ggplot2 extensions are easy – right??

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Outline[1]

- Quick review of the ggplot2 layering system
- Examples
- More examples

[1]Thanks to Chris Bourke for making the UNL Beamer Theme

ggplot2 is ...

- pretty wildly used (more than 1 million downloads each month)
- based on the Grammar of Graphics, i.e conceptually sound
- supports a layering system
- very flexible with (relatively) good defaults

References:

- Hadley Wickham's book: ggplot2: Elegant Graphics for Data Analysis (3e)
- Winston Chang's book: R Graphics Cookbook (2e)
- ggplot2 online documentation

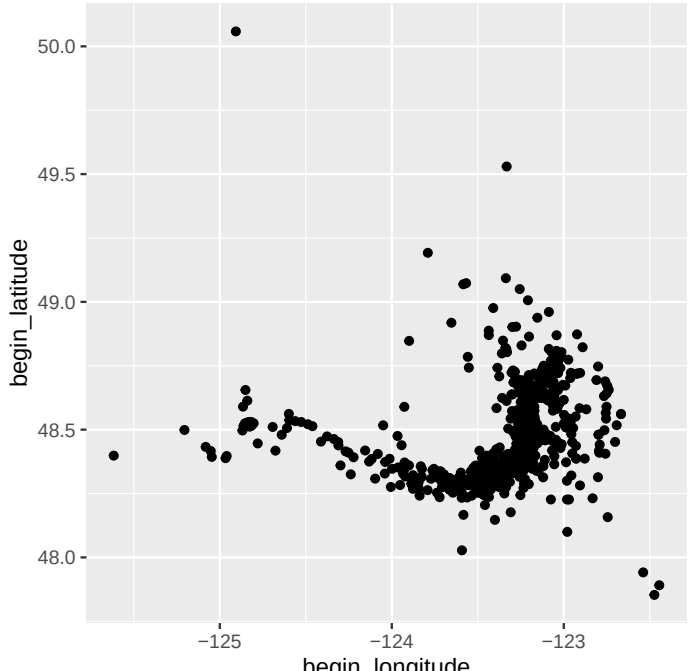
Components of a ggplot2 chart: data is number 0

1. **mappings** (`aes`): data variables are mapped to graphical elements
2. **layers**: geometric elements (`geoms`, such as points, lines, rectangles, text, ...) and statistical transformations (`stats`, are identity, counts, bins, ...)
3. **scales**: map values in the data space to values in an aesthetic space (e.g. color, size, shape, but also position)
4. **coordinate system** (`coord`): defaults to Cartesian, but pie charts use e.g. polar coordinates
5. **facetting**: for small multiples (subsets) and their arrangement
6. **theme**: defaults to `theme_grey` fine-tune display items, such as font and its size, color of background, margins, ...

Defaults!

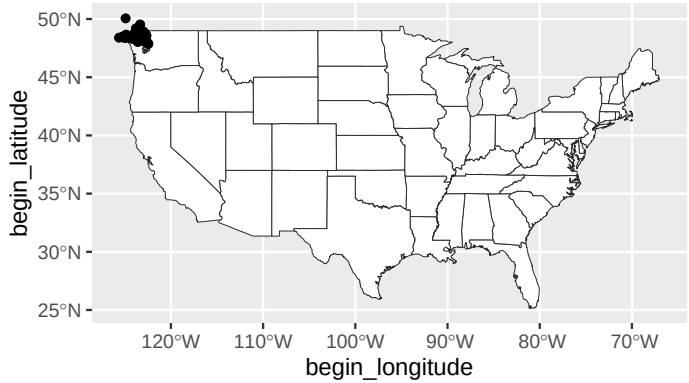
Usually only need `data`, mapping with `aes` and one `geom`:

```
orcas <- tidytuesdayR::tt_load(2024, week = 42)$orcas

orcas %>% #<< data
  ggplot(aes(x = begin_longitude, y = begin_latitude)) +
  geom_point()
```



