

GALLERY 4: GRAYSCALE IMAGES OF CONTINUOUS DATA

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The curse of dimensionality

Visualization Problem

continuous vs discrete

Solution

dotplot or table

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dotplot or table

scatterplot or lineplot

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Visualization Problem

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dotplot or table

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" " with glyphs and/or color

The curse of dimensionality

Visualization Problem	Solution
continuous vs discrete	dotplot or table
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continuous vs continuous vs continuous	?

Visualizing many continuous variables at once poses problems

Can't see more than 3D

Can't print/display more than 2D

The curse of dimensionality

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Candidate Solutions

Imageplots with continuous colorscales

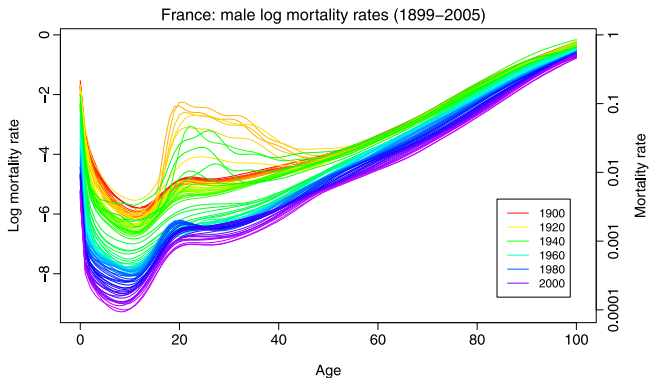
3D perspective plots

Animation / Interactive plots in 2D or 3D

Consider cross-national mortality rates (WHO / IHME data)

For each country, we estimate mortality rates by year, age, sex, and cause of death

How do we visually explore such vast and multidimensional data?



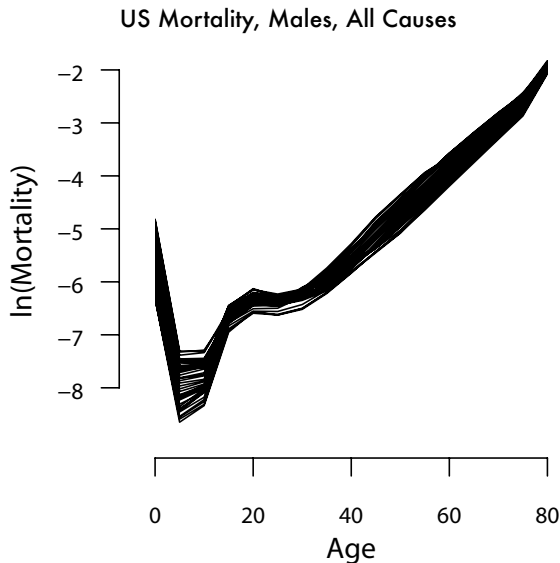
Source: Hyndman and Shang (2010) "Rainbow plots, bagplots, and boxplots for functional data" *JCGS* 19:1

Look at lots of plots like this one?

Hard to read if colors don't "line up"

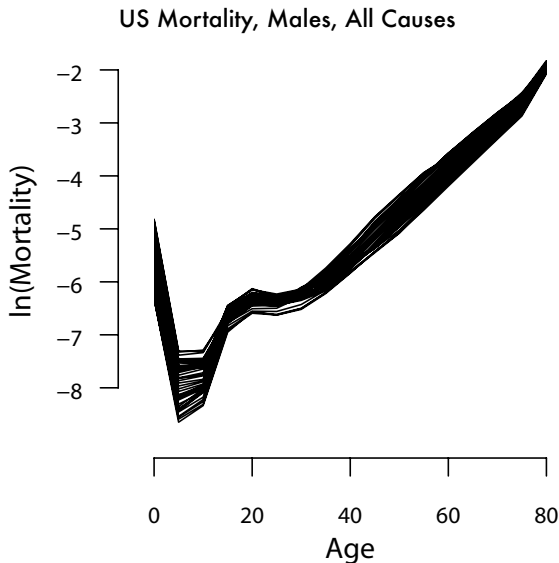
And what if the lines overlap?

