Observable

Sahil Chinoy • Oct 11, 2018
gfx

25

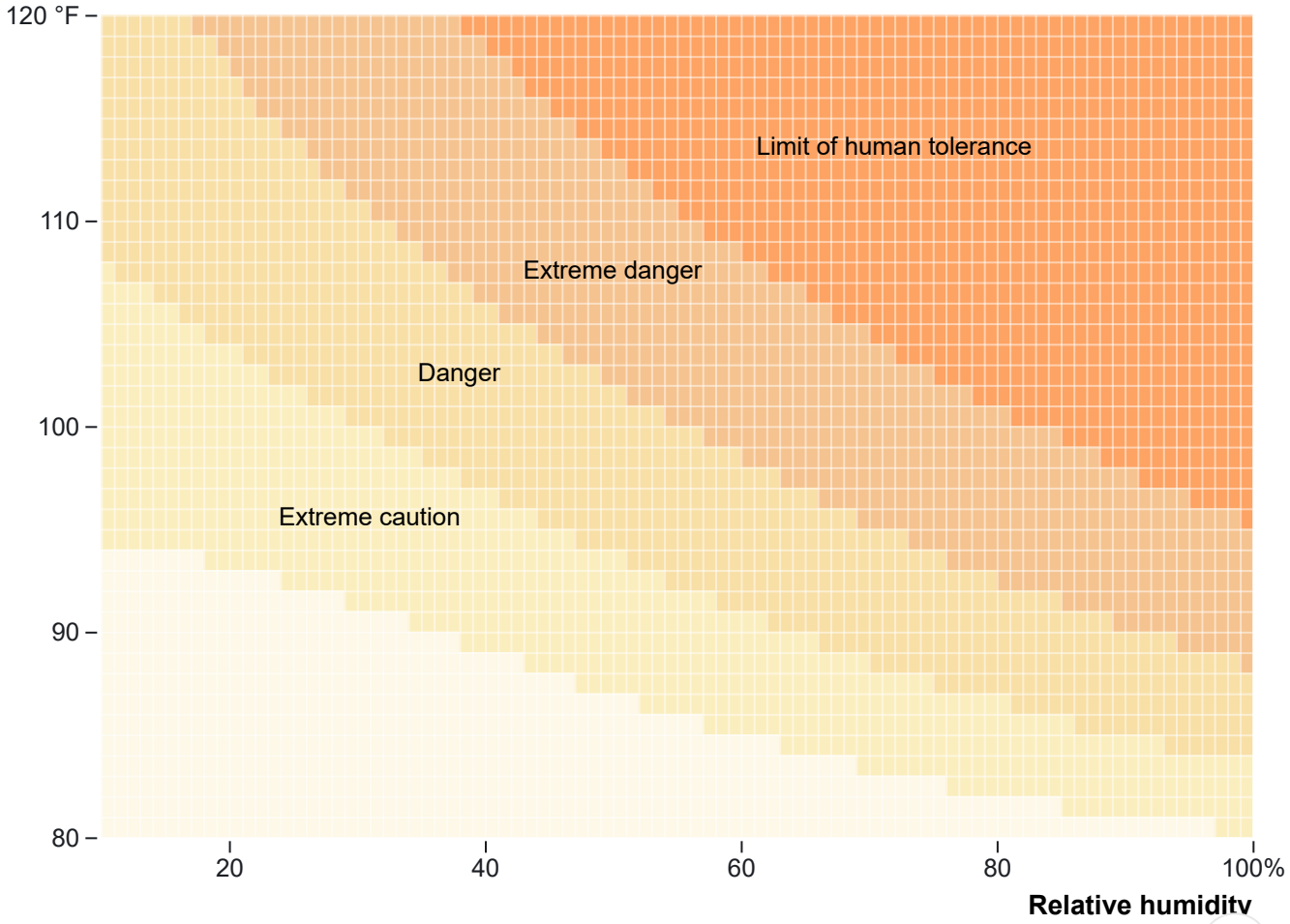
Listed in Visualization and NYT stories 3 forks

Heat index

```
md`# Heat index`
```

For a New York Times story about rising heat and humidity creating conditions beyond the limit of human tolerance.

```
md`For a [New York Times story]
(https://www.nytimes.com/interactive/2018/10/11/opinion/heat-humidity-killer-
combination.html) about rising heat and humidity creating conditions beyond the limit of
human tolerance.`
```