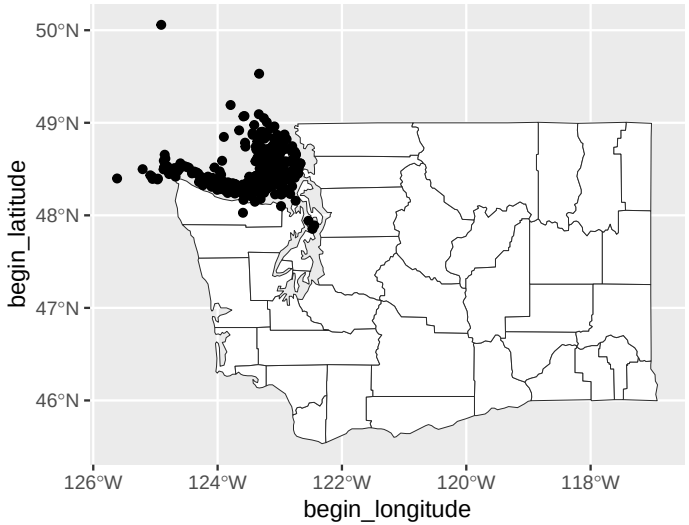
Layering

```
ggplot(usa) +
  geom_sf(color = "#2b2b2b", fill = "white", size=0.1
  geom_point(
    aes(x = begin_longitude, y = begin_latitude),
    data = orcas)
```



Layering

```
ggplot(wa) +
  geom_sf(color = "#2b2b2b", fill = "white", size=0.1
  geom_point(
    aes(x = begin_longitude, y = begin_latitude),
    data = orcas)
```



A first extension

from ggplot2 vignette on extensions

Making a convex hull: Object definition

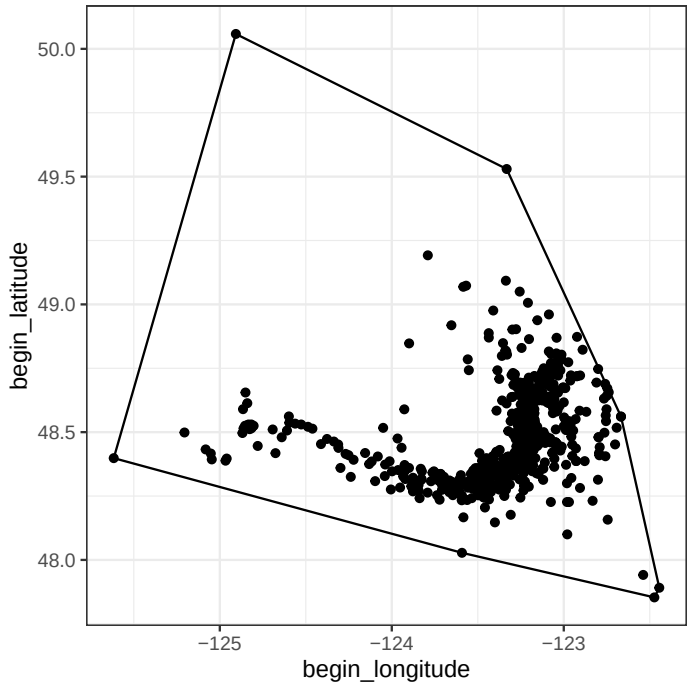
```
StatChull <- ggproto(
  "StatChull", Stat,
  required_aes = c("x", "y"),

  compute_group = function(data, scales) {
     data[chull(data$x, data$y), , drop = FALSE]
  }
)
```

Each object needs to be made


```
stat_chull <- function(
    mapping = NULL, data = NULL, geom = "polygon",
    position = "identity", na.rm = FALSE,
    show.legend = NA,  inherit.aes = TRUE, ...) {

  layer(
    stat = StatChull, data = data, mapping = mapping,
    position = position, show.legend = show.legend,
    inherit.aes = inherit.aes, params = list(na.rm = 
  )
}
```

Now use it

```
orcas %>%
  ggplot(aes(x = begin_longitude, y = begin_latitude)) +
  geom_point() +
  stat_chull(fill=NA, colour = "black") + theme_bw()
```



A Stat? That wasn't on the list!