Mortality Rates by Cause, Country, Age, Year, Cohort & Sex



Let's leave color behind,
and look at less
convenient examples, like
US male mortality in the
late 20th century

Mortality Rates by Cause, Country, Age, Year, Cohort & Sex



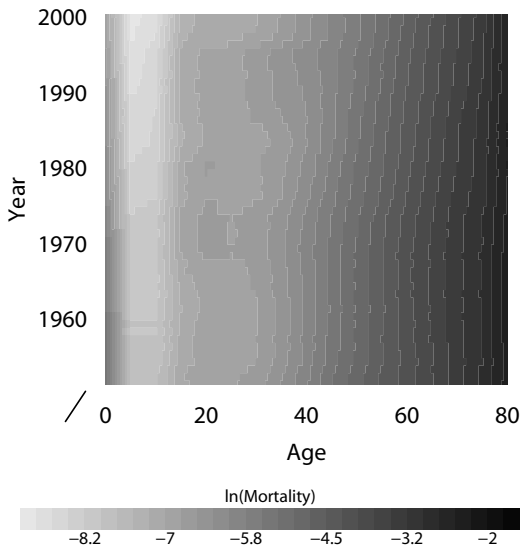
Let's leave color behind,
and look at less
convenient examples, like
US male mortality in the
late 20th century

Age pattern strongly
highlighted by choice of
axes

Year effect? Impossible to
see without labels or
color

Cohort effects?
Impossible to see

US Mortality, Males, All Causes



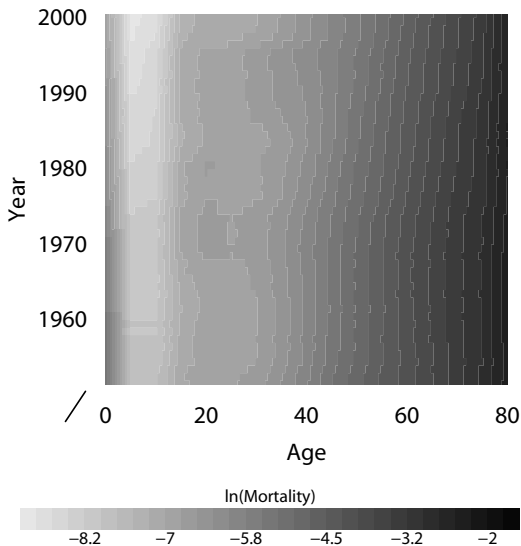
Consider an image plot of the same data, where the axes code age and year, and the shading of each cell is the mortality rate

Age and year effects are equally clear

Cohort effects can be seen on the 45deg line

(Recall the Age, Period, Cohort problem)

US Mortality, Males, All Causes

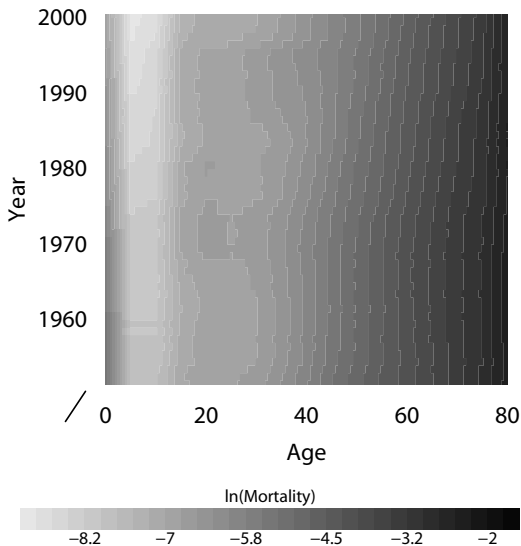


Consider an image plot of the same data, where the axes code age and year, and the shading of each cell is the mortality rate

What have we gained?

