

(quiz)

(laptops)

(design lab reflection)

Temporal visualization

SI 649 W20: Information visualization

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& Computer Science and Engineering
University of Michigan

Portions of slides adapted from Eytan Adar

Coronavirus update

If you have any reason to believe you shouldn't attend lecture (feeling sick, in a high-risk group, etc) **don't hesitate to let us know**; we'll waive your attendance

Lectures will be **live (and recorded) via Bluejeans** for the rest of the semester (link on Slack before each lecture)

Office hours

Licia's office hours are now **by appointment only** (this tends to work better for groups at this stage of the semester)

Mine are **unchanged**

This week

Lecture

Domain / abstract tasks reminder
Temporal visualization

Lab

Design jam: Temporal

Design jam

Please be on time!

We will figure out something for folks who can't make it due to coronavirus (announcement today or tomorrow on Slack)

Reminder: Group data exploration (3/15)

It **must**:

- describe structure of data
- convince us you have truly explored your data

Ideally, it **should**:

- convince us you have found / are on the path to finding an interesting insight / use case

Individual assignment round 2

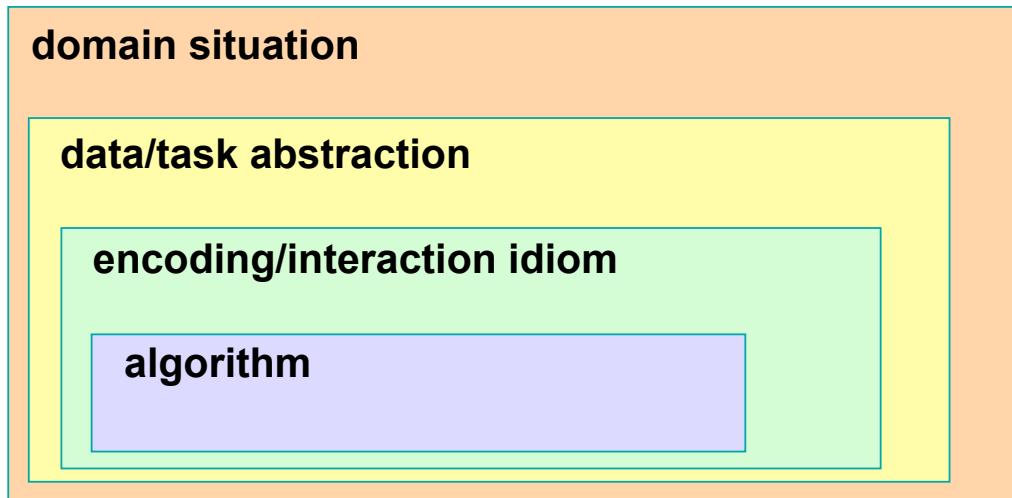
Due in a few weeks (3/27)

Nested model reminder

The Nested Model [Munzner]

4 **levels** of Vis design, **threats to validity** at each

We will take a simplified view of this...

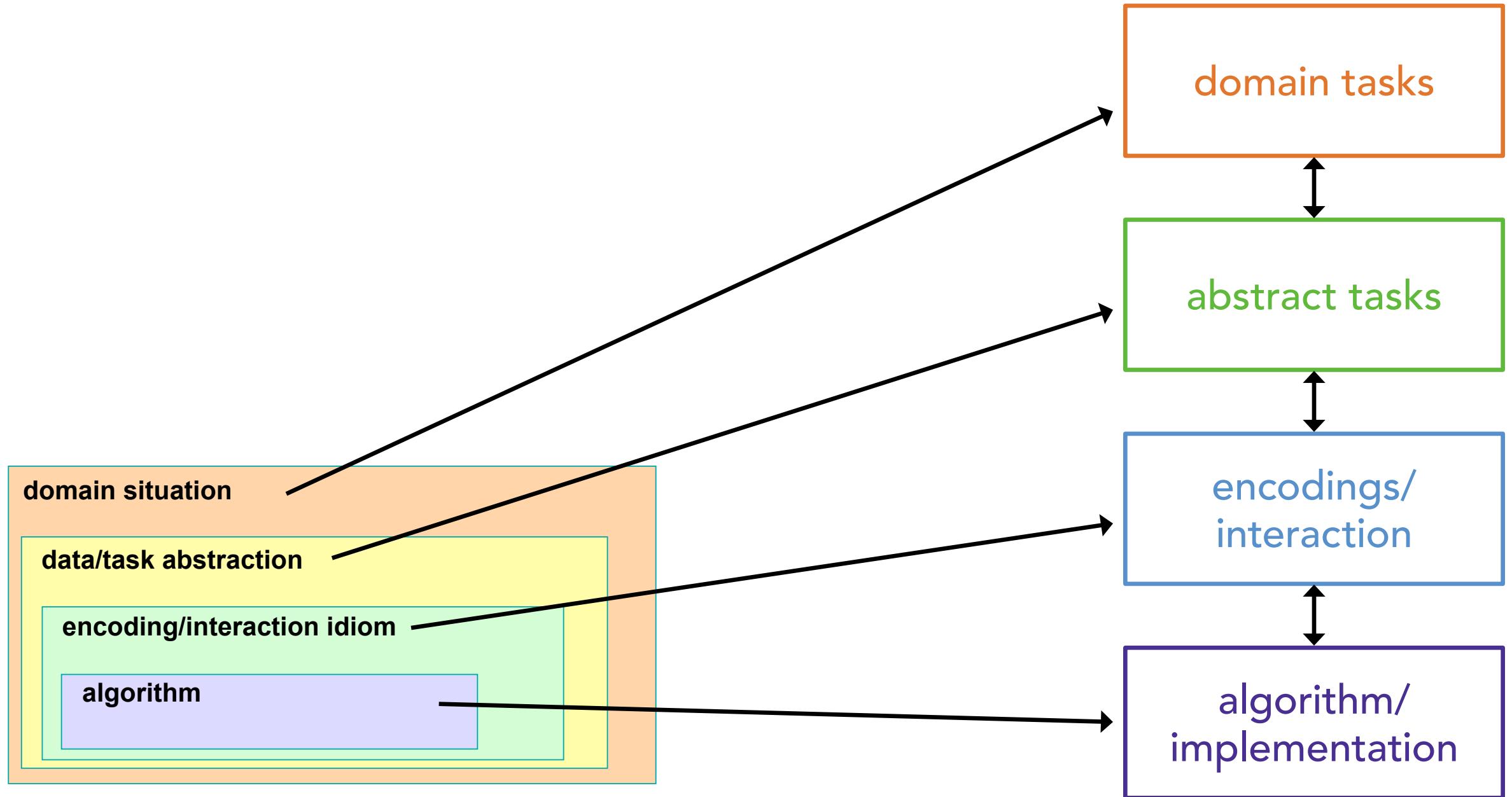


domain situation

data/task abstraction

encoding/interaction idiom

algorithm



domain tasks

abstract tasks

encodings/
interaction

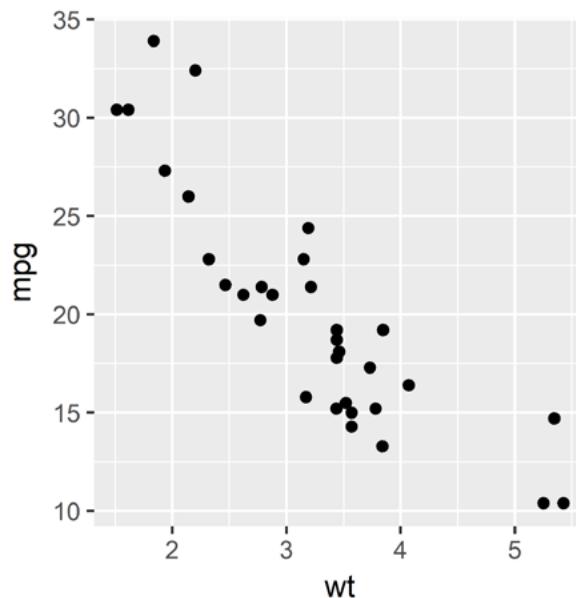
algorithm/
implementation



1. Find cars with low MPG
2. Understand relationship between MPG and weight

1. Find minimum value / quantitative comparison
2. Estimate correlation between variables

MPG -> y position
weight -> x position
car name -> tooltip



domain tasks

abstract tasks

encodings/
interaction

algorithm/
implementation

Given my **data and abstract tasks**...

...are my encodings **expressive?**
effective? **perceptually justified?**

domain tasks

abstract tasks

encodings/
interaction

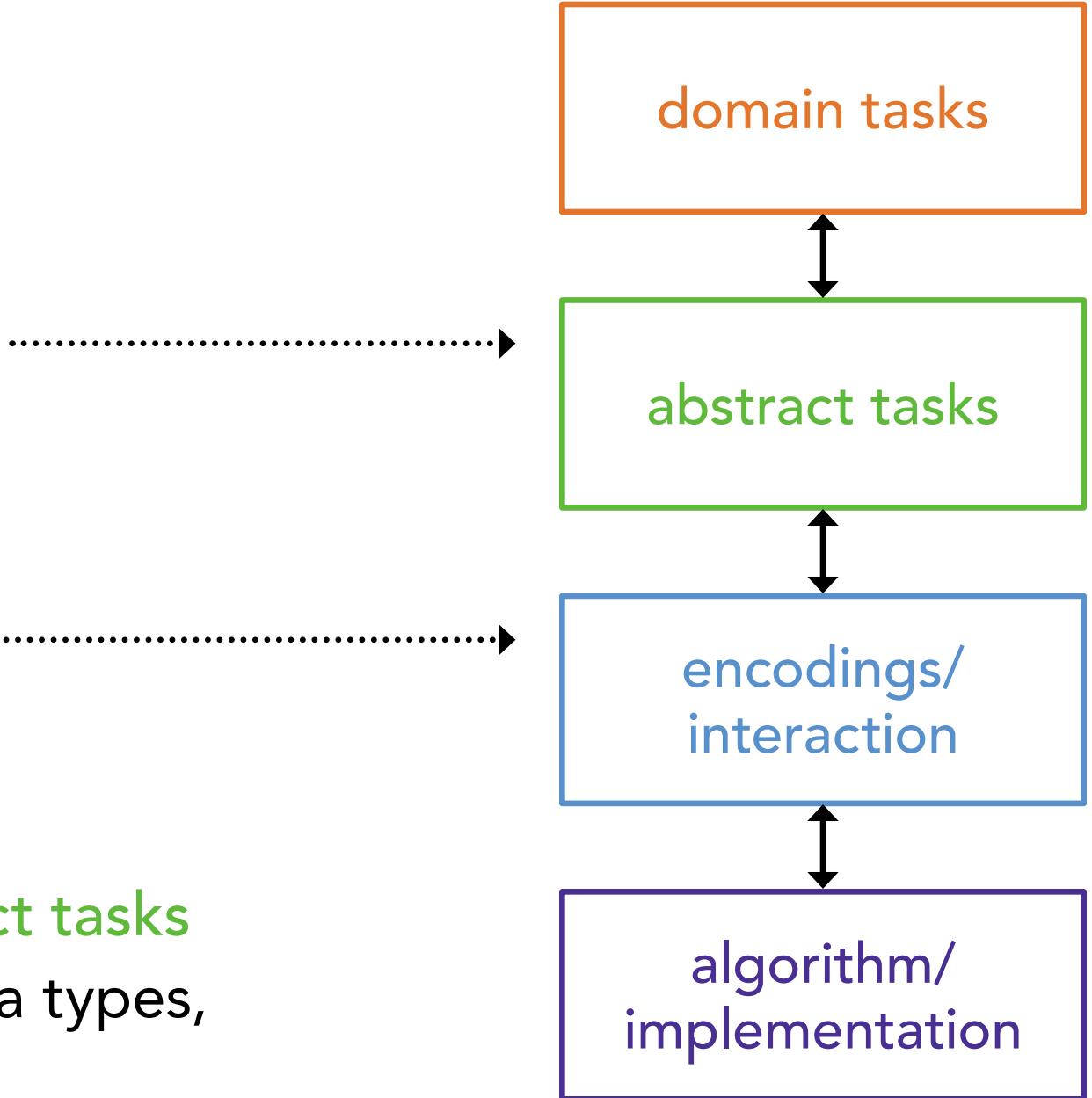
algorithm/
implementation



Given my **data** and **abstract tasks**...

...are my encodings **expressive?**
effective? **perceptually justified?**

We'll go through examples of **abstract tasks** and **typical encodings** for several data types, starting today with **temporal data**



Temporal visualization

If I asked you:

I have a single time series, how should I plot it?

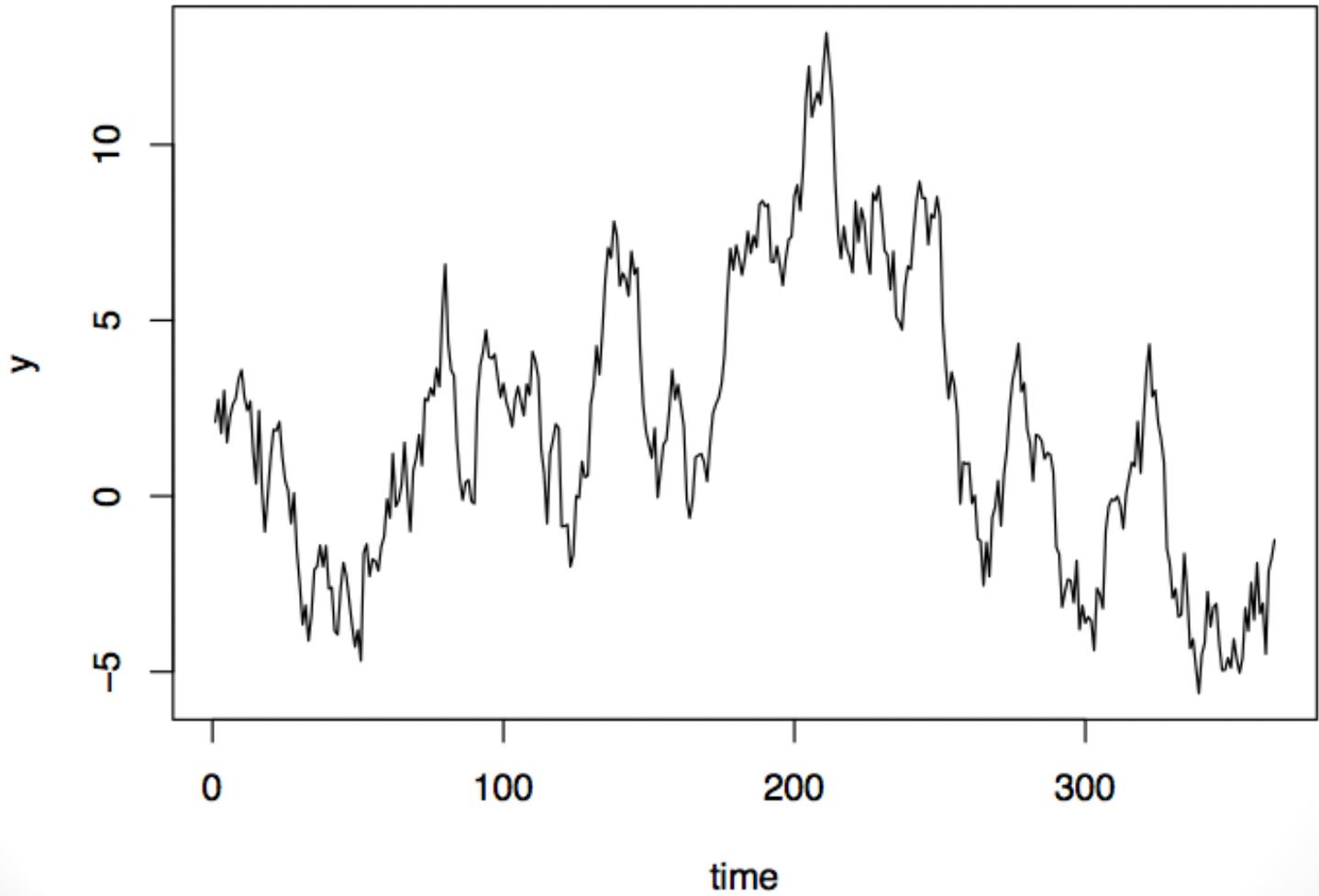
What would you say and **why**?