Every geom has a (default) stat

```
geom_point
```

```
function (mapping = NULL, data = NULL, stat = "identi
    ..., na.rm = FALSE, show.legend = NA, inherit.aes
{
    layer(data = data, mapping = mapping, stat = stat
        position = position, show.legend = show.legen
        params = list2(na.rm = na.rm, ...))
}
<bytecode: 0x7fbe02218668>
<environment: namespace:ggplot2>
```

The Stat and its Geom produce the same layer


```
geom_point()
```

```
geom_point: na.rm = FALSE
stat_identity: na.rm = FALSE
position_identity
```

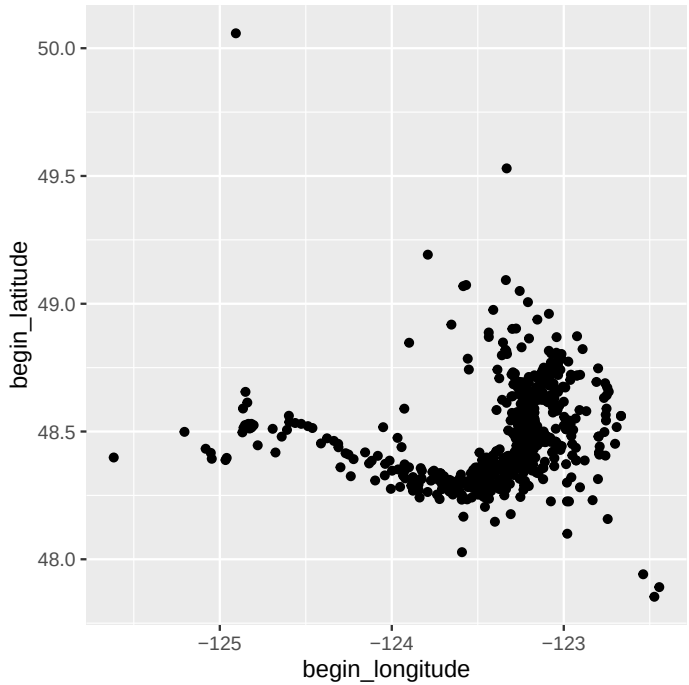
```
stat_identity()
```

```
geom_point: na.rm = FALSE
stat_identity: na.rm = FALSE
position_identity
```

Each function provides access to a different aspect in the layer: geoms control the look, stats control the data aspects

We can use stat_identity instead of geom_point

```
orcas %>%
  ggplot(aes(x = begin_longitude, y = begin_latitude)) +
  stat_identity()
```



Object-oriented foundation

Every extension starts at the `geom`/`stat` level

`ggplot2` is expecting a `Geom` and a `Stat` specification for every layer

But: you don't need to (and can not) start from scratch

Two prototype objects: `ggplot2::Geom` and `ggplot2::Stat`

The Geom Object

```
<ggproto object: Class Geom, gg>
    aesthetics: function
    default_aes: uneval
    draw_group: function
    draw_key: function
    draw_layer: function
    draw_panel: function
    extra_params: na.rm
    handle_na: function
    non_missing_aes:
    optional_aes:
    parameters: function
    rename_size: FALSE
    required_aes:
    setup_data: function
    setup_params: function
```

The Stat Object


```
<ggproto object: Class Stat, gg>
    aesthetics: function
    compute_group: function
    compute_layer: function
    compute_panel: function
    default_aes: uneval
    dropped_aes:
    extra_params: na.rm
    finish_layer: function
    non_missing_aes:
    optional_aes:
    parameters: function
    required_aes:
    retransform: TRUE
    setup_data: function
    setup_params: function
```

Useful (?) Strategy

Rely on the defaults: pick the Geom/Stat that is closest to what you want to do, and expand

Make minimal changes otherwise

A look back

Specifies required mappings, and `compute_group`

```
StatChull <- ggproto(
  "StatChull", Stat,
  required_aes = c("x", "y"),

  compute_group = function(data, scales) {
     data[chull(data$x, data$y), , drop = FALSE]
  }
)
```

Linking between StatChull and polygon


```
stat_chull <- function(
    mapping = NULL, data = NULL, geom = "polygon",
    position = "identity", na.rm = FALSE,
    show.legend = NA,  inherit.aes = TRUE, ...) {

  layer(
    stat = StatChull, data = data, mapping = mapping,
    position = position, show.legend = show.legend,
    inherit.aes = inherit.aes, params = list(na.rm =
  )
}
```