You have 21 unsaved changes. Fork this notebook to save.

```
{
  const svg = d3.select(DOM.svg(width, height));

  const margin = {
    left: 85,
    top: 30,
    right: 20,
    bottom: 45
  };

  const chartWidth = width - margin.left - margin.right;
  const chartHeight = height - margin.top - margin.bottom;

  const chart = svg.append('g')
  .style('font-family', 'sans-serif')
  .attr('transform', `translate(${margin.left}, ${margin.top})`);

  const x = d3.scaleLinear()
  .domain(d3.extent(humidityTicks))
  .range([0, chartWidth]);

  const y = d3.scaleLinear()
  .domain(d3.extent(temperatureTicks))
  .range([chartHeight, 0]);

  chart.append("g")
  .attr('transform', `translate(0, ${chartHeight + 2})`)
  .style('font-size', '13px')
  .style('font-weight', 300)
  .call(d3.axisBottom(x).ticks(5))
  .call(g => g.select('.tick:last-of-type text').text('100%'))
  .selectAll('.domain').remove();

  chart.append('text')
  .attr('x', chartWidth)
  .attr('y', chartHeight + 40)
  .text('Relative humidity')
  .style('text-anchor', 'end')
  .style('font-weight', 600)
  .style('font-size', '14px');

  chart.append("g")
  .attr('transform', 'translate(-2, 0)')
  .style('font-size', '13px')
  .style('font-weight', 300)
```

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```
  .call(g => g.select('.tick:last-of-type text').text('120 °F'))
  .selectAll('.domain').remove();

  chart.append('text')
  .attr('x', 0)
  .attr('y', -15)
  .text('Temperature')
  .style('text-anchor', 'end')
  .style('font-weight', 600)
  .style('font-size', '14px');

  const area = d3.area()
  .x(d => x(d.rh))
  .y0(d => y(d.temp))
  .y1(d => y(d.prevTemp))
  .curve(d3.curveStepAfter);

  const paths = chart.append('g')
  .selectAll('path')
  .data(chartData)
  .enter().append("path")
  .attr('d', d => area(d.values))
  .style('fill', d => colors[+d.key])
  .style('opacity', .8);

  chart.append('g')
  .attr('transform', `translate(0, ${chartHeight})`)
  .call(d3.axisBottom(x)
    .ticks(humidityTicks.length)
    .tickSize(-chartHeight)
    .tickFormat('')
  ).selectAll('line')
  .style('stroke', 'white')
  .style('stroke-width', 1)
  .style('stroke-opacity', .5);