Basic time series plot

Position against a common baseline

Best encoding perceptually!

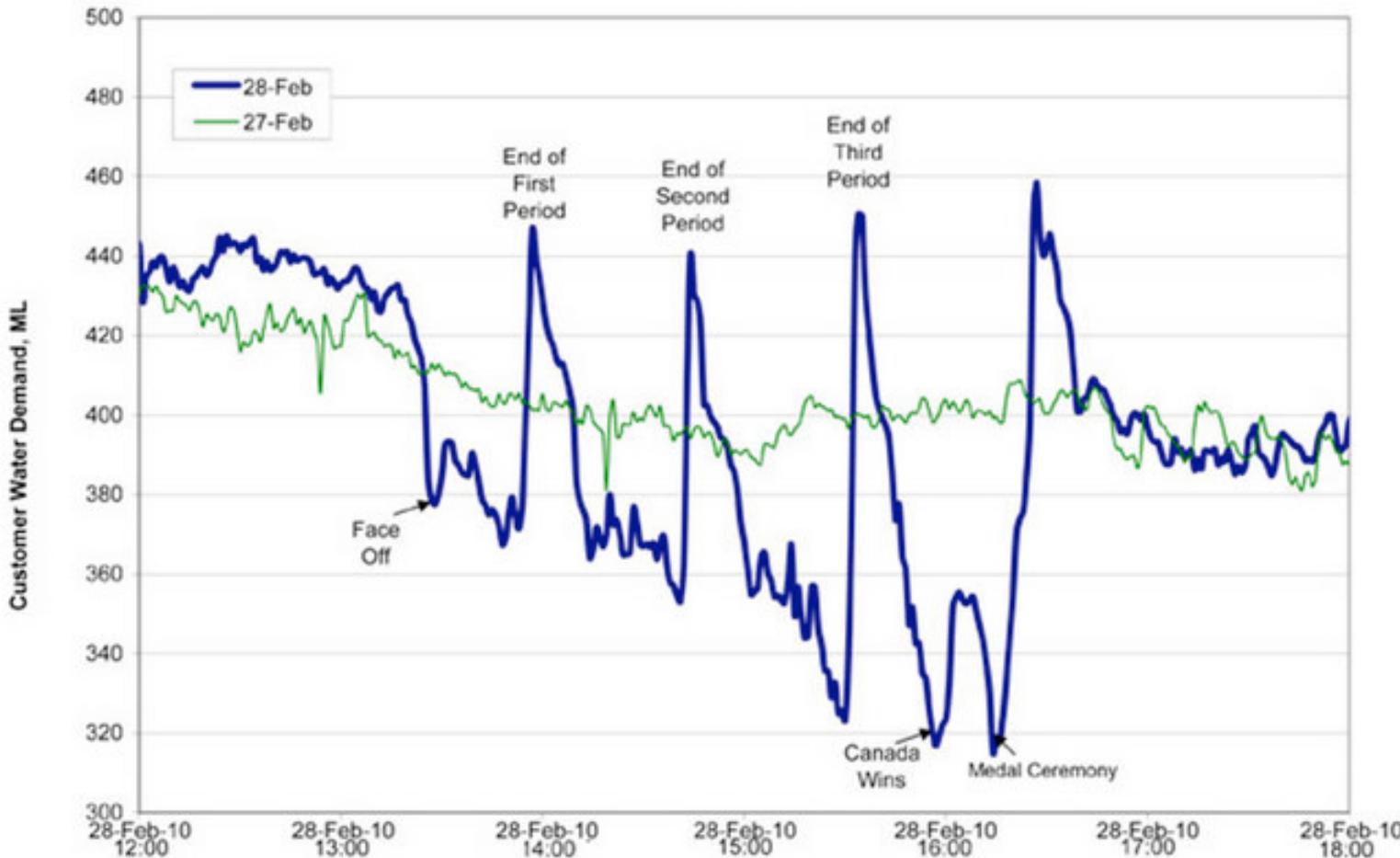
High effectiveness



Basic time series plot



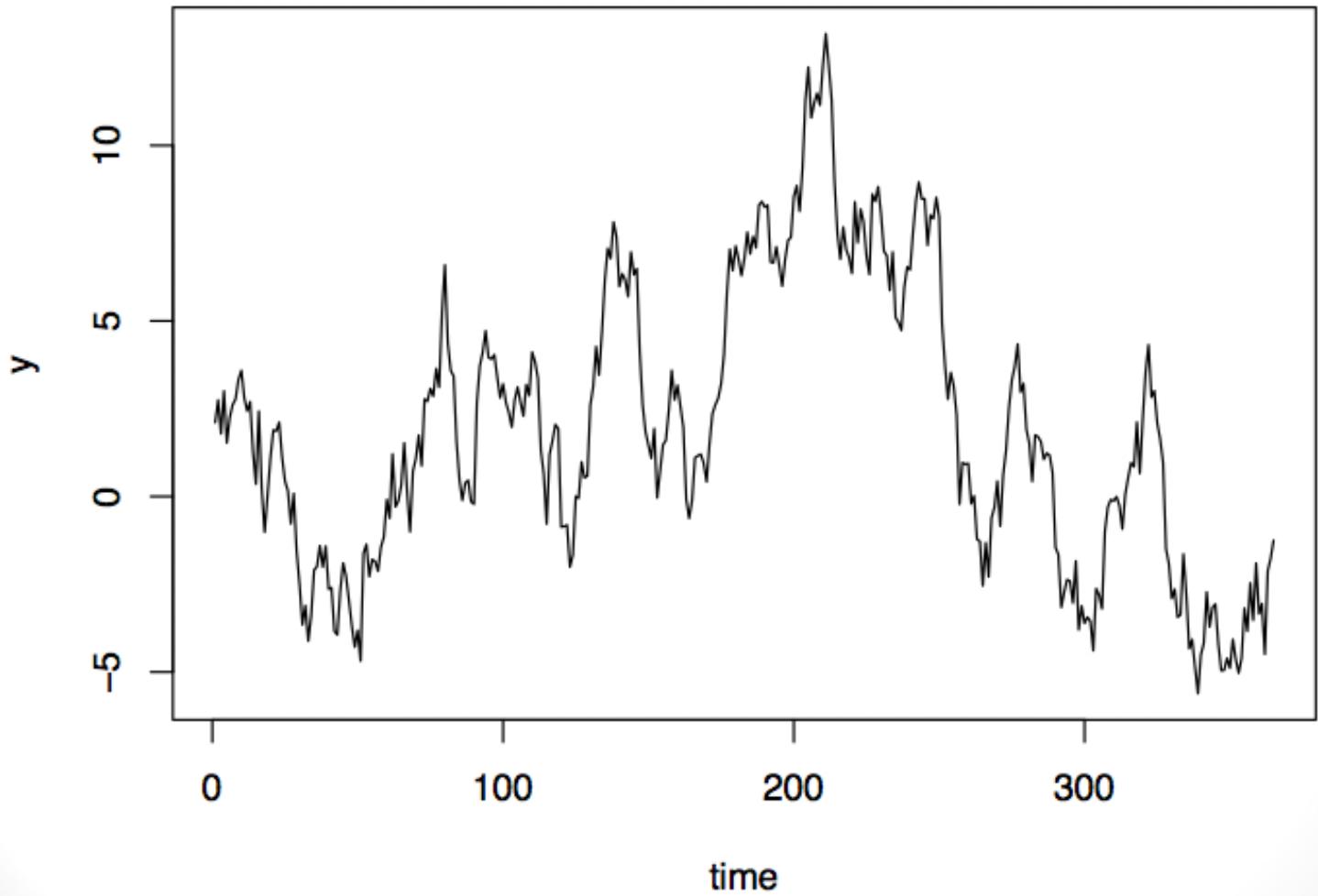
Water Consumption in Edmonton During Olympic Gold Medal Hockey Game



Easy to make
comparisons

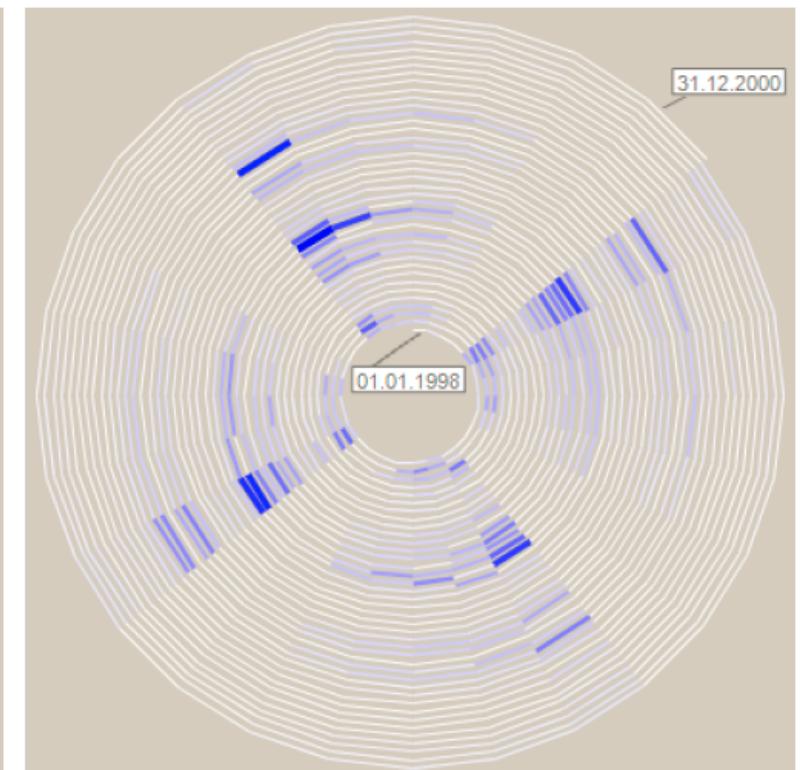
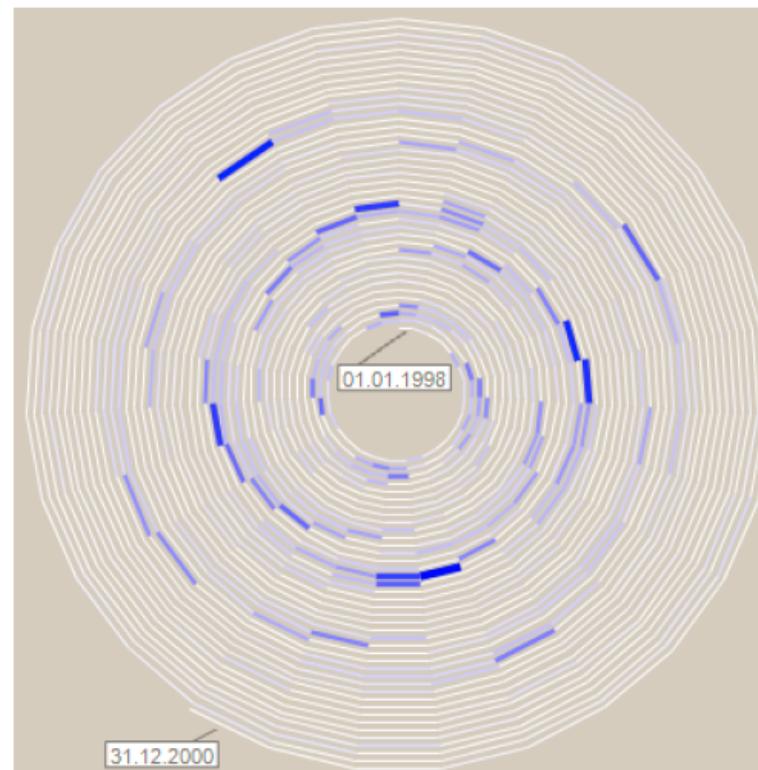
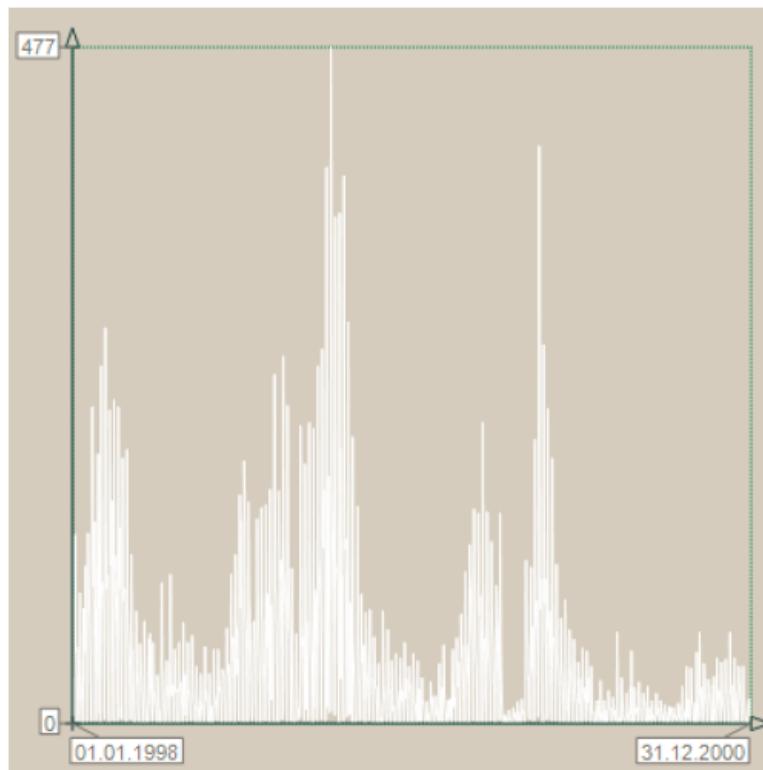
Disadvantages of basic time series plot?

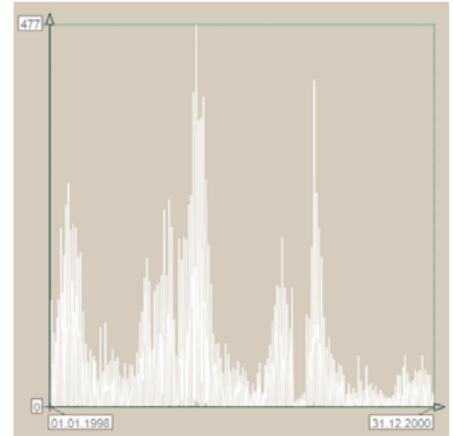
Tasks it may not be
as well suited for?



