0.1 General Structure

```
 rating_density = alt.Chart(df, title="Title").transform_density(
   density='col',
   groupby=['col2'],
   as_=['col', 'density']
).mark_area(
   opacity=0.6,
   line={'color': 'white'}
).encode(
   x=alt.X('col1:Q',
          title='the value',
          scale=alt.Scale(domain=[0, 10000]),
          axis=alt.Axis(format='~s',grid=False,tickCount=10)),
   y=alt.Y('density:Q',
          title='density',
          scale=alt.Scale(domain=[0, 0.000100]),
          axis=alt.Axis(format='.6f',grid=False)).stack(False),
   color=alt.Color('where:N',
                  scale=alt.Scale(
                      domain=['My state', 'Neighboring states'],
                      range=['#A0D2E8', '#A0E8AF']
                  ),
                  legend=alt.Legend(
                      orient='top'
                  )
                 )
).properties(
   width=600,
   height=400
)
```

```
 options(repr.plot.width=7, repr.plot.height=3)

chart <- ggplot(wages) +
   aes(
      x = salary,
      y = when,
      fill = when
   ) +
   geom_violin() +
   geom_point(stat = 'summary', fun = median, color = 'White') +
   geom_point(stat = 'summary', fun = mean, color = 'Black') +
   labs(
      x = "Worker Salary ($)",
      y = "When",
      title = "Salary Distribution Before and After Policy
         Implementation"
   ) +
   scale_x_continuous(
      limits = c(10, 40), oob = scales::oob_keep,
             labels = scales::dollar_format(),
   )
chart
```

0.2 HEAT MAPS

A 2D histogram is a type of heatmap, where count is mapped to color, you could also have used a mark that maps size to color, which might even be more effective but that is not as commonly seen.

```
alt.Chart(df).mark_rect().encode(alt.X('col1').bin(maxbins=40),
alt.Y('col2').bin(maxbins=40),alt.Color('count()')
)
```

Instead of squares,**hexagonal bins** can be used. These have theoretically superior qualities over squares, such as a more natural notation of neighbors.
2 dimensional **KDEs** in ggplot. This works just like 1D KDEs, except that the kernel on each data point extends in 2 dimensions
Use **ridges contours**, similar to a topographic map. These contour plots are often less intuitive than the density plot above, so the recommendation is to use the density plot instead.

```
ggplot(df) + aes(x = col1, y = col2) + geom_bin2d() or geom_hex()
    or geom_density_2d_filled() or geom_density_2d()
```

0.3 AXIS LABEL FORMATTING

Scientific Notation & Grid Tick Modifications
Scientific notation, Consider formatting axis labels using plain numbers or appropriate unit prefixes (e.g., thousands, millions, micro, milli) to improve readability.

Note that tickCount cannot be applied to binned data, so the plot has been adjusted here to demonstrate its effect.

```
.alt.X('col').axis(format='e') # For e like notation
.alt.X('col').axis(format='s') # Standard international (SI) units
.alt.X('col').axis(format='~s') # Removes trailing zeros
.alt.X('col').axis(format='\$~s') # Formatters can also be combined.
.alt.X('col').axis(format='.1%') # Decimal formats
.alt.X('col').axis(None) #Remove an axis altogether
.alt.Y('col').axis(tickCount=2) #ticks on axis
.alt.Y('col').axis(grid=False) #Remove grid
.alt.Y('col').sort('-y') #Sort y axis
alt.Y('coly').bin(maxbins=400).scale(domain=[0, 2000]), #Set scale
alt.themes.enable('dark') #Dark theme scale
alt.Color('count()').legend(None) # remove a legend
alt.Y('coly').bin(maxbins=400).scale(domain=(0, 2000),
     reverse=True), #Reversing an axis
alt.Y('col:Q',bin=alt.Bin(maxbins=20),
       title='Y Label', #Set Label
       axis=alt.Axis(format='.1%', titleFontSize=14,
            labelFontSize=12))
```

```
ggplot(df) + aes(x = colx,y = coly) + geom_hex() +
  guides(fill = "none") # remove a legend
  scale_x_continuous(
    labels = scales::label_dollar(scale = .001, suffix = "K"),
    labels = scales::label_number(scale_cut = scales::cut_si('')),
    limits = c(10, 31), oob = scales::oob_keep, #scale limit
    limits = c(2000, 0), trans = 'reverse', #reversing an axis
    labels = scales::label_dollar(), #label formatter
    breaks = scales::pretty_breaks(n = 10) #tick count
  )
```

```
ggplot(df) + aes(x = col1, y = col2) + geom_hex() +
  labs(
    x = 'col1',
    y = 'col2',
    title = 'title'
  )
```