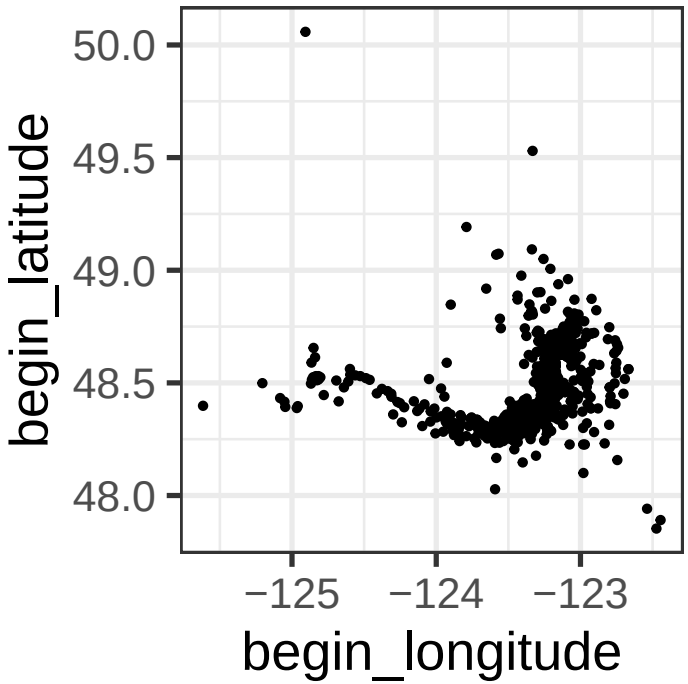
What do you need to change when ...

you want to ...

- put on branding on charts? the theme
- automatically combine several layers? the geom
- implement a new type of chart? everything

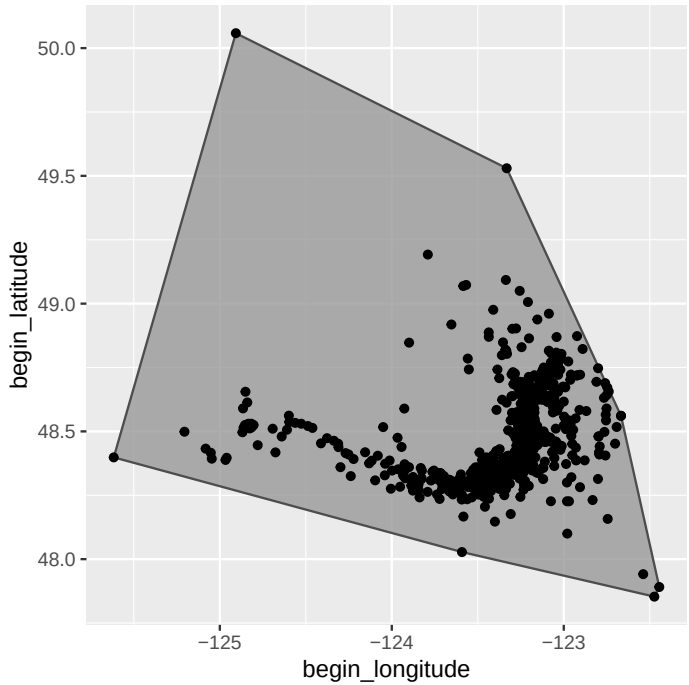
Making a new theme


```
theme_slides <- theme_bw(base_size = 24)
orcas %>%
  ggplot(aes(x = begin_longitude, y = begin_latitude)) +
  stat_identity() + theme_slides
```



Wrapping multiple layers into one

```
orcas %>%
  ggplot(aes(x = begin_longitude, y = begin_latitude)
  stat_chull(fill="grey60", colour = "grey30", alpha
  geom_point()
```



Wrapper for defaults

Define defaults

```
GeomChull <- ggproto(
  "GeomChull", GeomPolygon,
  default_aes = ggplot2::aes(
    colour = "grey30", fill = "grey50", alpha = 0.5,
    linewidth=0.5, linetype = 1, subgroup=NULL
    )
)
```