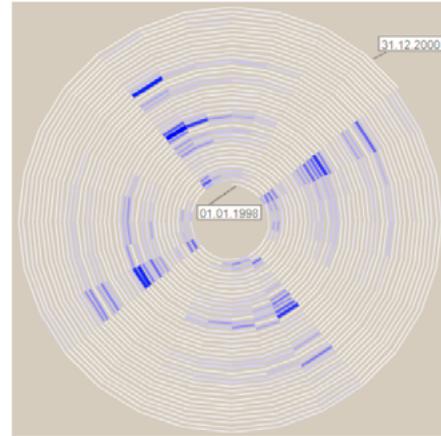
Disadvantages of basic time series plot?

Spiral graphs may show **periodic patterns** more easily
(when period is correctly chosen). **But?**

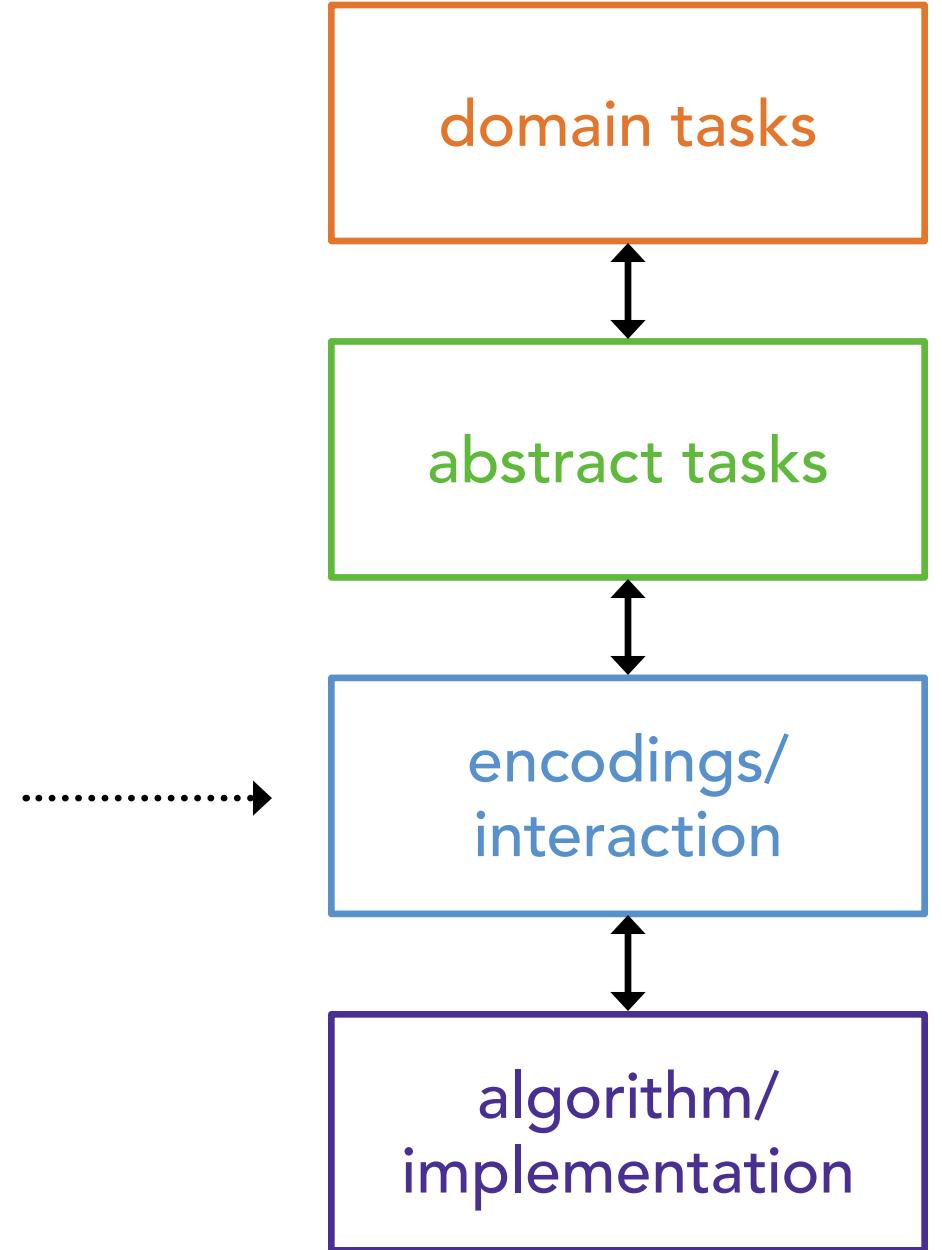




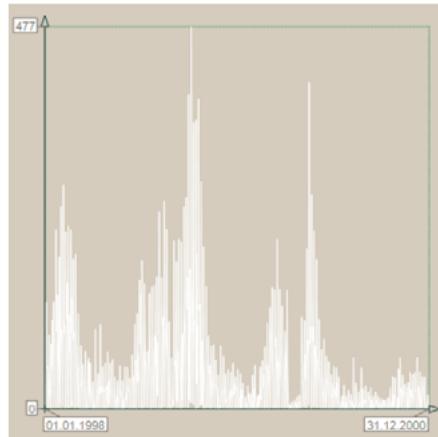
Time series plot



Spiral graph

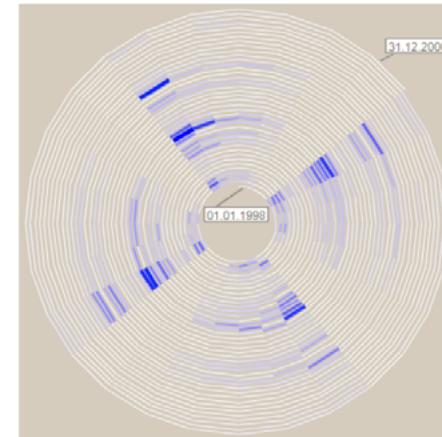


- Direct comparison of time points
- Comparison of two time series



Time series plot

- Identification of periodic patterns



Spiral graph



domain tasks

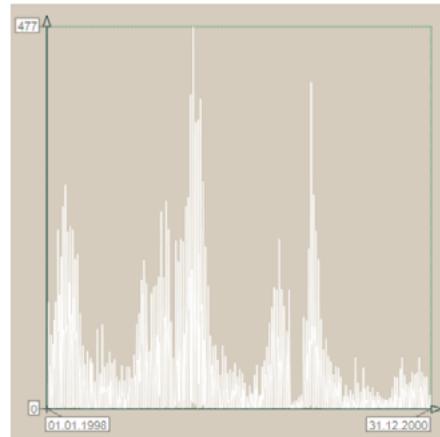
abstract tasks

encodings/
interaction

algorithm/
implementation

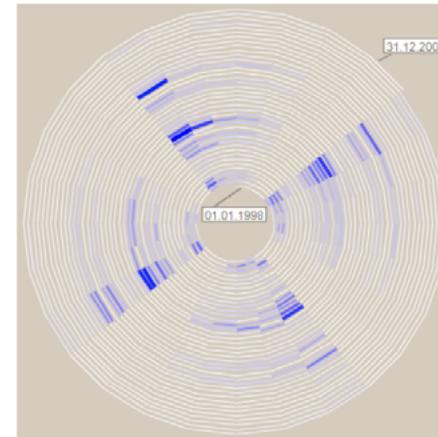
Now consider **domain tasks** to
systematically choose encoding

- Direct comparison of time points
- Comparison of two time series



Time series plot

- Identification of periodic patterns



Spiral graph



domain tasks



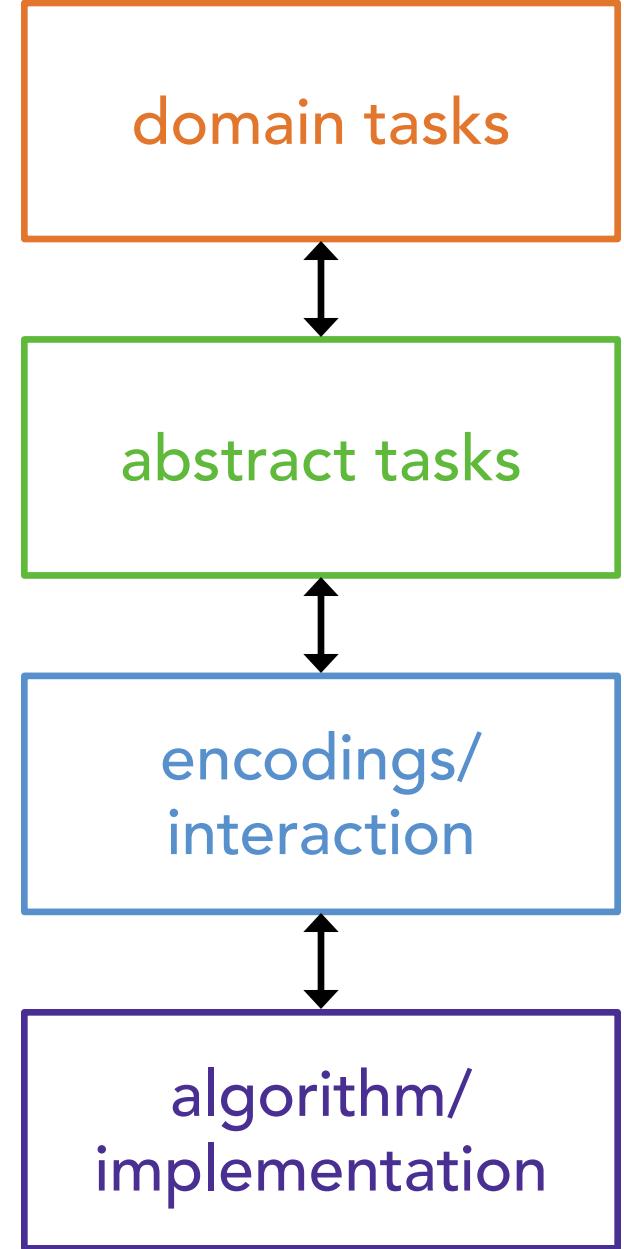
abstract tasks



encodings/
interaction



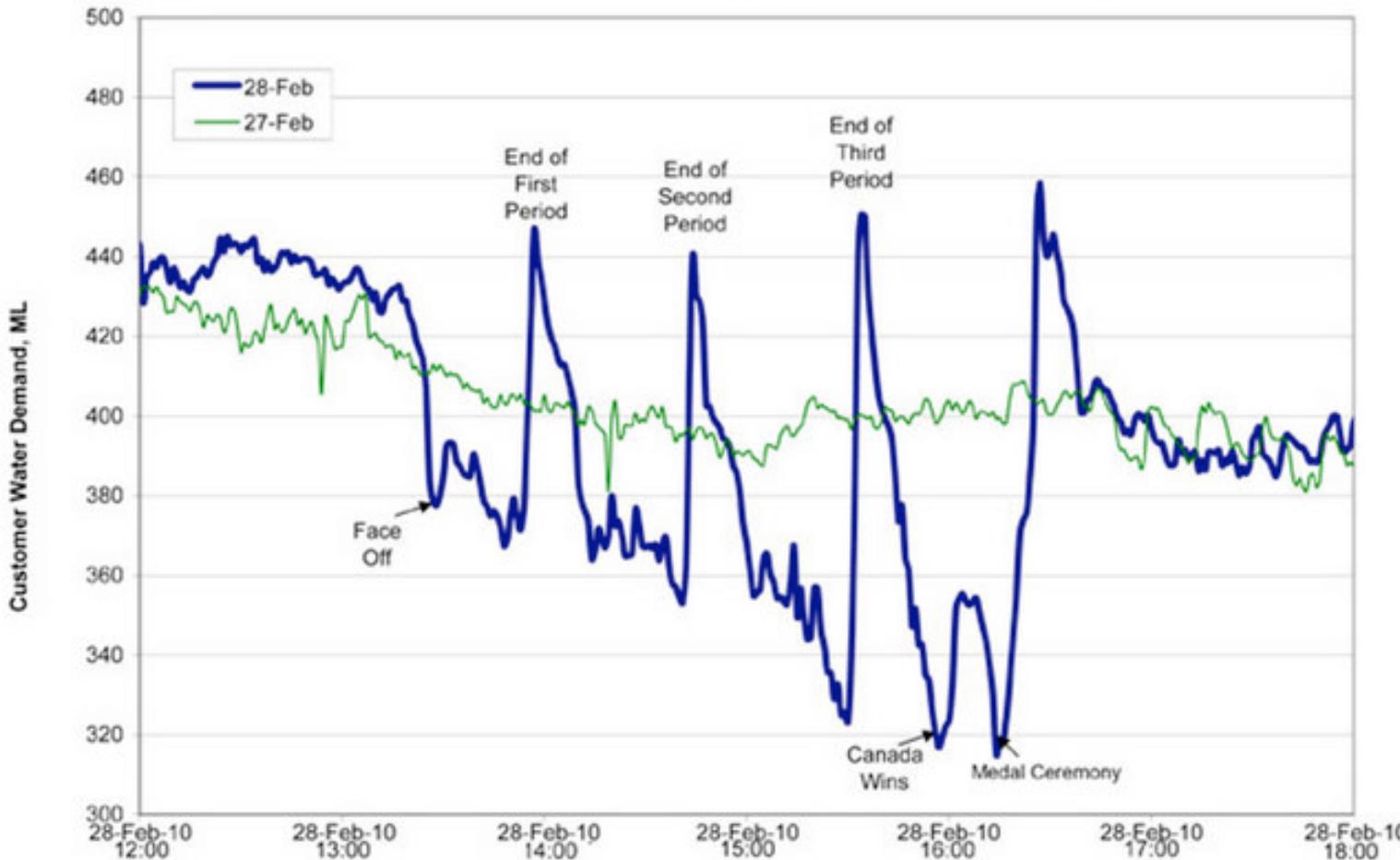
algorithm/
implementation



Basic time series plot



Water Consumption in Edmonton During Olympic Gold Medal Hockey Game



Why does this work?

Domain tasks?
Abstract tasks?
Encodings?