What have we lost?

US Mortality, Males, All Causes



Consider an image plot of the same data, where the axes code age and year, and the shading of each cell is the mortality rate

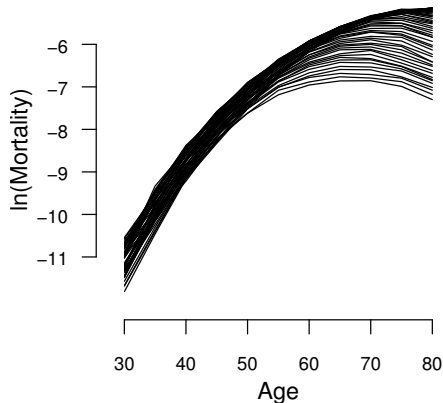
What have we gained?

What have we lost?

Could you look up exact values from this plot?

Mortality Rates by Cause, Country, Age, Year, Cohort & Sex

US Mortality, Males, Lung Cancer



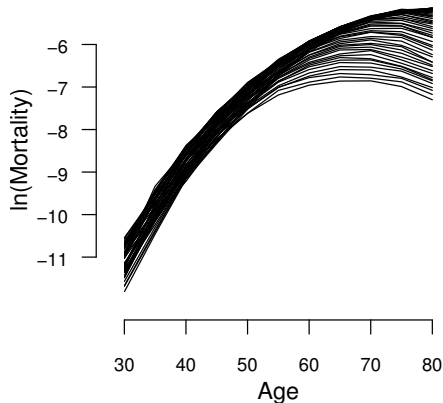
Now consider lung cancer, a major cause of death in the 20th century

Complex evolution of mortality as smoking first spread, then receded

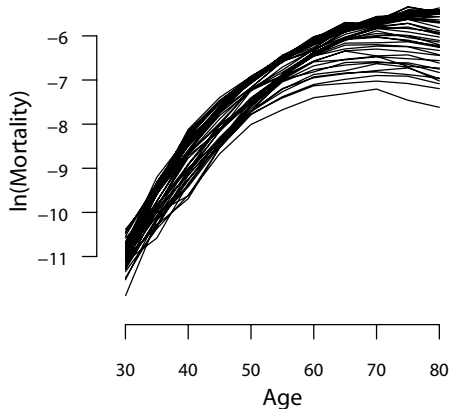
Can we see cohort effects in this lineplot?

Mortality Rates by Cause, Country, Age, Year, Cohort & Sex

US Mortality, Males, Lung Cancer



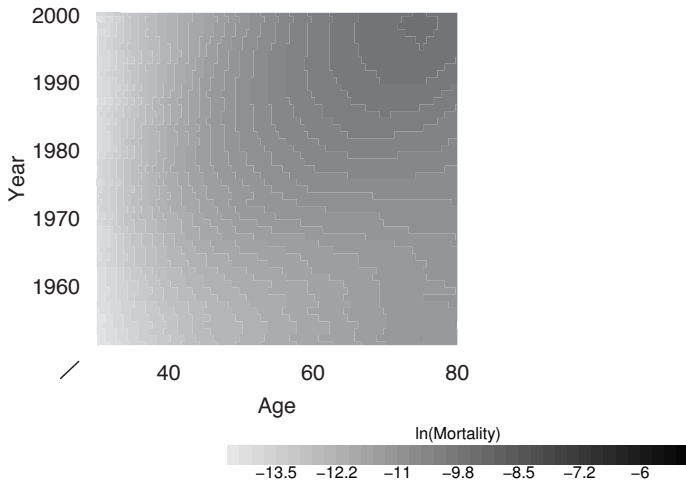
France Mortality, Males, Lung Cancer



How useful are these plots for comparisons across cases?

Do you see differences across American and French cohorts of smokers?