Basis is geom_polygon

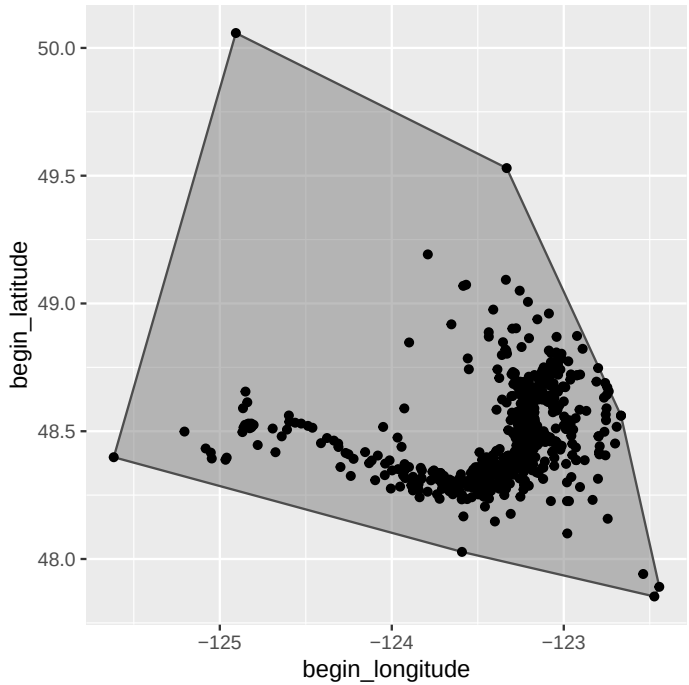
Change `stat` to chull, and `GeomPolygon` to `GeomChull`.

Everything else stays the same

```
geom_chull <- function (mapping = NULL, data = NULL,
                        stat = "chull", position = "i
    rule = "evenodd", ..., na.rm = FALSE, show.legend
{
    layer(data = data, mapping = mapping, stat = stat
          geom = GeomChull, position = position,
          show.legend = show.legend, inherit.aes = in
        params = list(na.rm = na.rm, rule = rule, ...
}
```

Previous example

```
orcas %>%
  ggplot(aes(x = begin_longitude, y = begin_latitude)
#  stat_chull(fill="grey60", colour = "grey30", alpha
  geom_chull() +
  geom_point()
```

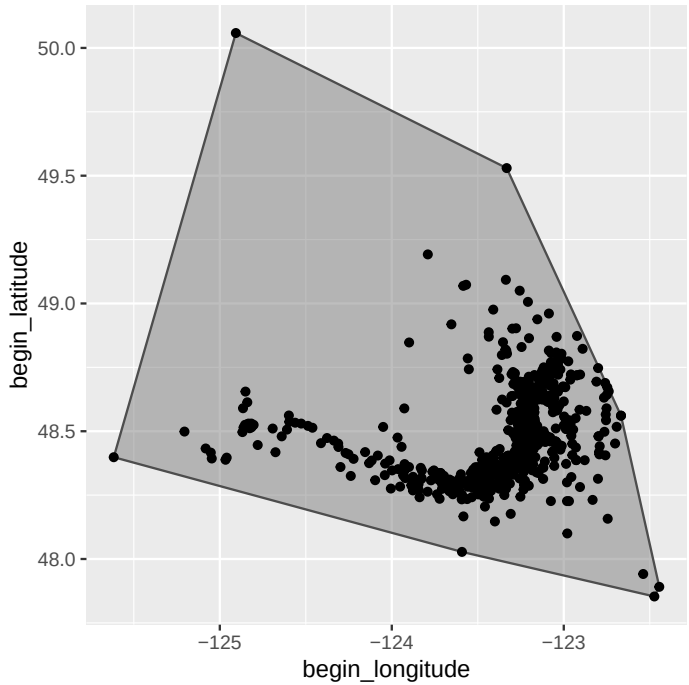


Show edge points with the frame ... prepping

```
GeomChull <- ggproto(
  "GeomChull", GeomPolygon,
  default_aes = ggplot2::aes(
    colour = "grey30", fill = "grey50", alpha = 0.5,
    linewidth=0.5, linetype = 1, subgroup=NULL,
    size = 3, shape = 19, stroke = 0.5  # for the poi
    ),

  draw_panel = function(..., self = self) {
    GeomPolygon$draw_panel(..., self)
  }
)
```