Trade-offs?

domain tasks

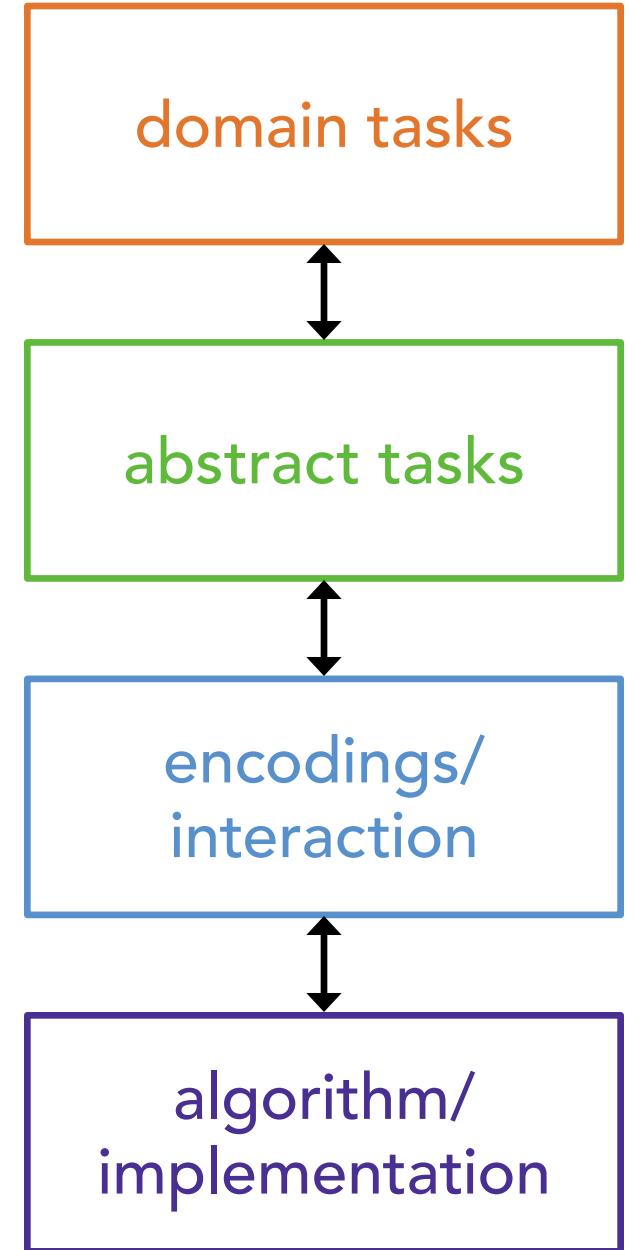
abstract tasks

encodings/
interaction

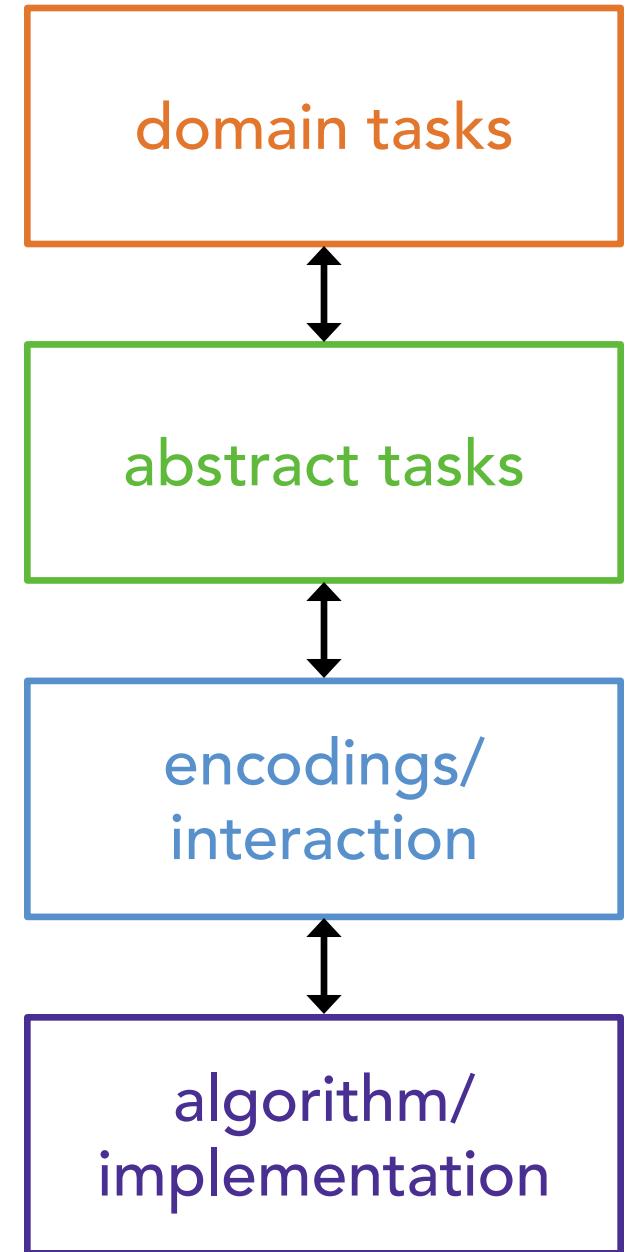
algorithm/
implementation



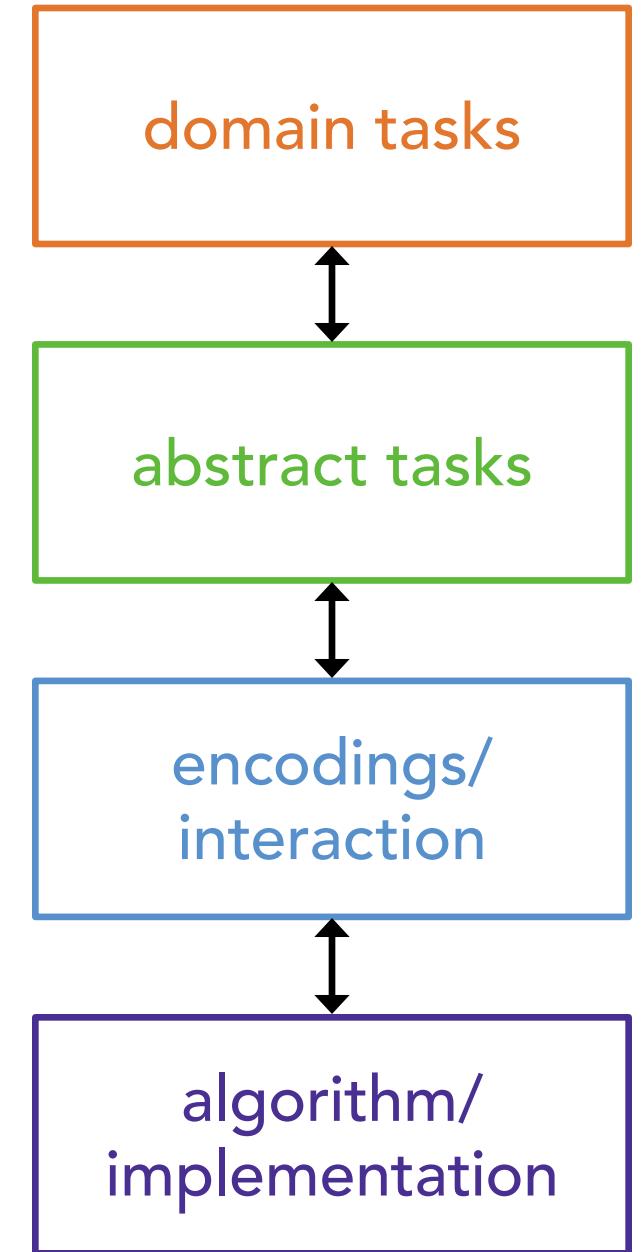
- See atypical peaks in usage in between periods



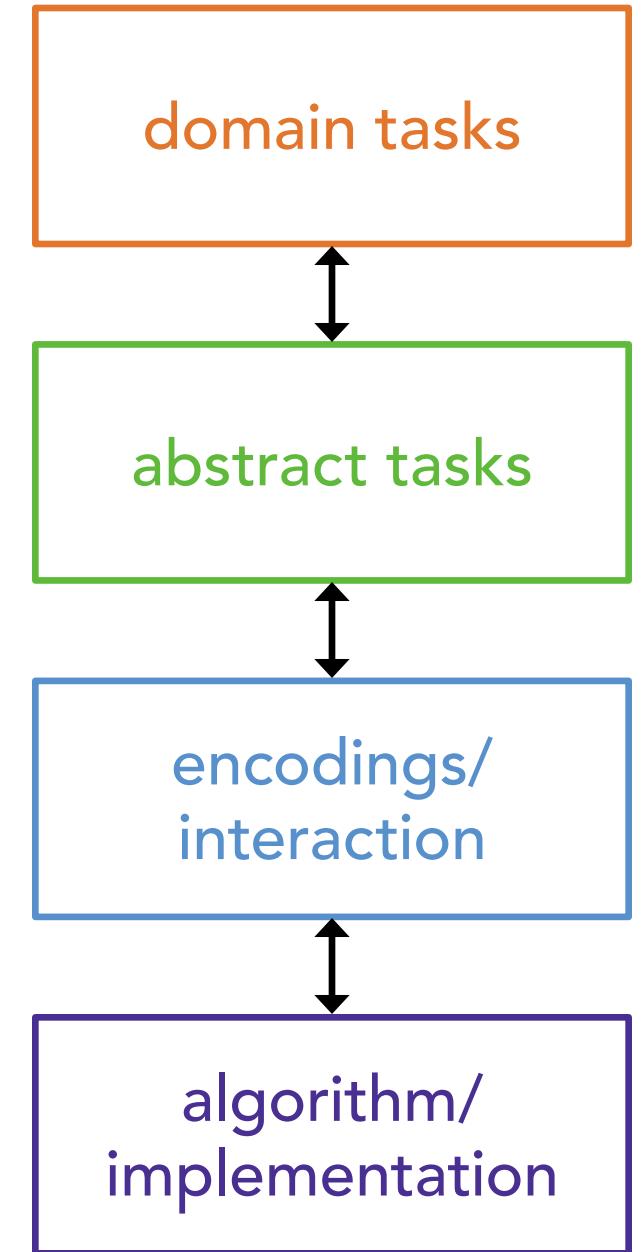
- See atypical peaks in usage in between periods
- Comparison of two time series



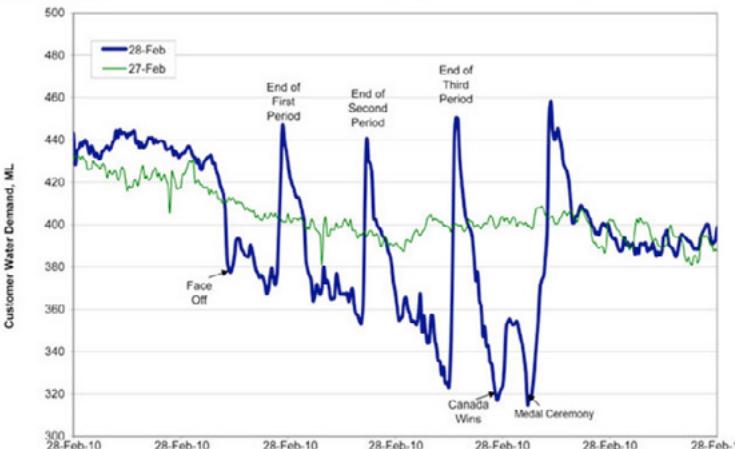
- See atypical peaks in usage in between periods
- Comparison of two time series
- Identification of periodic patterns



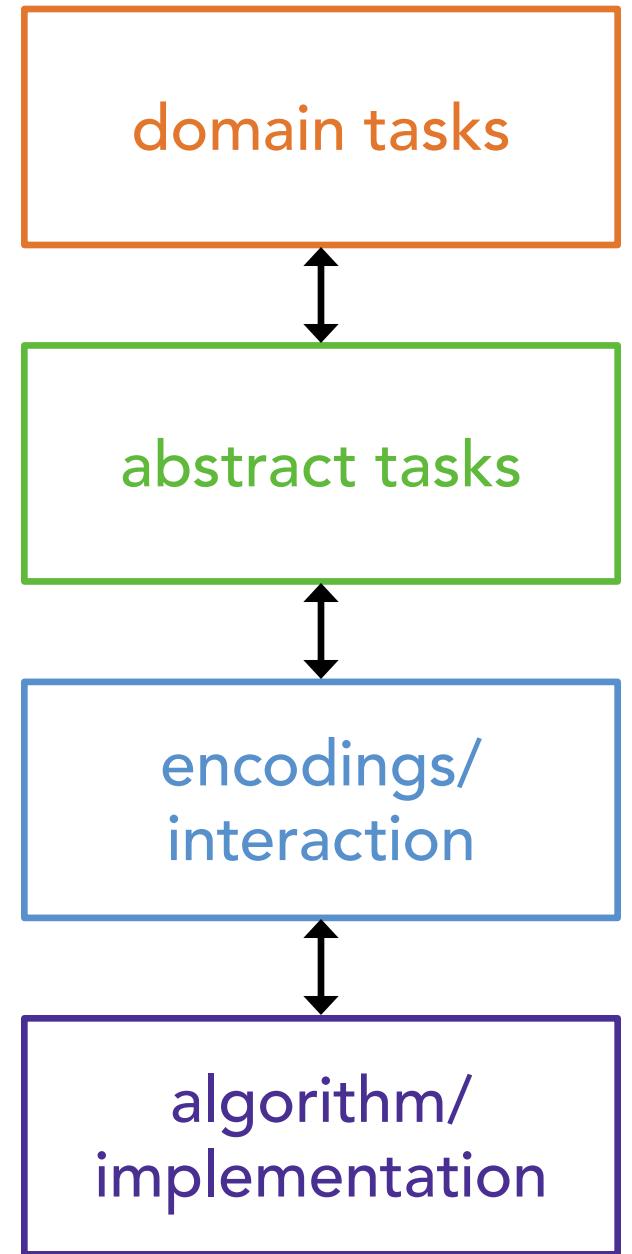
- See atypical peaks in usage in between periods
 - Comparison of two time series
 - Identification of periodic patterns
- More important**



- See atypical peaks in usage in between periods
 - Comparison of two time series
 - Identification of periodic patterns
- More important**



Time series plot



**Life gets even more complicated
if we add more variables...**

Carte Figurative des pertes successives en hommes de l'Armée Française dans la Campagne de Russie 1812-1813.

Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite.

Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en lettres des zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. — Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chiers, de Léger, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre.

Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Sébastien et du Maréchal Davout, qui avaient été détachés sur Minsk et Mohilow et qui rejoignirent Orsha et Vitebsk, avaient toujours marché avec l'armée.

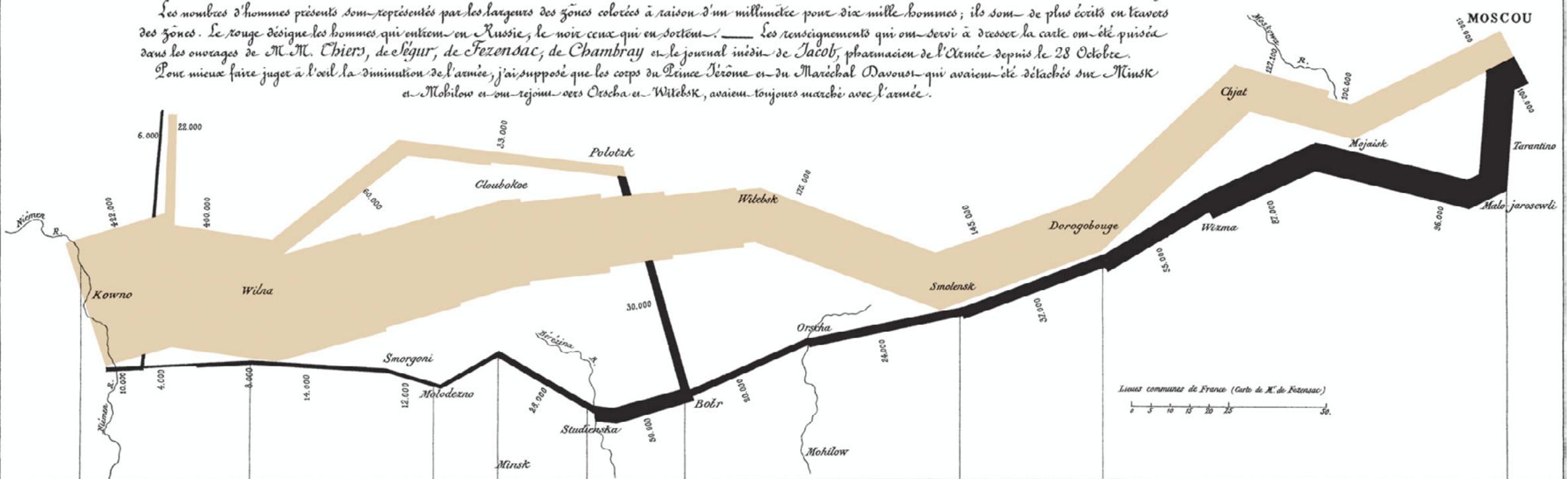
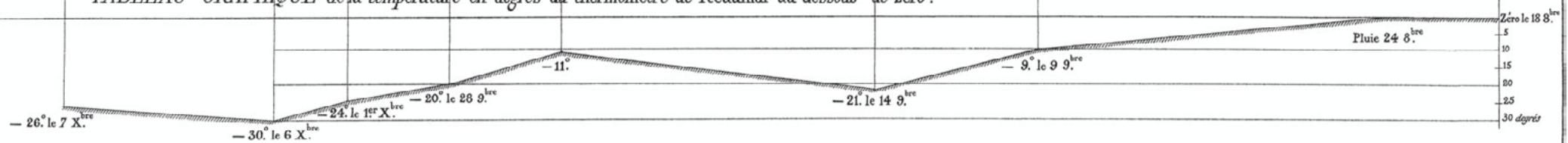


TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.