  chart.append('g')
  .call(d3.axisLeft(y)
    .ticks(temperatureTicks.length)
    .tickSize(-chartWidth)
    .tickFormat('')
  ).selectAll('line')
  .style('stroke', 'white')
  .style('stroke-width', 1)
  .style('stroke-opacity', .5);
```

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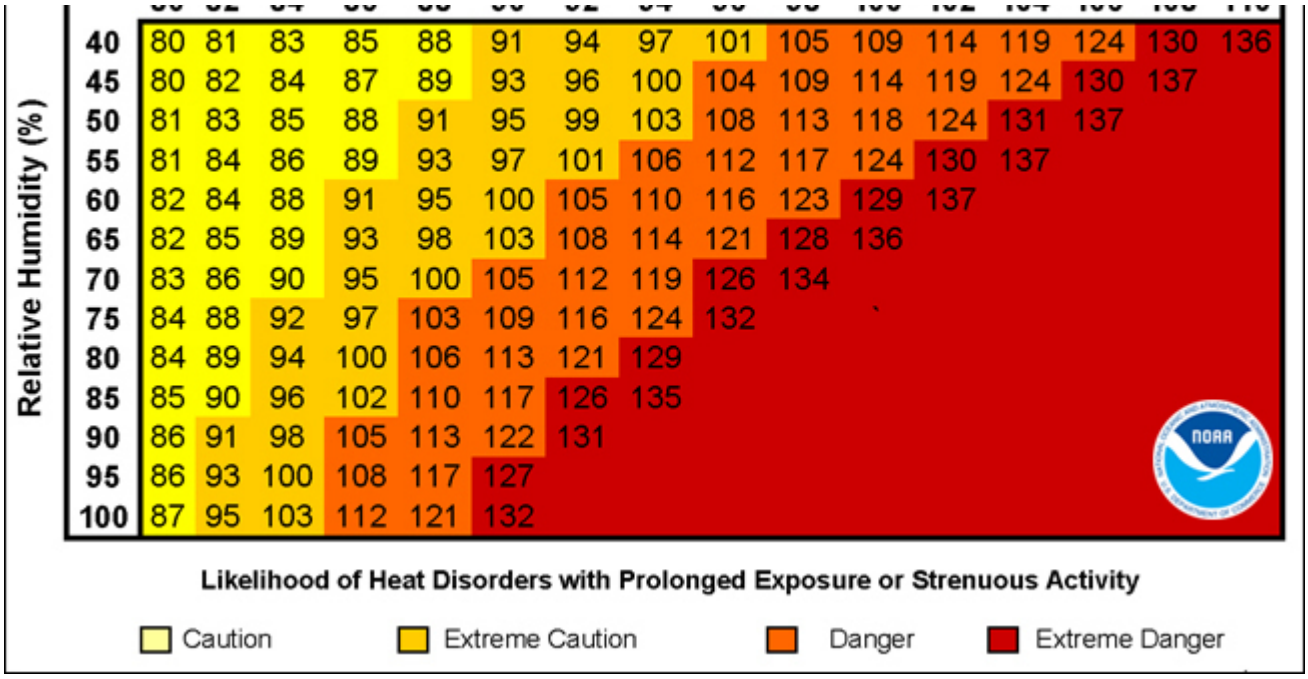
```
  chart.append('g')
  .selectAll('text')
  .data(thresholds)
  .enter().append('text')
  .text(d => d.text)
  .attr('transform', d => `translate(${x(d.H)}, ${y(d.T) - 2})`)
  .attr('x', 0)
  .attr('y', 0)
  .style('text-anchor', 'middle')
  .style('font-size', '13px')
  .style('font-weight', 300);

  return svg.node();
}
```

Weather Service.

```
md`We wanted to recreate this classic, gridded heat index chart from the National Weather Service.`
```



The heat index, which measures how hot it actually feels when considering both

```
html`<img src="https://www.weather.gov/images/safety/heatindexchart-650.jpg" style="max-width:500px%;">`
```