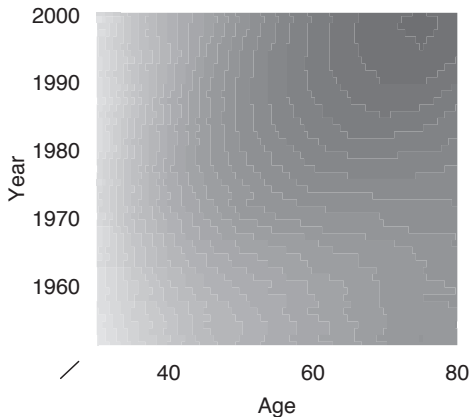
US Mortality, Males, Lung Cancer



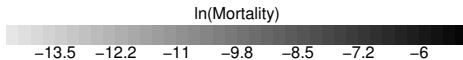
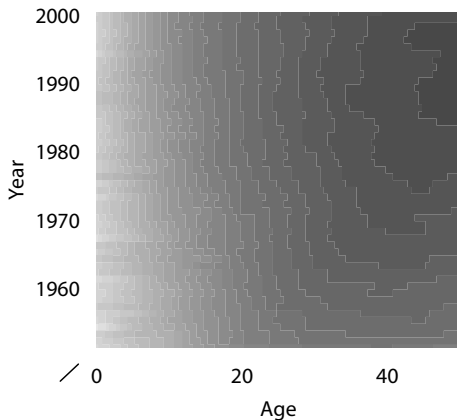
What about from the image plot? What cohort effects do you see?

Can you use this plot to predict the “future” for US smokers?

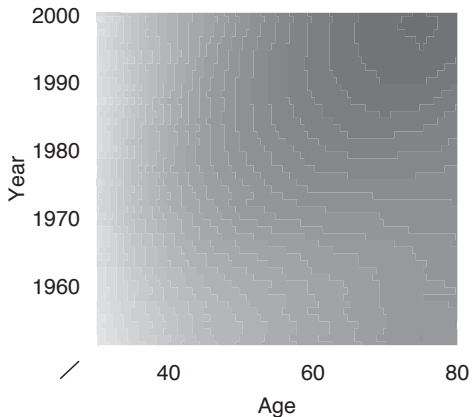
US Mortality, Males, Lung Cancer



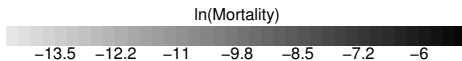
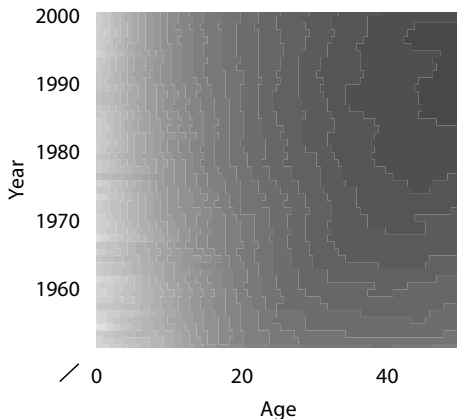
France Mortality, Males, Lung Cancer



US Mortality, Males, Lung Cancer

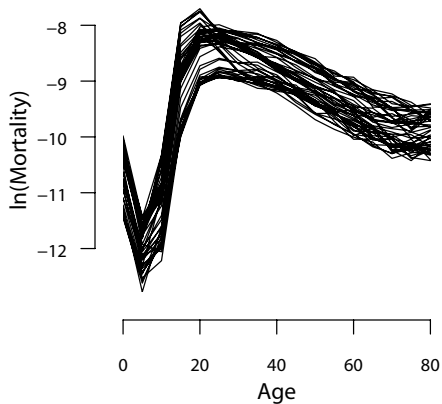


France Mortality, Males, Lung Cancer



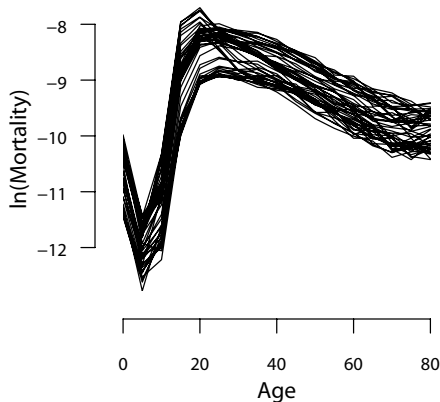
Not everyone was quitting smoking in the late 20th century...