Les cosaques passent au galop
le Niemen gelé.



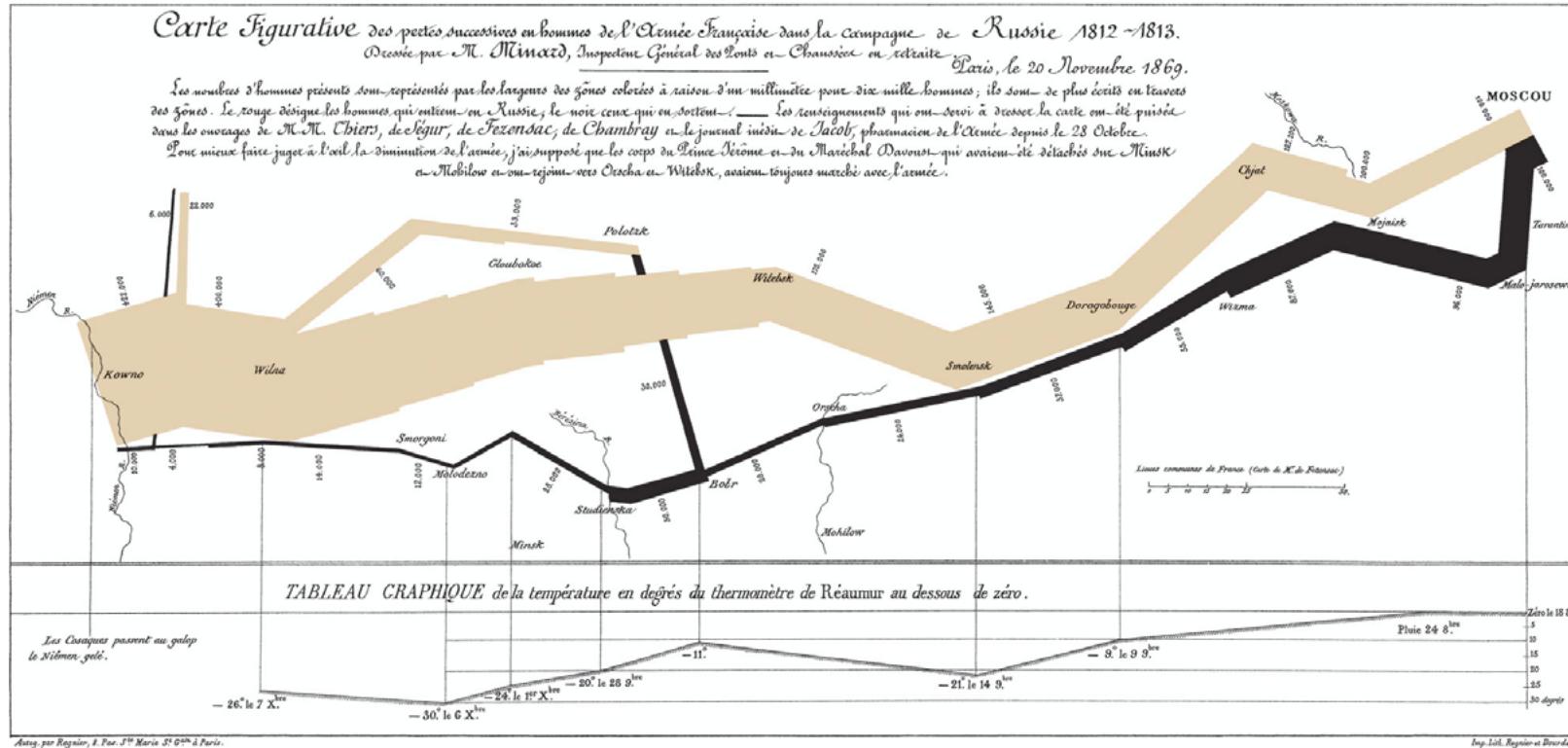
Autog. par Regnier, 8. Pas. S^e Marie S^e Gal^e à Paris.

Imp. Lith. Regnier et Dourdet.

(Minard) See also a nice breakdown here: <https://robots.thoughtbot.com/analyzing-minards-visualization-of-napoleons-1812-march>

Break down Minard

Domain tasks, abstract tasks, encodings
Why these choices?



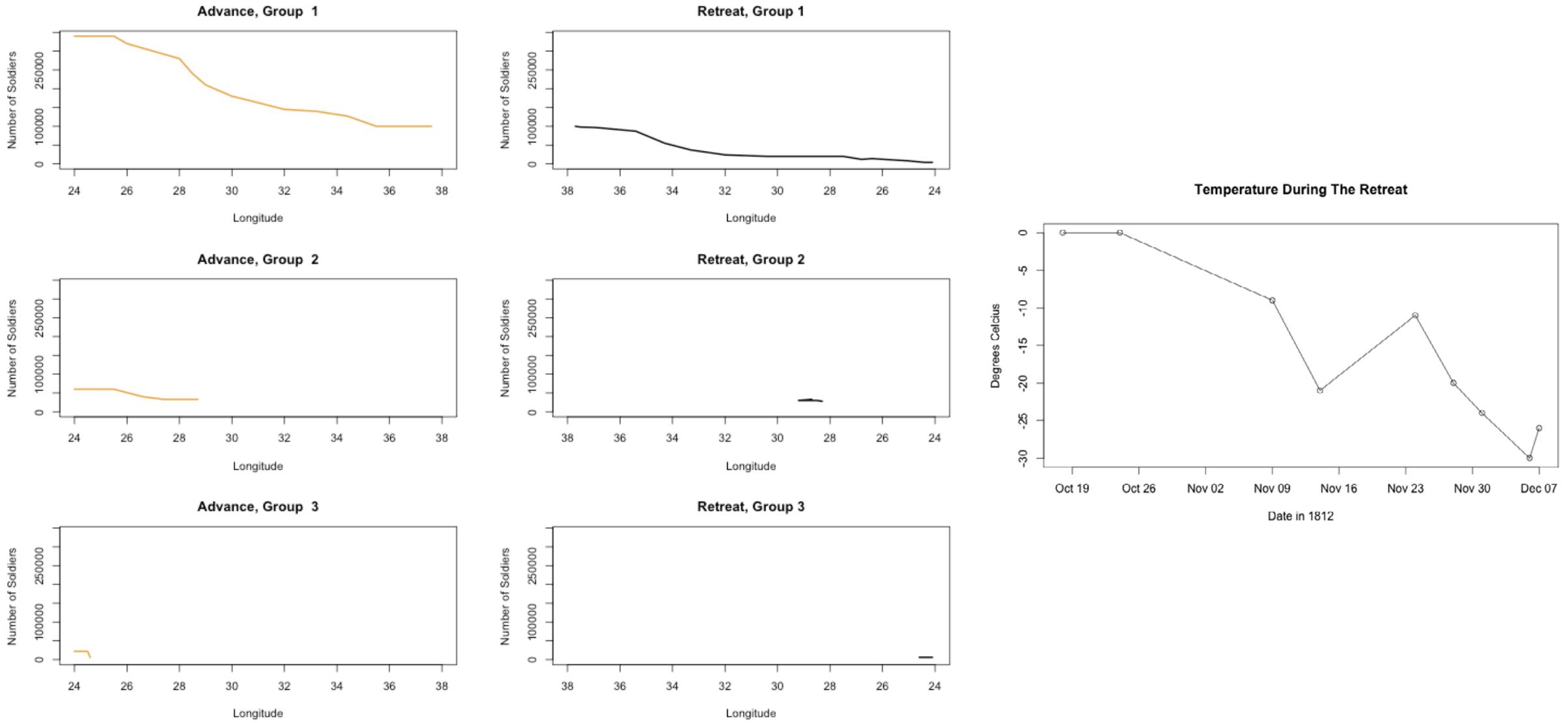
domain tasks

abstract tasks

encodings/
interaction

algorithm/
implementation

Let's break this down...



Carte Figurative des pertes successives en hommes de l'Armée Française dans la Campagne de Russie 1812-1813.

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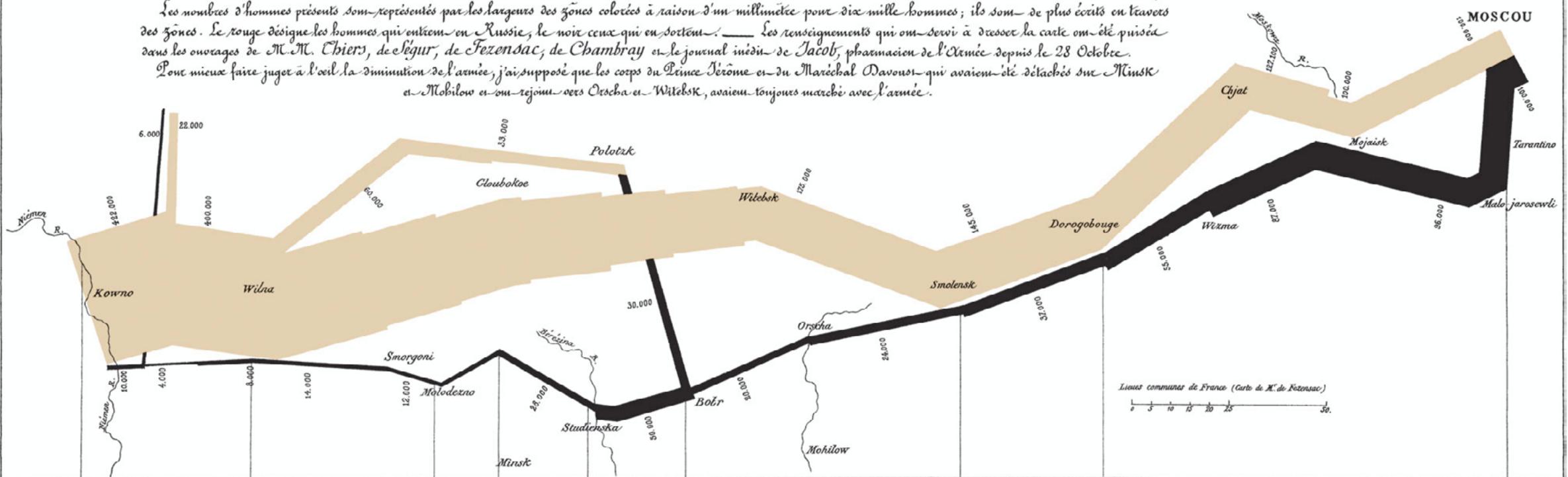
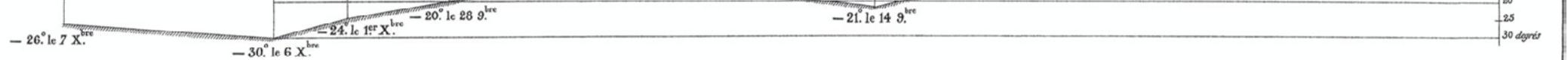


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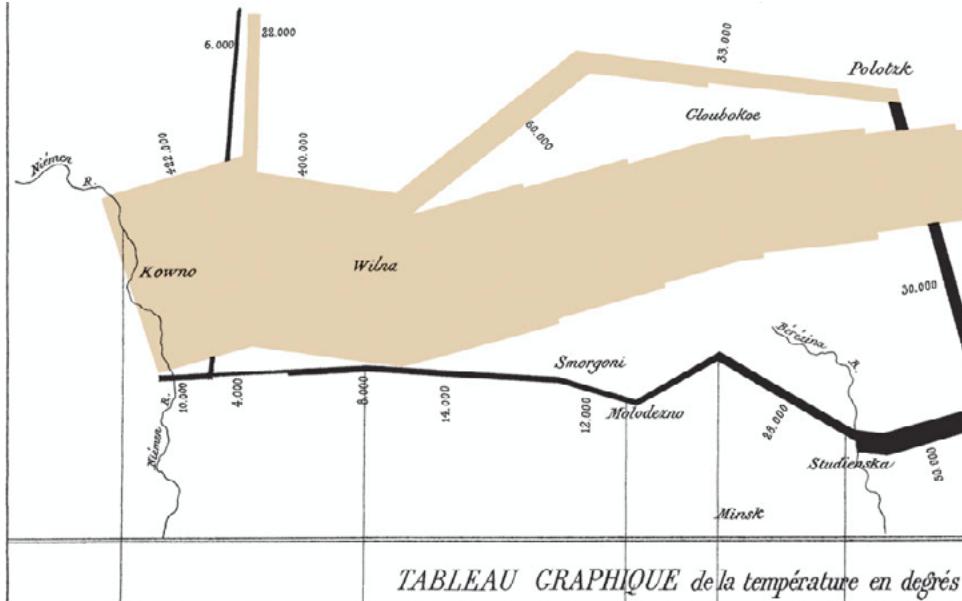
(Minard) See also a nice breakdown here: <https://robots.thoughtbot.com/analyzing-minards-visualization-of-napoleons-1812-march>

Minard versus Hurricane visualization



What does **width** encode here?

Be careful when using size to encode something abstract in time and space...