0.4 Trendlines - Mean Line

Trendlines (also sometimes called "lines of best fit", or "fitted lines") are good to highlight general trends in the data that can be hard to elucidate by looking at the raw data points. This can happen if there are many data points or many groups inside the data.

```
points + points.mark_line().encode(y='mean(Horsepower)')
```

```
ggplot(cars) + aes(x = Year, y = Horsepower, color = Origin) +
  geom_point() + geom_line(stat = 'summary', fun = 'mean')
```

0.5 Trendlines - Regression Lines

If you want an easy-to-interpret trend line, use a rolling mean (or a simple mean if the data isn't too noisy). It naturally highlights patterns as we would notice them visually and requires fewer statistical assumptions than methods like **linear regression**.

```
points + points.mark_line(size=3).transform_regression(
    'Year',
    'Horsepower',
    groupby=['Origin'],
    method='poly' #for regression line that is quadratic, polynomial
)
```

0.6 Trendlines - loess/lowess Lines

Where the w stands for "weighted". You can fit multiple equations (usually linear and quadratic) to smaller subsets of the data, and add them together to get the final line. **bandwidth** parameter controls how much the loess fit should be influenced by local variation in the data, similar to the effect of the bandwidth parameter for a KDE. bandwidth of 1 corresponds to using all the data and will be similar to a linear regression

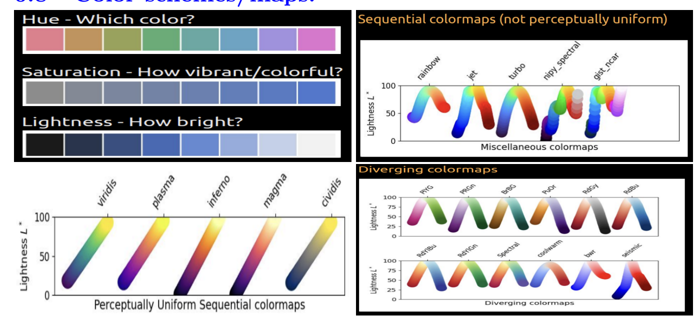
```
points + points.mark_line(size=3).transform_loess(
    'Year',
    'Horsepower',
    groupby=['Origin'],
    bandwidth=0.8 #optional param
)
```

```
ggplot(cars) +
    aes(x = Year,
        y = Horsepower,
        color = Origin,
        fill = Origin) + #color the confidence interval the same as
            the lines.
    geom_point() +
    geom_smooth() #Introduce CI
    geom_smooth(se = FALSE, linewidth = 1, span=1) #Introduce
         bandwidth use span
    geom_smooth(se = FALSE, linewidth = 1, method = 'lm') #linear
         regression instead of loess
```

0.7 When to choose which trendline:

- **Rolling mean / mean:** Best for clear, easy-to-read trends and general audiences. Simple and intuitive, but not suitable for predictions beyond your data.
- **Linear (or similar model):** Use when your data follows a clear equation. Good for showing consistent patterns and making predictions outside your data range.
- **Loess (or smooth curve):** Ideal for showing natural, flexible trends in current data without assuming a strict model, though poor for extrapolation.