```
md The heat index, which measures how hot it actually feels when considering both
temperature and humidity, is defined by a pretty gnarly [nonlinear function]
(https://www.wpc.ncep.noaa.gov/html/heatindex_equation.shtml):`
```

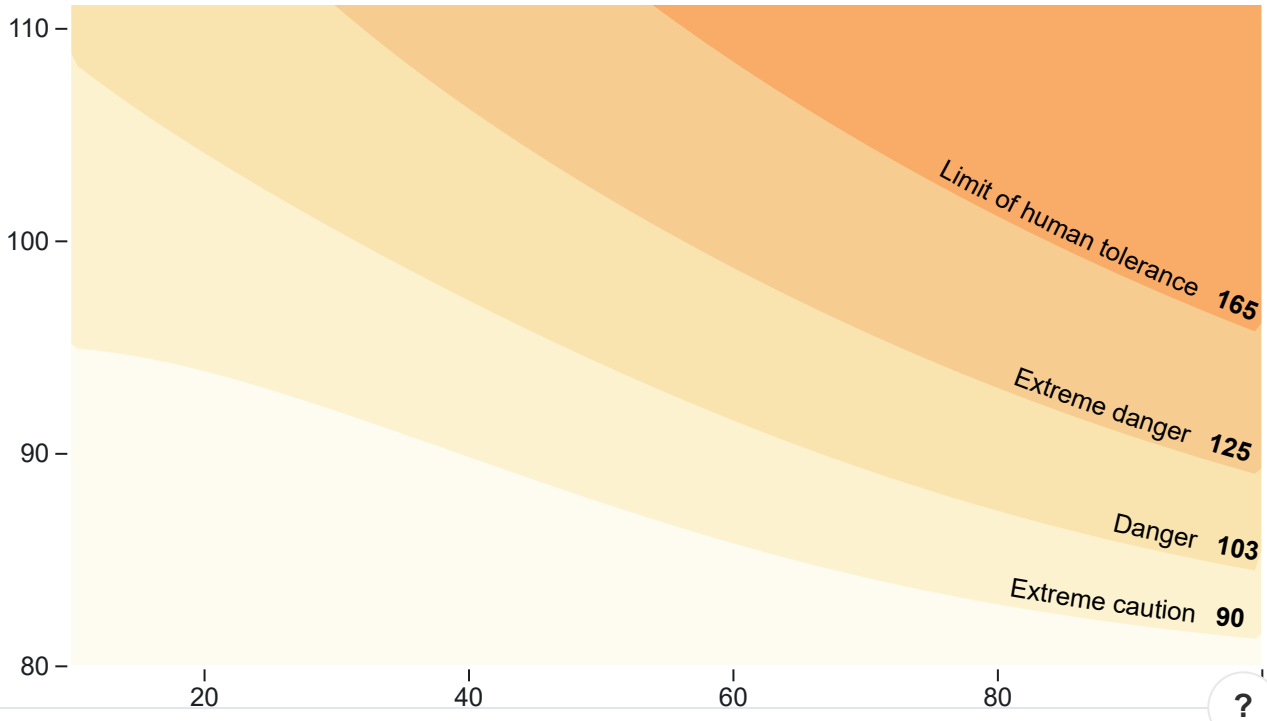
```
tex`HI = -42.379 + 2.04901523 \times T + 10.14333127 \times RH - .22475541 \times T
\times RH - .00683783 \times T^2 - .05481717 \times RH^2 + .00122874 \times T^2 \times RH
+ .00085282 \times T \times RH^2 - .00000199 \times T^2 \times RH^2`
```

individual cells. (This approach, h/t Adam Pearce, is mostly for performance reasons — in the story, we wanted to show and hide a portion of the chart.)

I also played with drawing contours instead of individual cells, but we decided the result looked *too* clean.

```
md`Here, we calculate the heat index at every combination of temperature and humidity.
But instead of drawing each cell as a \`rect\`, we do some tricks with \`d3.nest\` and
then use \`d3.area\` to plot paths, superimposing white gridlines to give the appearance
of individual cells. (This approach, h/t Adam Pearce, is mostly for performance reasons —
in the story, we wanted to show and hide a portion of the chart.)

I also played with drawing contours instead of individual cells, but we decided the
result looked *too* clean.`
```



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  const chart = svg.append('g')
  .style('font-family', 'sans-serif')
  .attr('transform', `translate(${margin.left}, ${margin.top})`);

  const x = d3.scaleLinear()
  .domain(d3.extent(humidityTicks))
  .range([0, chartWidth]);

  const y = d3.scaleLinear()
  .domain(d3.extent(temperatureTicks))
  .range([chartHeight, 0]);

  chart.append('g')
  .attr('transform', `translate(0, ${chartHeight + 2})`)
  .style('font-size', '13px')
  .style('font-weight', 300)
  .call(d3.axisBottom(x).ticks(5))
  .call(g => g.select('.tick:last-of-type text').text('100%'))
  .selectAll('.domain').remove();

  chart.append('text')
  .attr('x', chartWidth)
  .attr('y', chartHeight + 40)
  .text('Relative humidity')
  .style('text-anchor', 'end')
```

```
chart.append("g")
.attr('transform', 'translate(-2, 0)')
.style('font-size', '13px')
.style('font-weight', 300)
.call(d3.axisLeft(y).ticks(5))
.call(g => g.select('.tick:last-of-type text').text('120 °F'))
.selectAll('.domain').remove();

chart.append('text')
.attr('x', 0)
.attr('y', -15)
.text('Temperature')
.style('text-anchor', 'end')
.style('font-weight', 600)
.style('font-size', '14px');

//const values = cartesianProduct(temperatureTicks, humidityTicks).map(d => HI(...d));

const contours = d3.contours()
.size([humidityTicks.length, temperatureTicks.length])
.thresholds(thresholds.map(d => d.value))(values.map(d => d.HI));

// background color
chart.append('rect')
.attr('x', 0)
.attr('y', 0)
.attr('width', chartWidth)
.attr('height', chartHeight)
.style('fill', colors[0])
.style('opacity', .5);

const projection = d3.geoTransform({
  point: function(x, y) {
    const newX = x * chartWidth / humidityTicks.length;
    const newY = y * chartHeight / temperatureTicks.length;
    this.stream.point(newX, newY);
  }
});

chart.append('g')
.selectAll('path')
.data(contours)
.enter().append('path')
.attr('id', d => 'g-' + d.value)
```