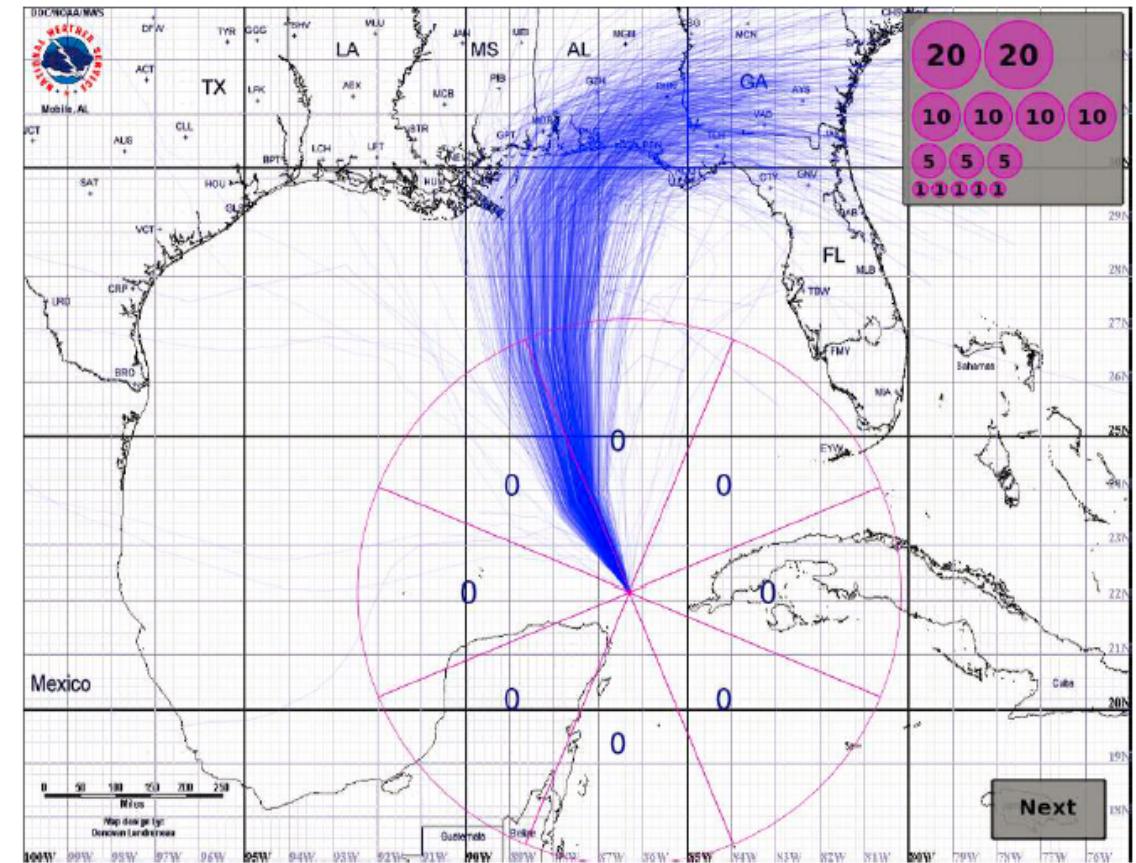
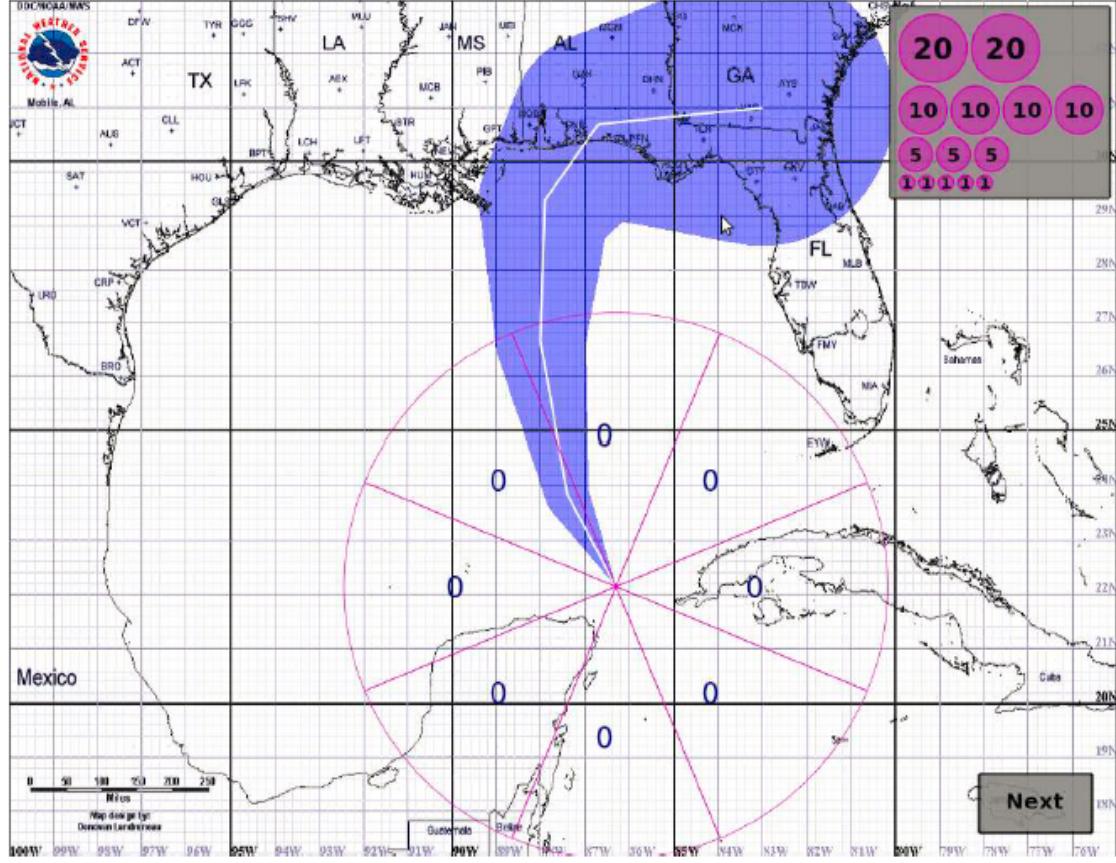


army size -> width



uncertainty -> width

(we will revisit cones of uncertainty later...)



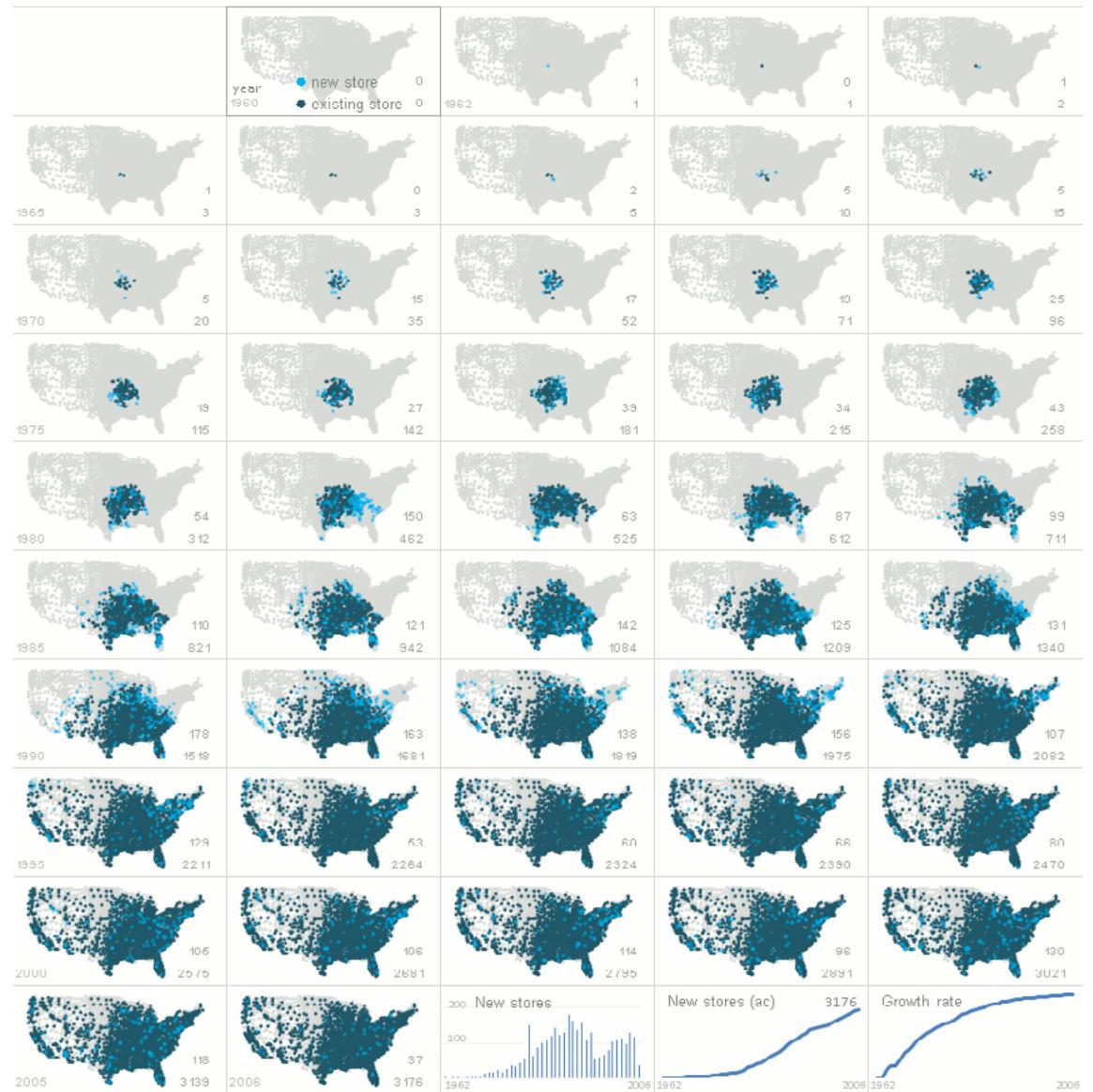
Animation is another approach
to geography + time

Remember this?

Small multiples vs
animation

<https://excelcharts.com/animation-small-multiples-growth-walmart-excel-edition/>

Growth of Walmart

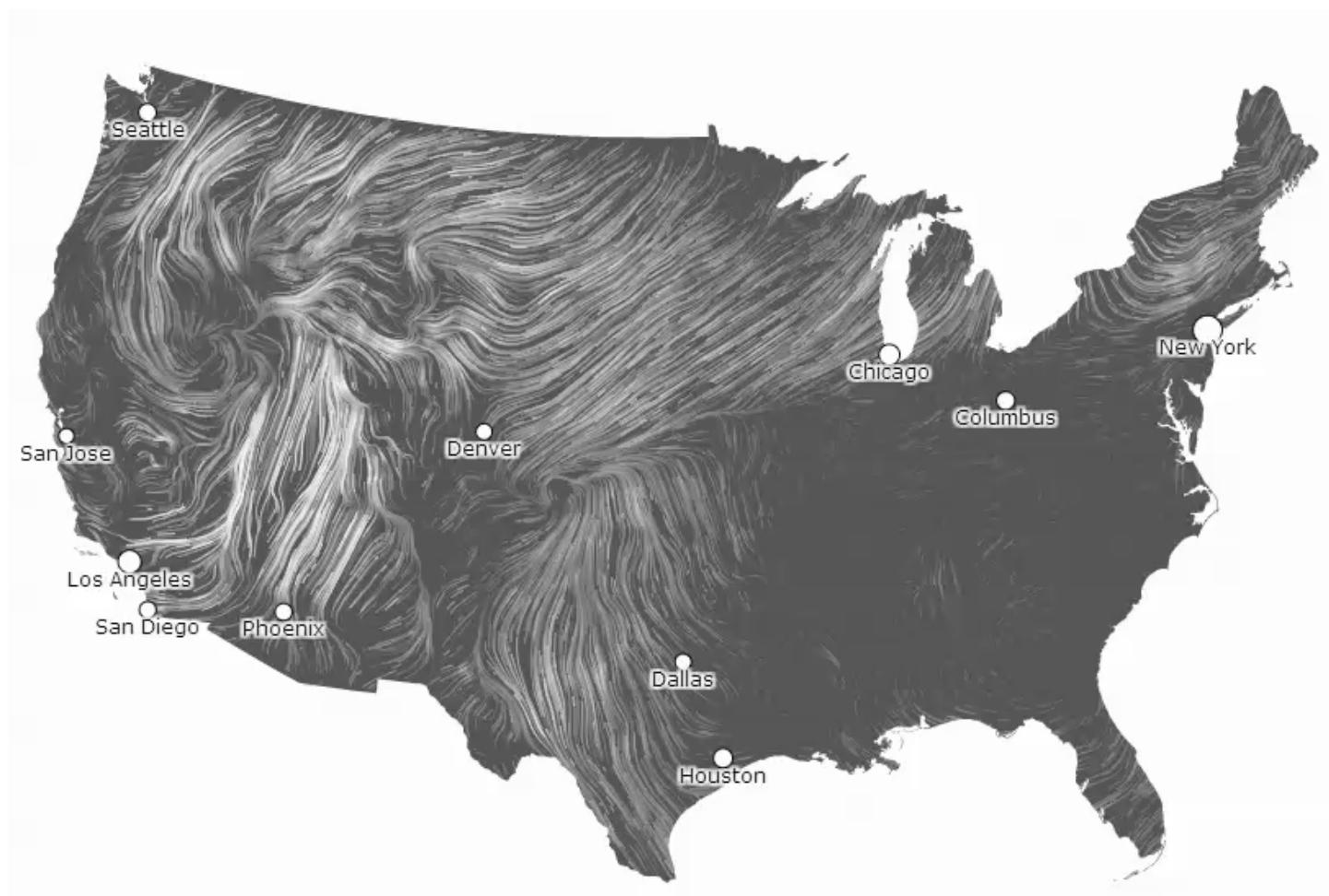


Flow visualization

Density gives speed,
as does movement
(double encoding)

Movement also
gives direction

<http://hint.fm/wind/>



Don't need animation for flow necessarily

Asymmetry
conveys direction



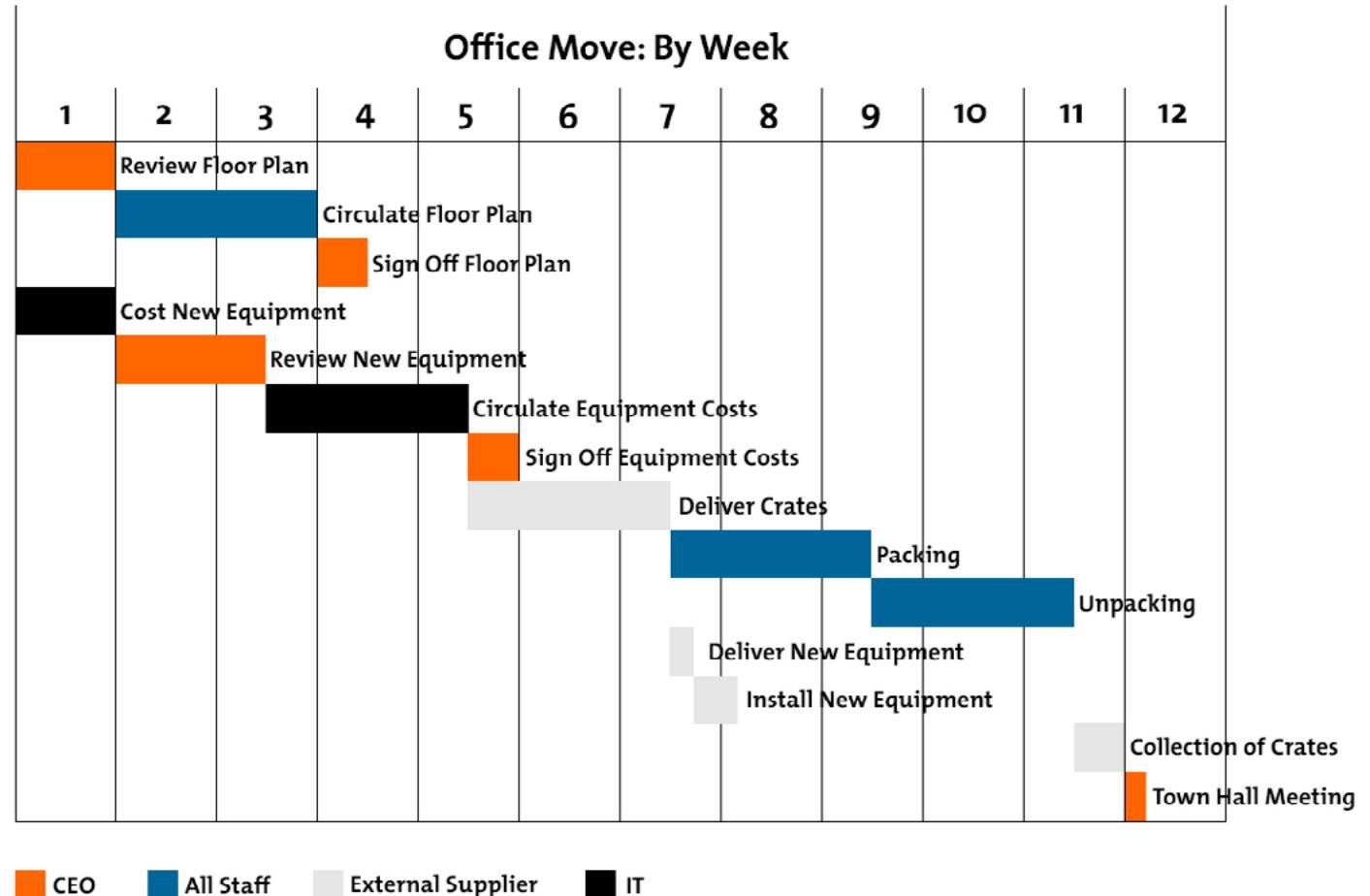
[See Ware, *Information Visualization, Third Edition: Perception for Design*]

Time intervals...