Nothing has changed yet

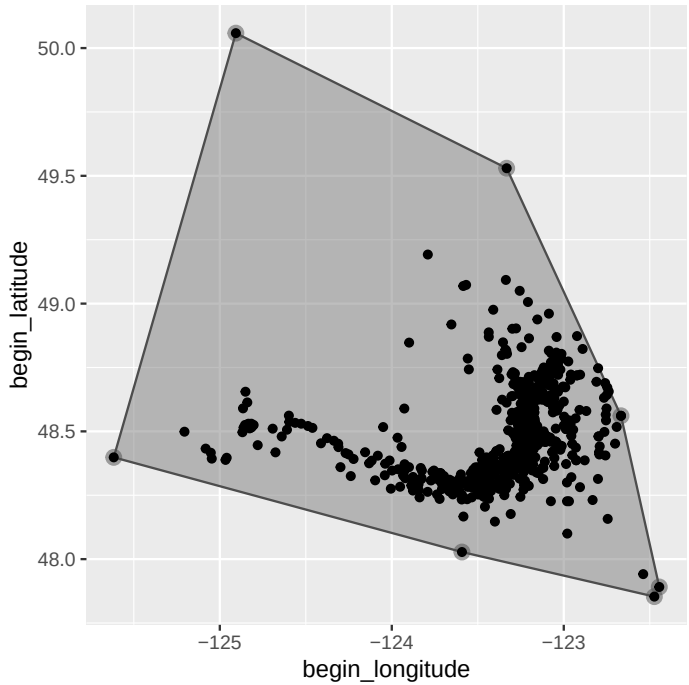
```
orcas %>%
  ggplot(aes(x = begin_longitude, y = begin_latitude)
#  stat_chull(fill="grey60", colour = "grey30", alpha
  geom_chull() +
  geom_point()
```



Show edge points with the frame

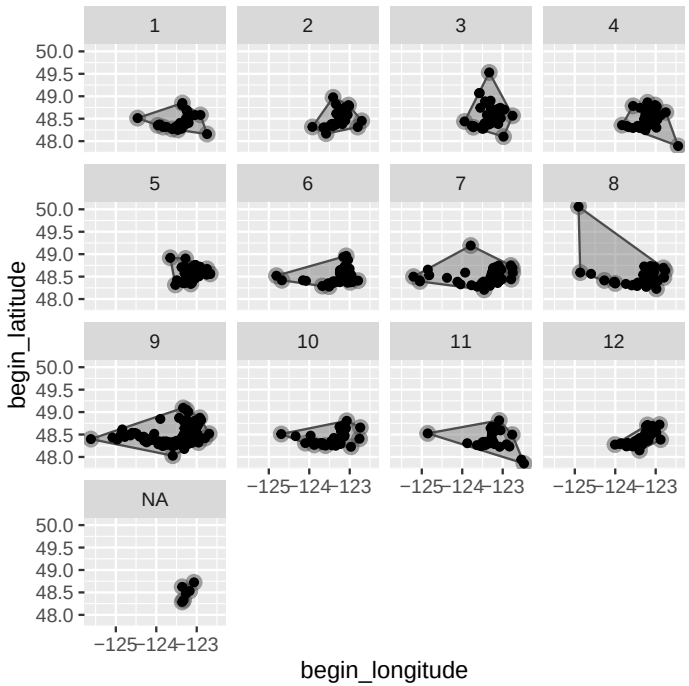

```
GeomChull <- ggproto(
  "GeomChull", GeomPolygon,
  default_aes = ggplot2::aes(
    colour = "grey30", fill = "grey50", alpha = 0.5,
    linewidth=0.5, linetype = 1,
    size = 3, shape = 19, stroke = 0.5  # for the poi
    ),

  draw_panel = function(..., self = self) {
    # using the two layers together
    grid::grobTree(
      GeomPolygon$draw_panel(..., self),
      GeomPoint$draw_panel(..., self)
    )
  }
)
```

```
orcas %>%
  ggplot(aes(x = begin_longitude, y = begin_latitude)) +
  geom_chull() +
  geom_point()
```



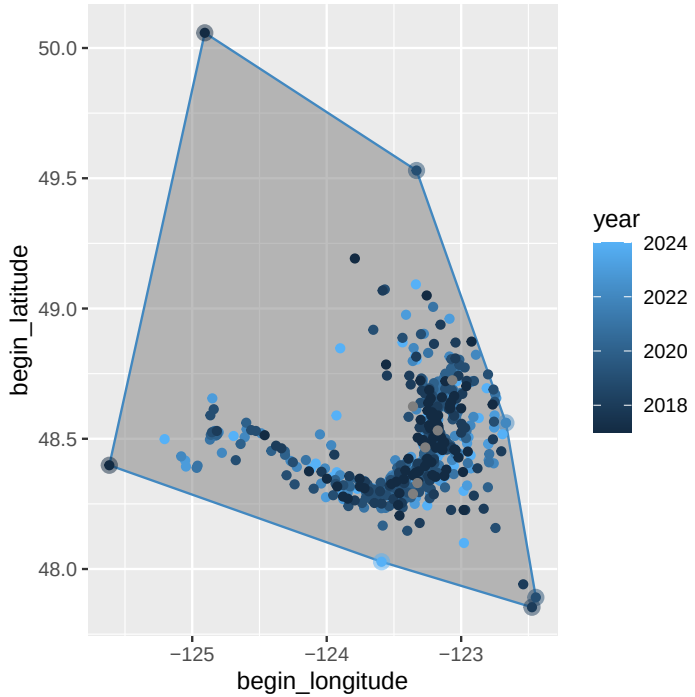
Freebies: Facetting

```
orcas %>%
  ggplot(aes(x = begin_longitude, y = begin_latitude)) +
  geom_chull() +
  geom_point() +
  facet_wrap(~month(date))
```



