Xest: Writing a Window Manager in Haskell

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CSM LUG
Wayland

Lower Level protocol with better security, performance, and flexibility. Represents the future of Linux desktops.
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Lower Level protocol with better security, performance, and flexibility.

Represents the future of Linux desktops.

Much more complicated and relatively young.

What this is (mostly) not [1]

- Complete
- well documented
A server draws and communicates events with clients.
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Who is a server?
A server draws and communicates events with clients.

Who is a server?

- Xorg
- Xephyr
- Xming
- Cygwin
- XQuartz
- Xvfb
What is a client?
What is a client?

- Firefox
- Gnome-Terminal
- Termite
- Google Chrome
- Steam
- Borderlands 2
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Almost everything is a client.

Server side decorations?

Xlib?
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Almost everything is a client. Server side decorations? Xlib?
Displays vs. Screens vs. Windows
Displays are not physical displays
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:0 is the first/default display
Displays are not physical displays

:0 is the first/default display

One display can have multiple screens
1 screen = 1 monitor

- Can have different color settings, dpi, resolutions, etc.
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(In the olden days)
Enter Xinerama
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Multiple graphics cards (and displays) = 1 screen

- None of the screen limitations exist
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• Window Managers can use the Xinerama library to figure out the
  monitor configuration
• Every rendering action has to happen on all cards
• Single threaded so slower than the worst card
• No 3D acceleration
• One DPI across all monitors
What’s left?
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Nvidia TwinView
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Nvidia TwinView (proprietary)
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Enter Randr
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- Multiple graphics cards?
Enter Wayland
windows (Little w)
The Tree

Windows are organized like a tree
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Every X session has one window by default: The root window
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New programs find the root window (using Xlib) then create themselves as children
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- Buttons
- Text Boxes
- Etc.
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It's like the Internet/DOM

(No one uses it like that anymore although toolkits like GTK still have remnants of it)
Callbacks

Clients ask to be notified on certain events. Usually only one client can get notified about events for one window.

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- Keyboard click
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- Becoming visible
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- Being killed
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- Keyboard click
- Becoming visible
- Being killed
- Changes to child windows

The root window doesn’t have any notifications or redirects at bootup...
Each window has properties (AKA a dictionary) associated with it.
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ICCCM (Inter-Client Communication Conventions Manual)

- Clipboard
- Window names
- Geometry
- Relationship to other windows
- Polite focus capture

EWMH (Extended Window Manager Hints)

- Multiple Desktops
- Pager information
- Polite window movement
- Type/State of window
- Actions others can take on a window
- Pinging/killing unresponsive windows
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Tying it all Together
Program Flow

- X server starts up
- Xest starts up
- Xest asks for SubstructureNotifyMask and SubstructureRedirectMask on the root window
- Xest writes a bunch of properties to the root window
- Google Chrome asks to make a child of the root window
- Xest hears about it. Accepts/denies the request
- Xest if accepted, Xest reparents the window
- Xest updates its internal state
- Xest issues move/resize/restack commands to the server
- Xest modifies/reads properties on the root/top level window
Haskell
Python is . . .
- Dynamically typed
- Scripting language
- Emphasizes practicality
- Provides the Pythonic way
- Strict execution
- Impure

Haskell is . . .
- Statically typed
- Compiled language
- Lots of theory (and weird names)
- Provides a million ways to abstract something
- Lazy evaluation
- Pure
Haskell is all about putting information in the types and forcing you to deal with them.

- If a value can be null
- If a value might contain an error
- If a value is nondeterministic
- If a value depends on some kind of state
- If a value may or may not exist yet
- If a value has additional data associated with it
Isn’t that annoying (See Go err, Java nulls, etc)?
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- Use better types (NonEmpty, Don’t wrap everything in Maybe, etc)
- Use existing abstractions
- Use generated code
### Abstractions

**Name**
- Foldable

**When**
Do you want to combine everything you’re wrapping into one value?
- sum
- concat
- and/or
- any/all
- max/min
- find

**What**
- List
- Trees
- Maps/Sequences
- Maybe (aka null)
- Either
Abstractions

Name

Functor

When

Do you want to modify everything being wrapped?
  ● map
  ● A whole bunch of cool things ...

What

● List
● Trees
● Maps
● Maybe (aka null)
● Either
● IO
Let’s see some code . . .
In summary:

- Least Privilege should be central to the code
- Recursion schemes are game changing to how you write functional code
- If you have clear semantics, writing code is a lot easier
- Writing imperative code in Haskell is pretty nice
- The standard library made questionable decisions
- There are still tons of experimentations/improvements I want to make
References

Recursion Schemes:
https://blog.sumtypeofway.com/an-introduction-to-recursion-schemes/

An incomplete guide to writing a window manager:
https://jichu4n.com/posts/how-x-window-managers-work-and-how-to-write-one-part-ii/

An awesome, incomplete guide to how X works:
https://magcius.github.io/xplain/article/