0.8 Color schemes/maps:



colormap is useful for (categorical, sequential, diverging, cyclic)
Categorical: Single color for each category
Sequential: Shades of a color

```
#Sequential
alt.Chart(iris).mark_circle(size=100).encode(
    x='petalWidth',
    y='petalLength',
    color=alt.Color('petalWidth').scale(scheme='viridis',
         reverse=True)
)
#Diverging has a natural midpoint,
# such as a correlation that is defined from -1 to 1
corr_df =
     data.gapminder().corr(numeric_only=True).stack().reset_index(name
alt.Chart(corr_df).mark_rect().encode(
    x='level_0',
    y='level_1',
    tooltip='corr',
    color=alt.Color('corr').scale(domain=(-1, 1),
         scheme='purpleorange')
).properties(
    width=200,
    height=200
)
```

```
#Sequential
ggplot(iris) +
    aes(x = Petal.Width,
        y = Petal.Length,
        color = Petal.Width) +
    geom_point(size = 5) +
    scale_color_viridis_c()
#Diverging has a natural midpoint,
# such as a correlation that is defined from -1 to 1
```

```
ggplot(corr_df) +
    aes(x = level_0,
        y = level_1,
        fill = corr) +
    geom_tile() +
    ggthemes::scale_fill_gradient2_tableau()
```

0.9 Direct labeling instead of using a legend

```
lines = alt.Chart(stocks).mark_line().encode(
    x='date',
    y='price',
    color=alt.Color('symbol').legend(None)
)
text = alt.Chart(stock_order).mark_text(dx=20).encode(
    x='date',
    y='price',
    text='symbol',
    color='symbol'
)
lines + text
```

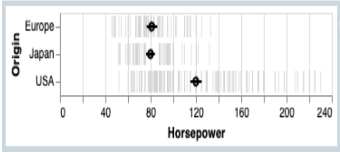
```
ggplot(stocks) +
    aes(x = date,
        y = price,
        color = symbol,
        label = symbol) +
    geom_line() +
    geom_text(data = stock_order, vjust=-1) +
    ggthemes::scale_color_tableau() +
    theme(legend.position = 'none')
```

0.10 Confidence Intervals

```
points.mark_errorband(extent='ci') +
     points.encode(y='mean(Horsepower)').mark_line() #add meanline
     with CI
```

```
err_bars = alt.Chart(cars).mark_errorbar(extent='ci',
      rule=alt.LineConfig(size=2)).encode(
    x='Horsepower',
    y='Origin'
)
(err_bars.mark_tick(color='lightgrey')
 + err_bars
 + err_bars.mark_point(color='black').encode(x='mean(Horsepower)'))
```

```
    geom_line(stat = 'summary', fun = mean) + #for line chart with
          CI
    geom_ribbon(stat = 'summary', fun.data = mean_cl_boot,
          alpha=0.5, color = NA)
    geom_violin(color = NA, fill = 'steelblue', alpha = 0.4) + #for
          point chart with CI bar lines
    geom_pointrange(stat = 'summary', fun.data = mean_cl_boot, size
          = 0.7)
```



0.11 Figure composition

```
mpg_weight & hp_weight #Concatenate plots vertically
mpg_weight | hp_weight #Concatenate plots Horizontally
plot_grid(hp_weight, mpg_weight) #Concatenate plots Horizontally
plot_grid(origin_count, mpg_weight, ncol=1) #Concatenate plots
      vertically
alt.Chart(cars).mark_circle().encode(...).interactive() #Panning
      and zooming
brush = alt.selection_interval()
alt.Chart(cars).mark_circle().encode(...).add_params(brush)
      #Interval selections
```

0.12 Highlighting points with selections

```
brush = alt.selection_interval()
alt.Chart(cars).mark_circle().encode(
    x='Horsepower',
    y='Miles_per_Gallon',
    color=alt.condition(brush, 'Origin', alt.value('lightgray'))
).add_params(brush)
```

0.13 Linking selections across plots

```
brush = alt.selection_interval(resolve='union') # The default is
      'global' #resolve='intersect'
points = alt.Chart(cars).mark_circle().encode(
    x='Horsepower',
    y='Miles_per_Gallon',
    color=alt.condition(brush, 'Origin', alt.value('lightgray'))
).add_params(brush)
points | points.encode(y='Weight_in_lbs')
```

0.14 Click selections

```
brush = alt.selection_interval()
click = alt.selection_point(fields=['Origin'], on='mouseover')
points = alt.Chart(cars).mark_circle().encode(
    x='Horsepower',
    y='Miles_per_Gallon',
    color=alt.condition(brush, 'Origin', alt.value('lightgray'))
).add_params(brush)
bars = alt.Chart(cars).mark_bar().encode(
    x='count()',
    y='Origin',
    color='Origin',
    opacity=alt.condition(click, alt.value(0.9), alt.value(0.2))
).add_params(click)
points & bars
```