Supposed Freebie: Color/groups

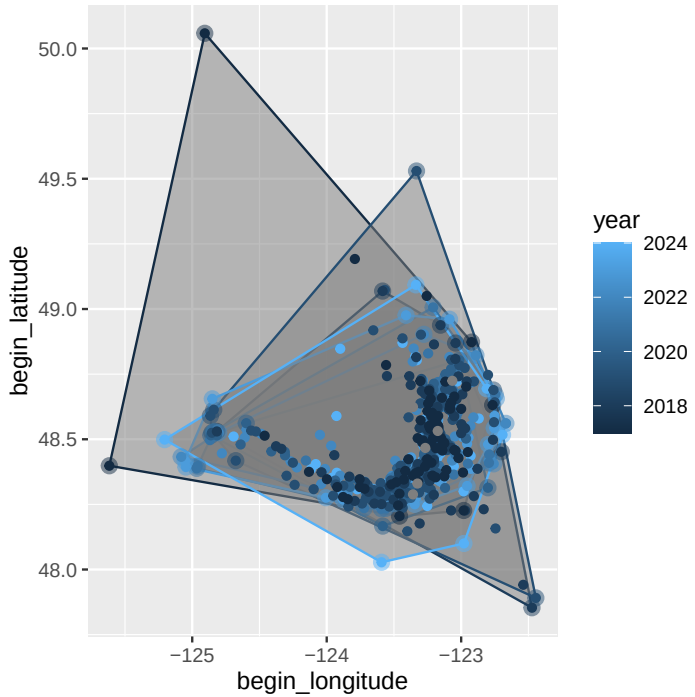
```
orcas %>%
  ggplot(aes(x = begin_longitude, y = begin_latitude,
             colour = year)) +
  geom_chull() +
  geom_point()
```



Why does this not draw separate convex hulls for each group?

Specify the group explicitly!

```
orcas %>%
  ggplot(aes(x = begin_longitude, y = begin_latitude,
             colour = year, group = year)) +
  geom_chull() +
  geom_point()
```



Changing everything: the lvplot package

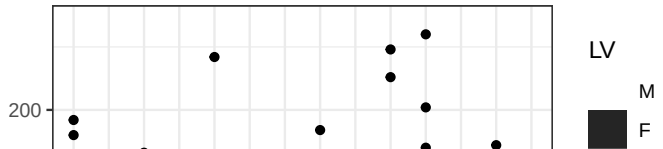
Making a new chart: letter value (box)plots are a suggestion by JW Tukey in Exploratory Data Analysis (~1980)

Instead of just doing a box for Quartiles, the next set of 2^{-k} quantiles are included (called the **F**ourth, the **E**ighths, D, C, B, A, Z, ...)