US Mortality, Males, Homicide

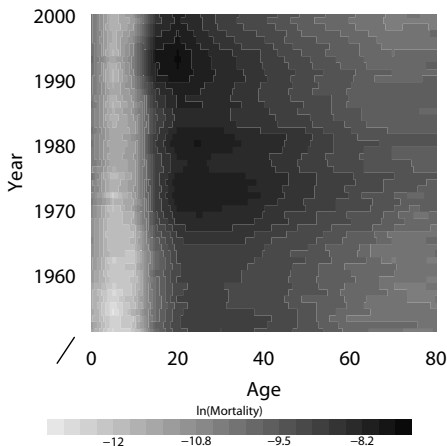


When is the time series plot clearly better than the image plot?

US Mortality, Males, Homicide



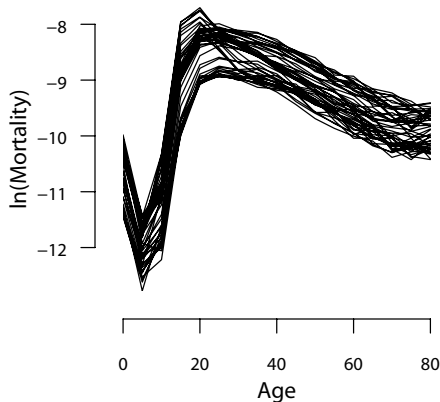
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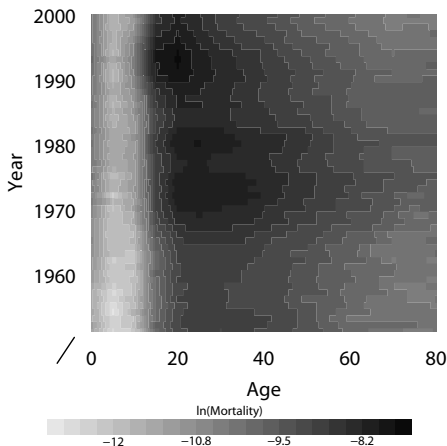
When is the time series plot clearly better than the image plot?

When age (the x-axis) is overwhelmingly important – but still reveals cohort differences

US Mortality, Males, Homicide



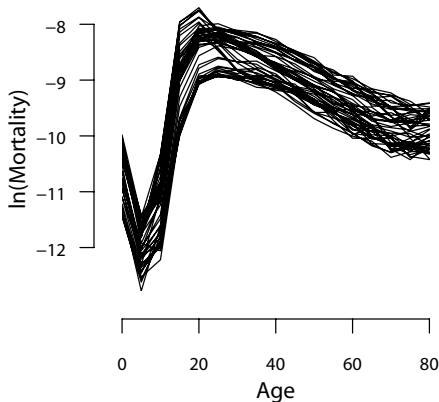
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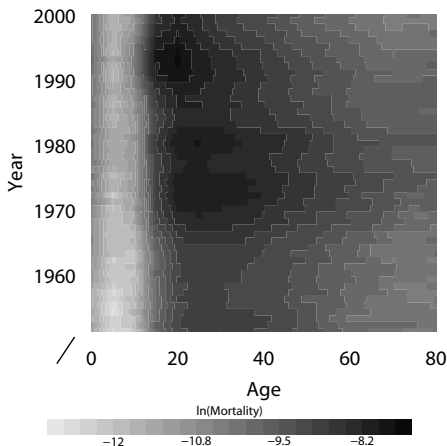
Are grayscale image plots effective? Sometimes, with effort

Key question: Are people good at reading shades of gray?