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```
    .style('fill', (d, i) => colors[i + 1])
    .style('opacity', .5);

  chart.append('g')
    .selectAll('text')
    .data(thresholds)
    .enter().append('text')
    .attr('transform', 'translate(0, -5)')
    .append('textPath')
    .attr('xlink:href', d => `#g-${d.value}`)
    .attr('startOffset', d => '99.5%')
    .style('text-anchor', 'end')
    .style('font-size', '13px')
    .append('tspan')
    .style('font-weight', 300)
    .text(d => d.text)
    .append('tspan')
    .attr('dx', 10)
    .text(d => d.value)
    .style('font-weight', 600)

  return svg.node();
}
```

```
temperatureTicks = ▶ Array(41) [120, 119, 118, 117, 116, 115, 114, 113, 112, 111, 110, 109
```

```
humidityTicks = d3.range(10, 101, 1)
```

```
temperatureTicks = d3.range(80, 121, 1).reverse()
```

```
values = cartesianProduct(temperatureTicks, humidityTicks).map(d => {
  return {
    temp: d[0],
    rh: d[1],
    HI: HI(...d),
    threshold: thresholdScale(HI(...d))
  }
})
```

```
]
```

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```
chartData = d3.nest()
  .key(d => d.threshold)
  .sortKeys(d3.ascending)
  .key(d => d.rh)
  .rollup(vals => d3.max(vals))
  .entries(values)
  .map(d => {
    return {
      key: d.key,
      values: humidityTicks.map(h => {
        const v = d.values.find(f => +f.key == h);
        return {
          rh: h,
          temp: v ? v.value.temp : 120
        }
      })
    }
  }).map( (d, i, arr) => {
    d.values = d.values.map( (f, j) => {
      f.prevTemp = i > 0 ? arr[i - 1].values[j].temp : 80;
      return f;
    })
    return d;
  })
```

```
thresholds = [
    {
      'value': 90,
      'text': 'Extreme caution',
      'T': 95,
      'H': 31
    },
    {
      'value': 103,
      'text': 'Danger',
      'T': 102,
      'H': 38
```

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```
    {
      'value': 125,
      'text': 'Extreme danger',
      'T': 107,
      'H': 50
    },
    {
      'value': 165,
      'text': 'Limit of human tolerance',
      'T': 113,
      'H': 72
    }
]
```

```
colors = ▶ Array(8) ["#fdf7e1", "#faeaae", "#f7d790", "#f3b473", "#fd8d3c", "#fc4e2a", "#e
```

```
thresholdScale = d3.scaleThreshold()
.domain(thresholds.map(d => d.value))
.range([0,1,2,3,4])
```

```
colors =
['#fdf7e1','#faeaae','#f7d790','#f3b473','#fd8d3c','#fc4e2a','#e31a1c','#b10026']
```

```
cartesianProduct = ƒ(…)
// compute the heat index given the temperature, T, and relative humidity, RH
HI = {
  return (T, RH) => -42.379 + 2.04901523*T + 10.14333127*RH - .22475541*T*RH -
.00683783*T*T - .05481717*RH*RH + .00122874*T*T*RH + .00085282*T*RH*RH -
.00000199*T*T*RH*RH;
}
```

```
width = 700
```

```
cartesianProduct = {
  // product-of-multiple-arrays-in-javascript
  const f = (a, b) => [].concat(...a.map(d => b.map(e => [].concat(d, e))));
  const cartesian = (a, b, ...c) => (b ? cartesian(f(a, b), ...c) : a);
  return cartesian;
}
```

```
d3 = ▶ Object {event: null, format: ƒ(t), formatPrefix: ƒ(t, n), timeFormat: ƒ(t), timePars
```

```
width = 700
```

You have 21 unsaved changes. Fork this notebook to save.

```
height = 500
```

```
d3 = require("d3@5")
```

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NEXT

The Cube Root Law