Gantt chart

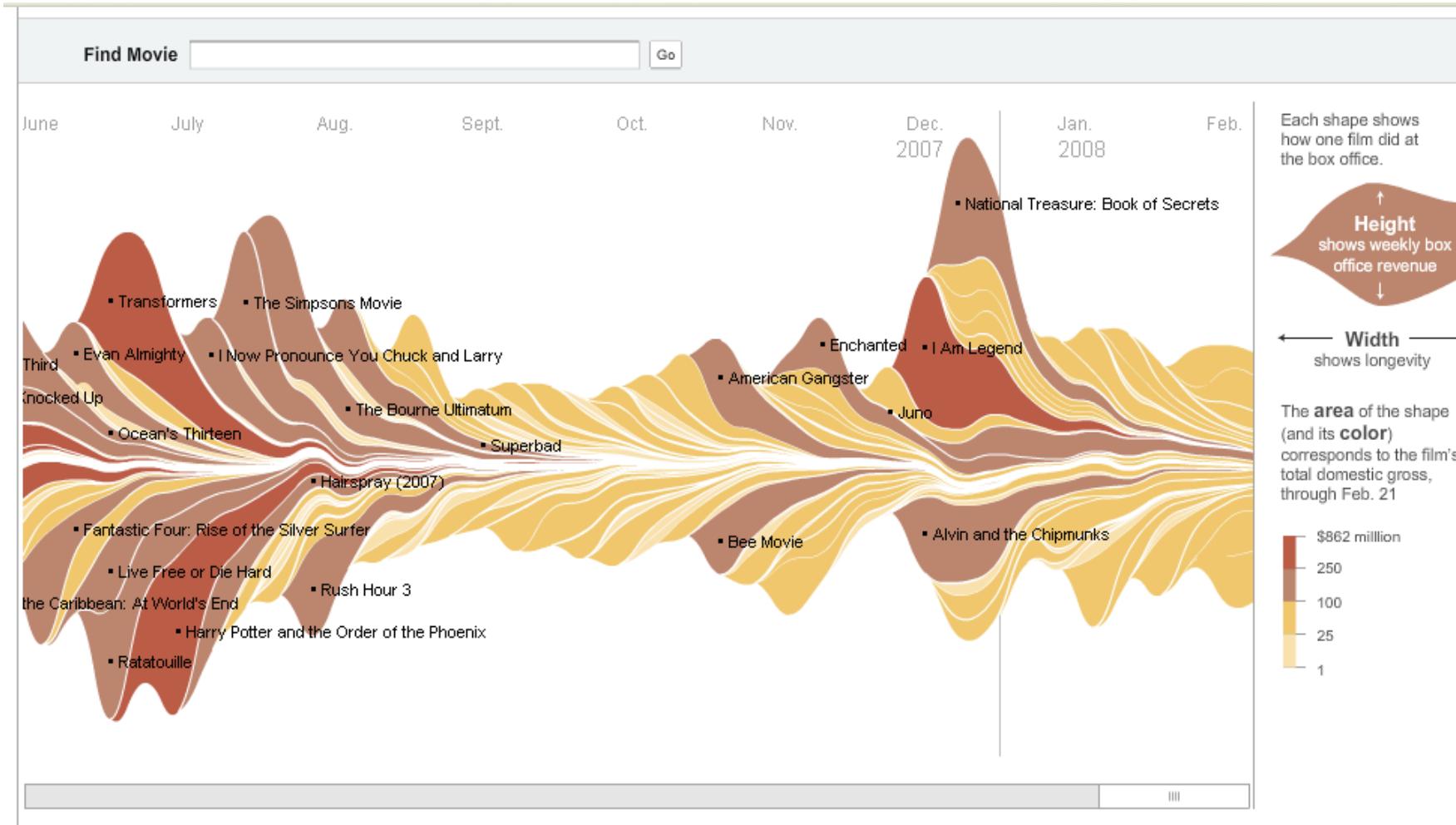
Time interval
encoding (primarily)

Shows dependencies



Stacked time series...

StreamGraphs – #1 problem with stacking?



<http://www.nytimes.com/interactive/2008/02/23/movies/20080223 REVENUE GRAPHIC.html>

Estimate the difference b/w these curves...

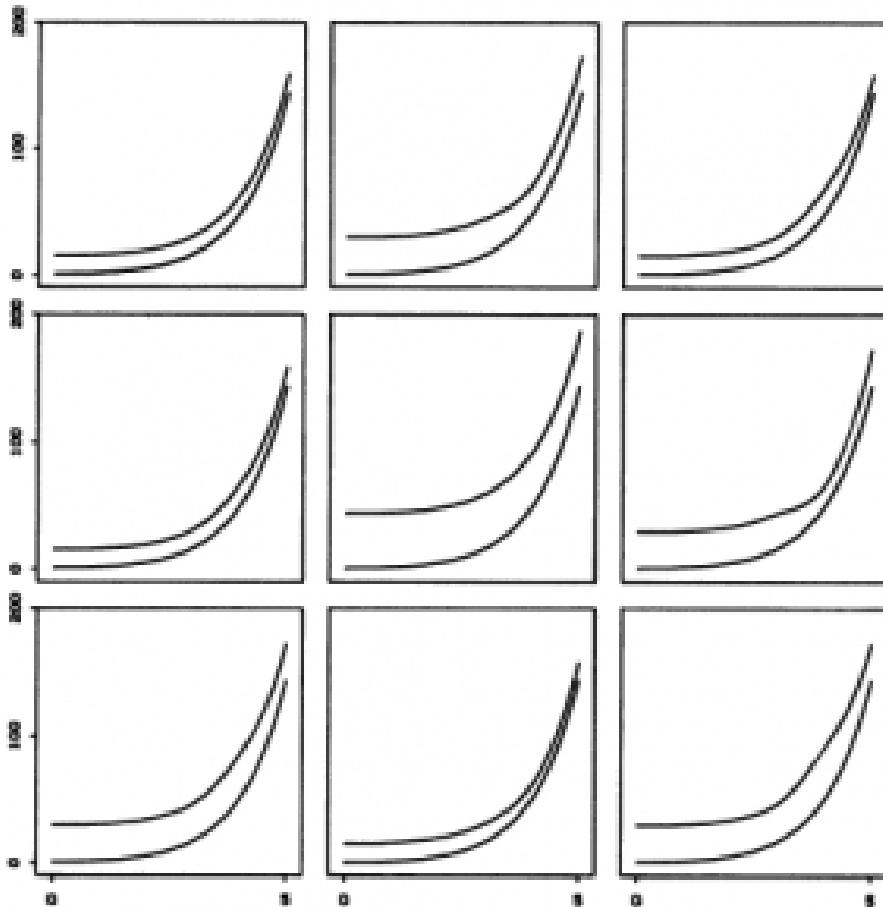


Figure 26. Curve-difference chart.

(Cleveland and McGill 1984)

Estimate the difference b/w these curves...

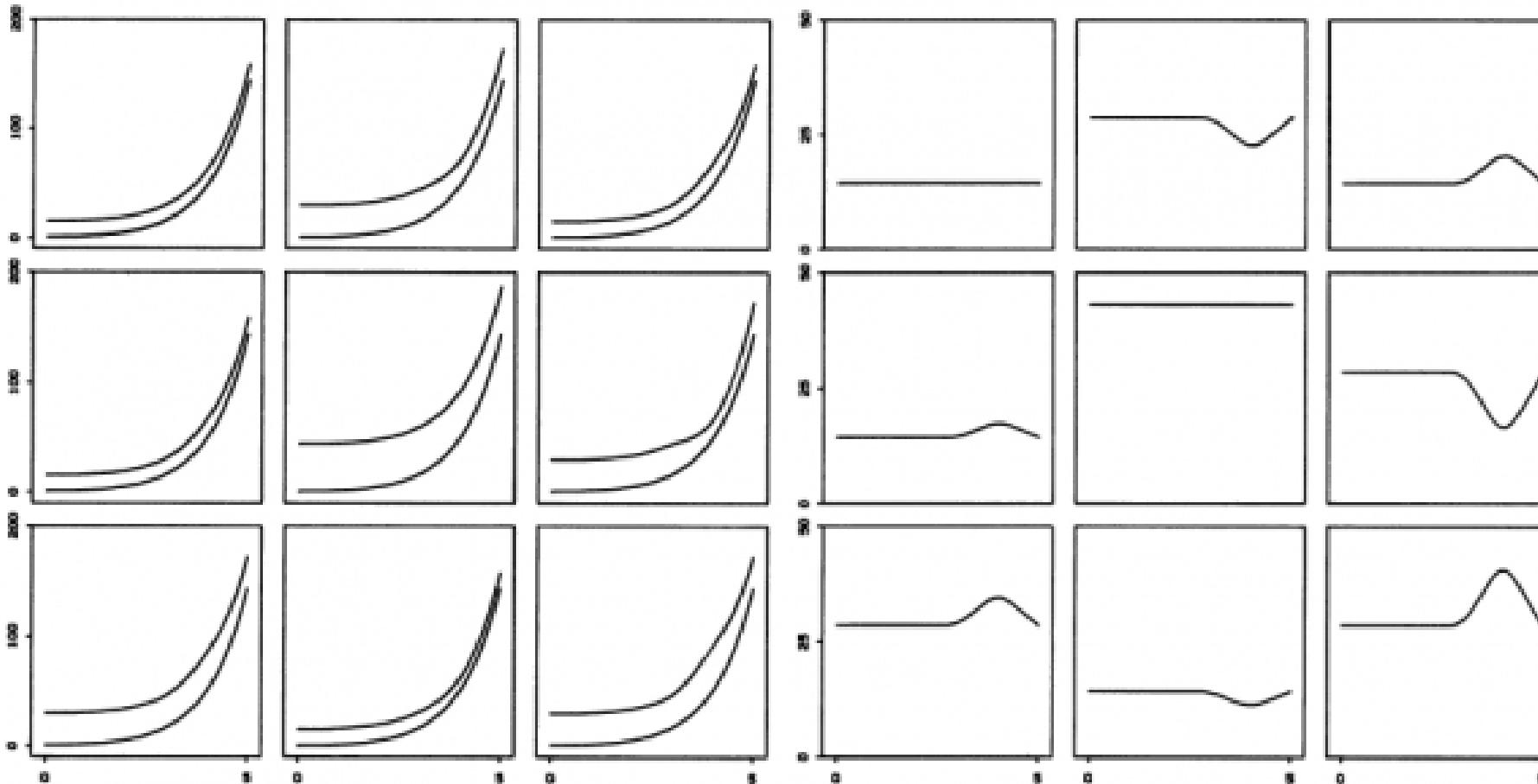


Figure 26. Curve-difference chart.

Figure 27. Curve differences.

(Cleveland and McGill 1984)

Layout algorithms help...

But really, no great solution
here without interaction

(and even then...)

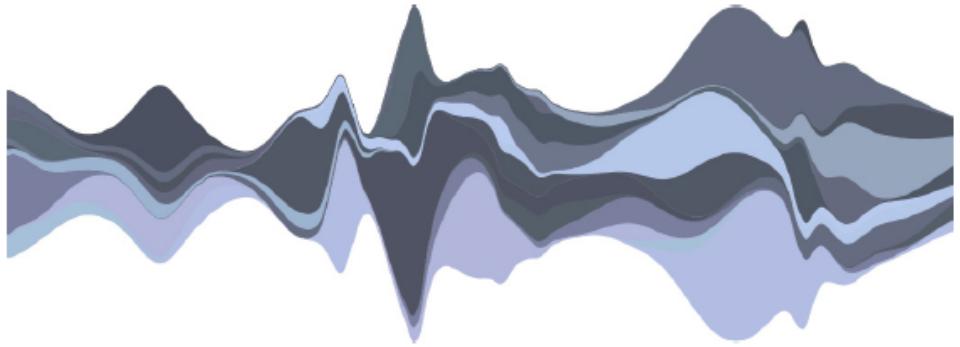


fig 6 – the same data set using the ThemeRiver layout algorithm

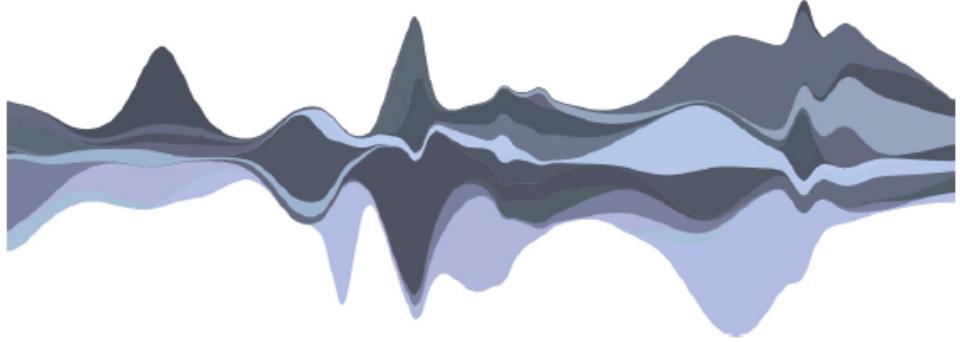


fig 7 – the same data set optimized to reduce the "wiggle" function, or overall variation in slope