US Mortality, Males, Homicide

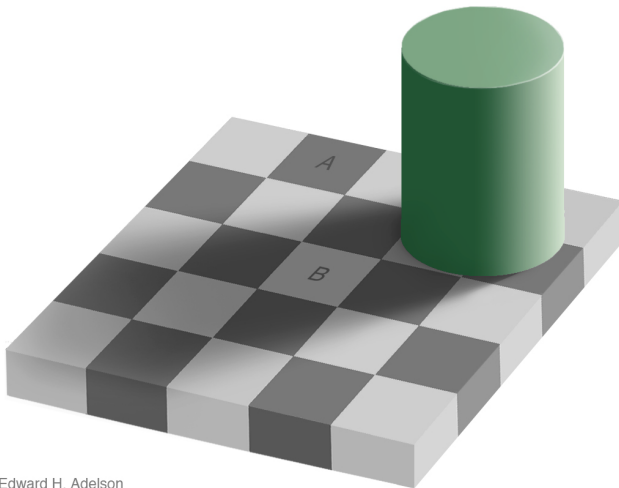


US Mortality, Males, Homicide



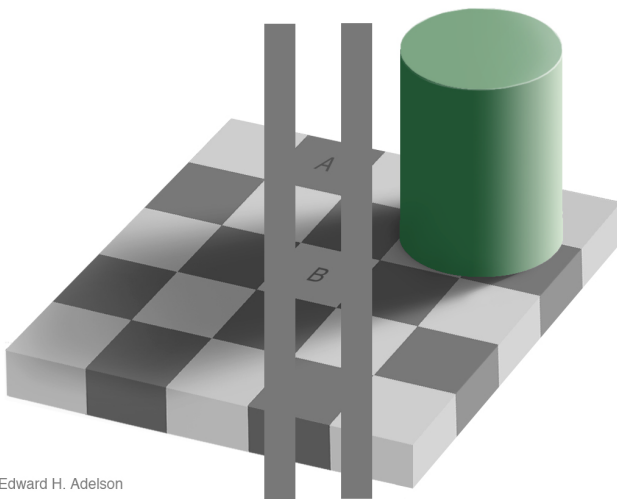
Are grayscale image plots effective? Sometimes, with effort

Key question: Are people good at reading shades of gray? NO.



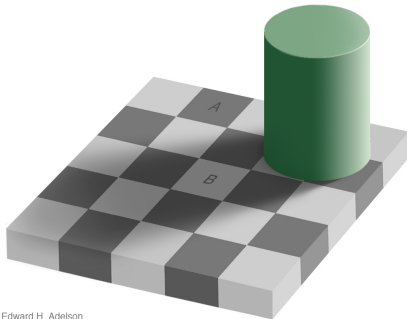
Edward H. Adelson

Which square is darker: A or B?