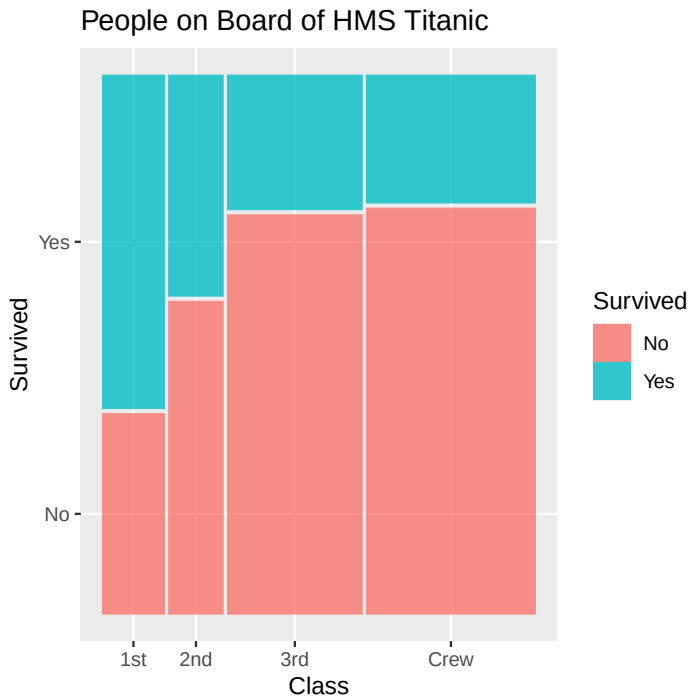
```
library(lvplot)
```

Implements pairs `geom_lv`, `GeomLv`, and `stat_lv`, `StatLv`

```
ggplot(ontime, aes(UniqueCarrier, TaxiIn + TaxiOut))
    geom_lv(aes(fill = after_stat(LV)), varwidth=TRUE
    scale_fill_lv() +
    theme_bw()
```

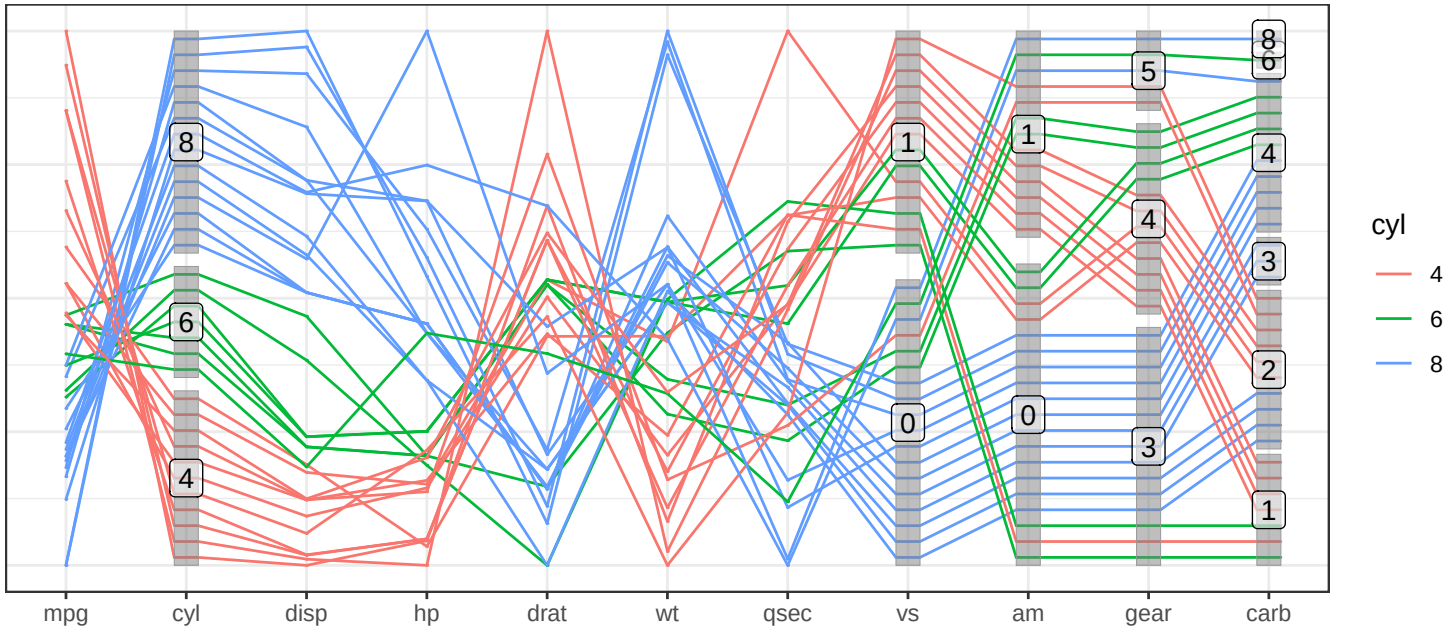


Another new graphic: Mosaicplots



Besides implementing a geom and a stat - what else is needed?

Parallel Coordinate Plots



How about this one?

Where to go from here ...

Look at more code!

Listing of 'official' extension packages: https://exts.ggplot2.tidyverse.org/gallery/

ggrepel package: https://github.com/slowkow/ggrepel

ggpcp package: https://heike.github.io/ggpcp/