constructor*(istream) to reconstitute it**
- What is the purpose of queue_draw()? **Notify the system that the display no longer matches the data, and should be redrawn when practical**
- What is a RadioToolButton? **One of a group of on/off toolbar buttons, only one of which may be on at a time** How is it added to a group? **button.set_group(first_button.get_group());**
- What precaution(s) in your initial design will simplify backward file compatibility later? **Use text, not binary. Put a unique "magic cookie" on the first line to validate the file type, and a file format version number on the second line to identify how it was written**
- Suggest a general algorithm for an unlimited depth undo feature. **Bundle data additions as atomic "transactions" added to a vector. Pop_back the vector to undo a transaction.**

Exam #2 is Tuesday, March 27

- Review the study sheet and all Quick Review solutions
- Do and review the Practice Exam