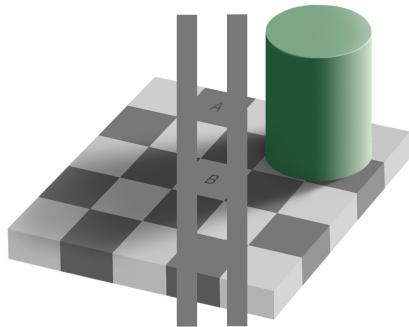


Edward H. Adelson

Neither



Edward H. Adelson



Great online collection of illusions

www.michaelbach.de/ot/index.html

Simultaneous contrast www.michaelbach.de/ot/lum_dynsimcontrast/index.html

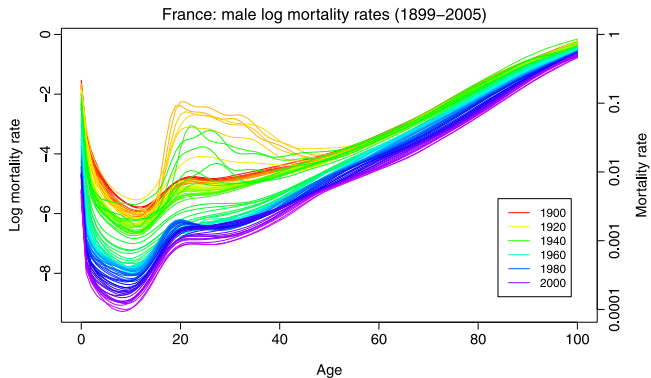
Cornsweet illusion www.michaelbach.de/ot/lum_cobc/index.html

Café-wall illusion www.michaelbach.de/ot/ang_cafewall/index.html

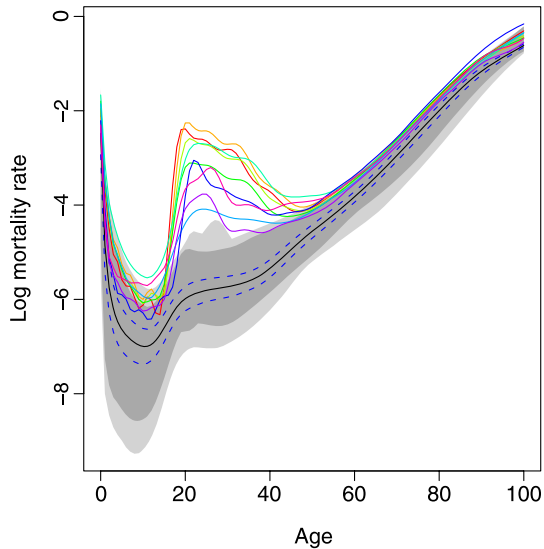
Contrast consistency www.michaelbach.de/ot/lum_contrast-contrast/index.html

Induced grating www.michaelbach.de/ot/lum_induced-grating/index.html

Other Solutions?



XXX



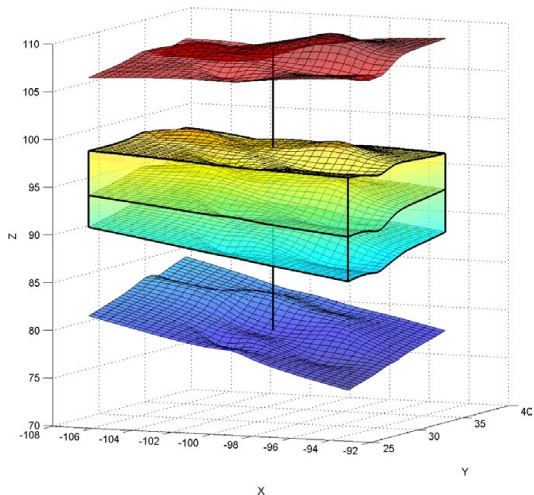


Figure 11. The surface boxplot with the box in the middle representing the 50% central region in $\mathbb{R}^3$, the middle surface inside the box denoting the median surface, and the upper and lower surfaces indicating the maximum non-outlying envelope.

Source: XXX

The Dawn Wall

El Capitan's Most Unwelcoming Route

By SHAN CARTER, WILSON ANDREWS, DEREK WATKINS and JOE WARD JAN. 9, 2015

Tommy Caldwell and Kevin Jorgeson etched their names into climbing lore on Wednesday by successfully completing a 19-day free-climb of the Dawn Wall on El Capitan. The route up the mostly smooth granite face is widely considered to be the most difficult free-climb in the world. A free-climb means that ropes are used only to catch a climber's fall — not to aid the ascent.

Photograph of El Capitan by [xRez Studio](#). 3-D model from M. Jaboyedoff, B. Matasci and A. Guerin of the University of Lausanne.

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