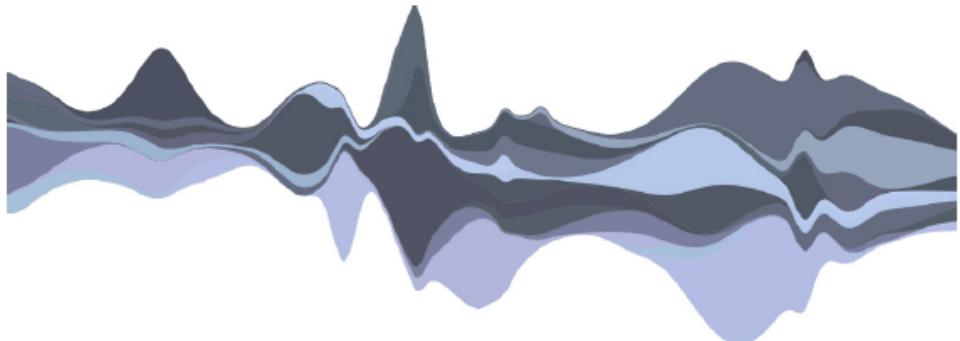
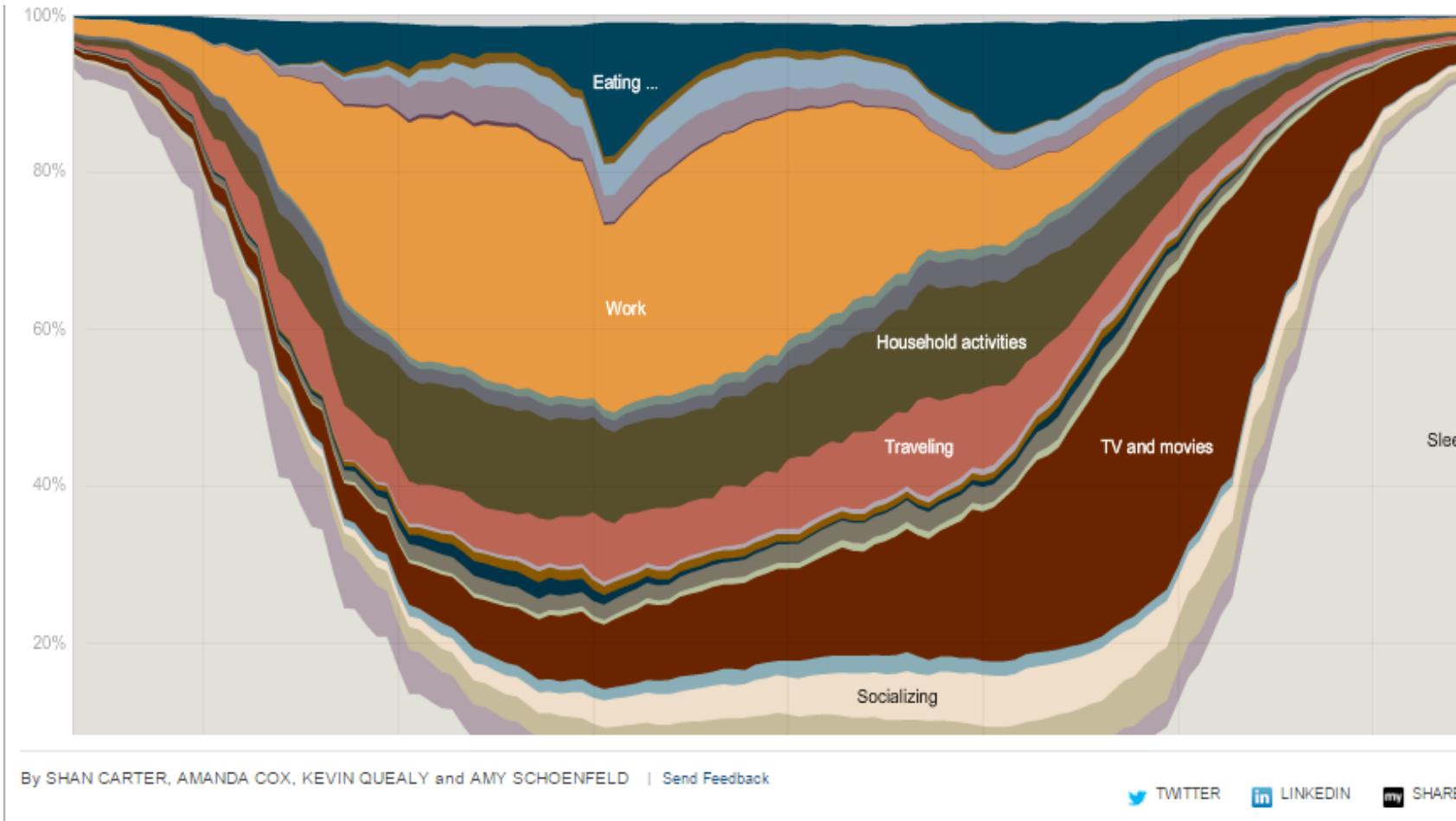


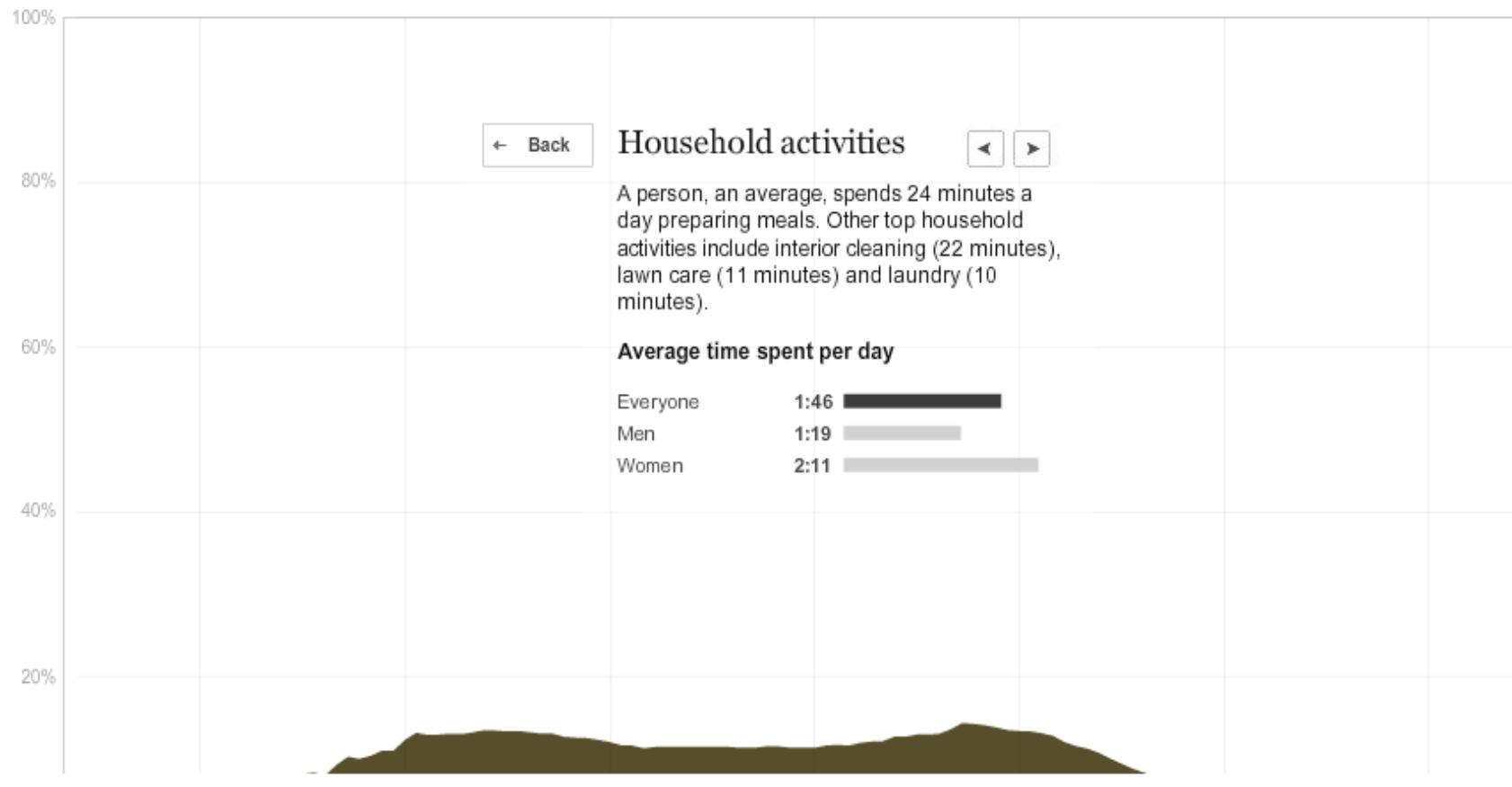
fig 8 – the same data set optimized to reduce the "weighted_wiggle," the algorithm used in Streamgraph

Dynamic baselines can also help...



<http://www.nytimes.com/interactive/2009/07/31/business/20080801-metrics-graphic.html>

Dynamic baselines can also help...



<http://www.nytimes.com/interactive/2009/07/31/business/20080801-metrics-graphic.html>

Many time series...

Many time series...

What comparisons / tasks
are well-supported here?

Alternatives?

(Percent change in food prices since 1990)

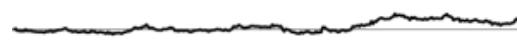
Flour, white, all purpose, per lb.



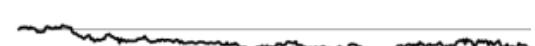
Spaghetti and macaroni, per lb.



Bread, white, pan, per lb.



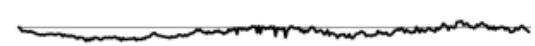
Cookies, chocolate chip, per lb.



Eggs, grade A, large, per doz.



Ice cream, prepackaged, bulk, regular, per 1/2 gal.



Bananas, per lb.



Lemons, per lb.



Potatoes, white, per lb.



Orange juice, frozen concentrate, 12 oz. can, per 16 oz.



Sugar, white, all sizes, per lb.



Sugar, white, 33-80 oz. pkg, per lb.



Peanut butter, creamy, all sizes, per lb.



Potato chips, per 16 oz.



Ground chuck, 100% beef, per lb.



Chuck roast, USDA Choice, boneless, per lb.



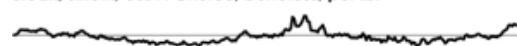
Round roast, USDA Choice, boneless, per lb.



Steak, round, USDA Choice, boneless, per lb.



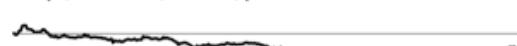
Steak, sirloin, USDA Choice, boneless, per lb.



Bacon, sliced, per lb.



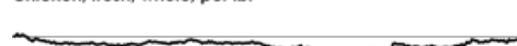
Chops, center cut, bone-in, per lb.



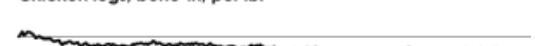
Bologna, all beef or mixed, per lb.



Chicken, fresh, whole, per lb.

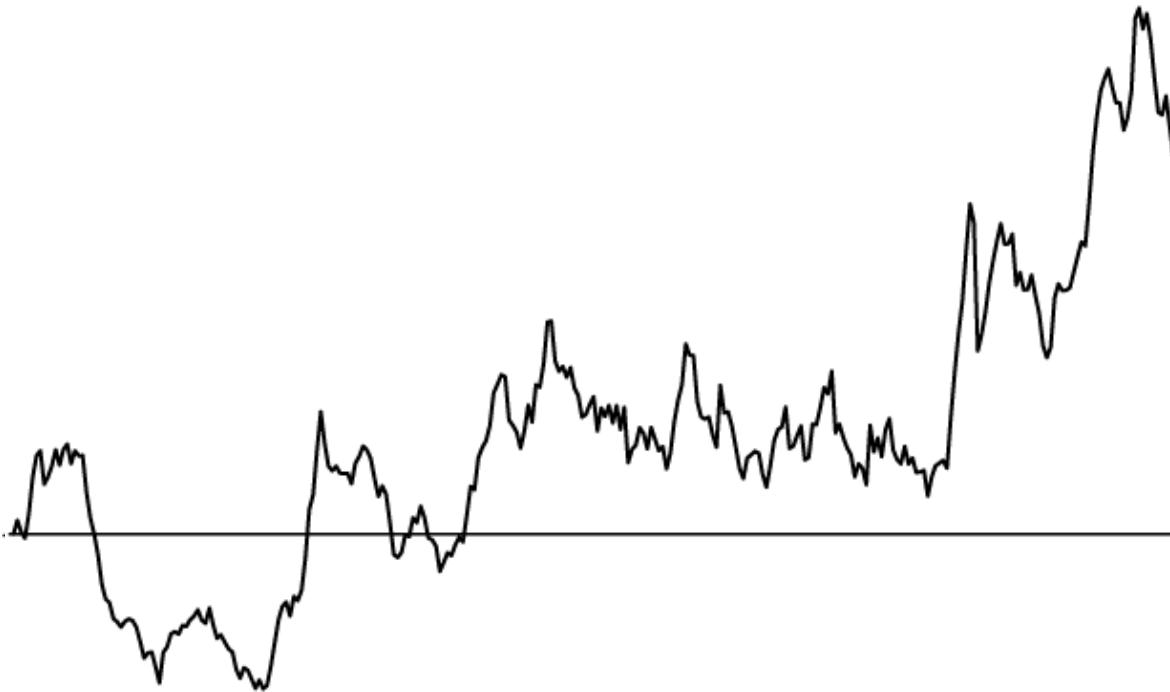


Chicken legs, bone-in, per lb.



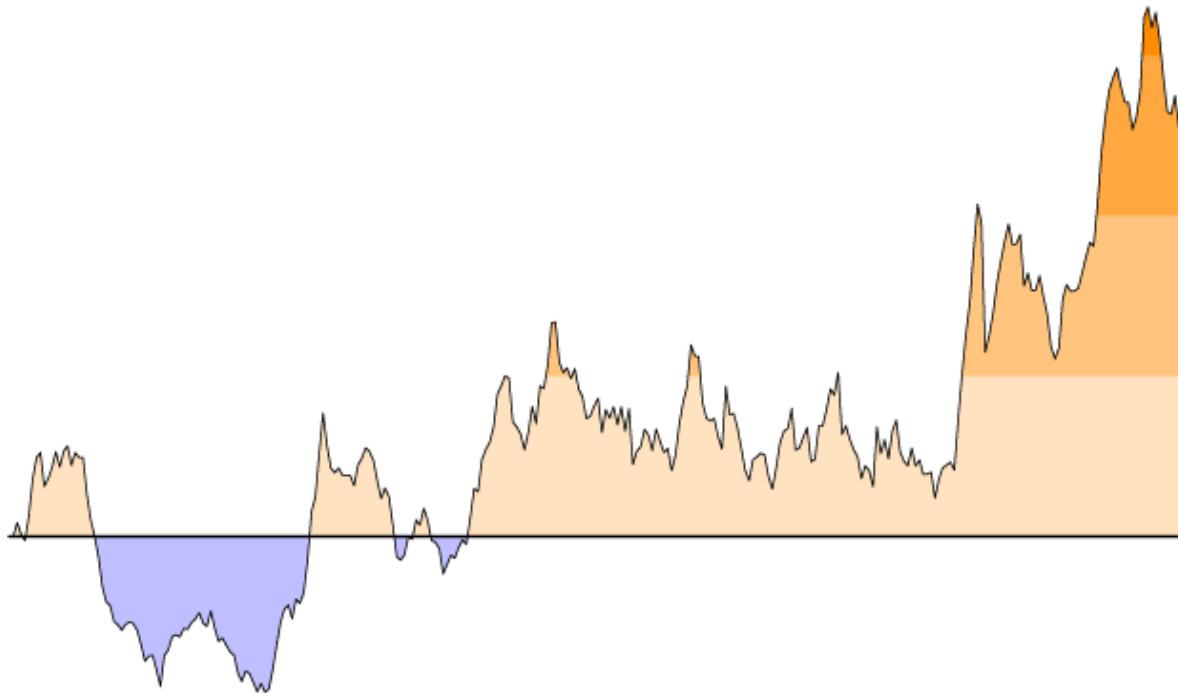
Horizon graphs: squishing a time series

<https://flowingdata.com/2015/07/02/changing-price-of-food-items-and-horizon-graphs/>



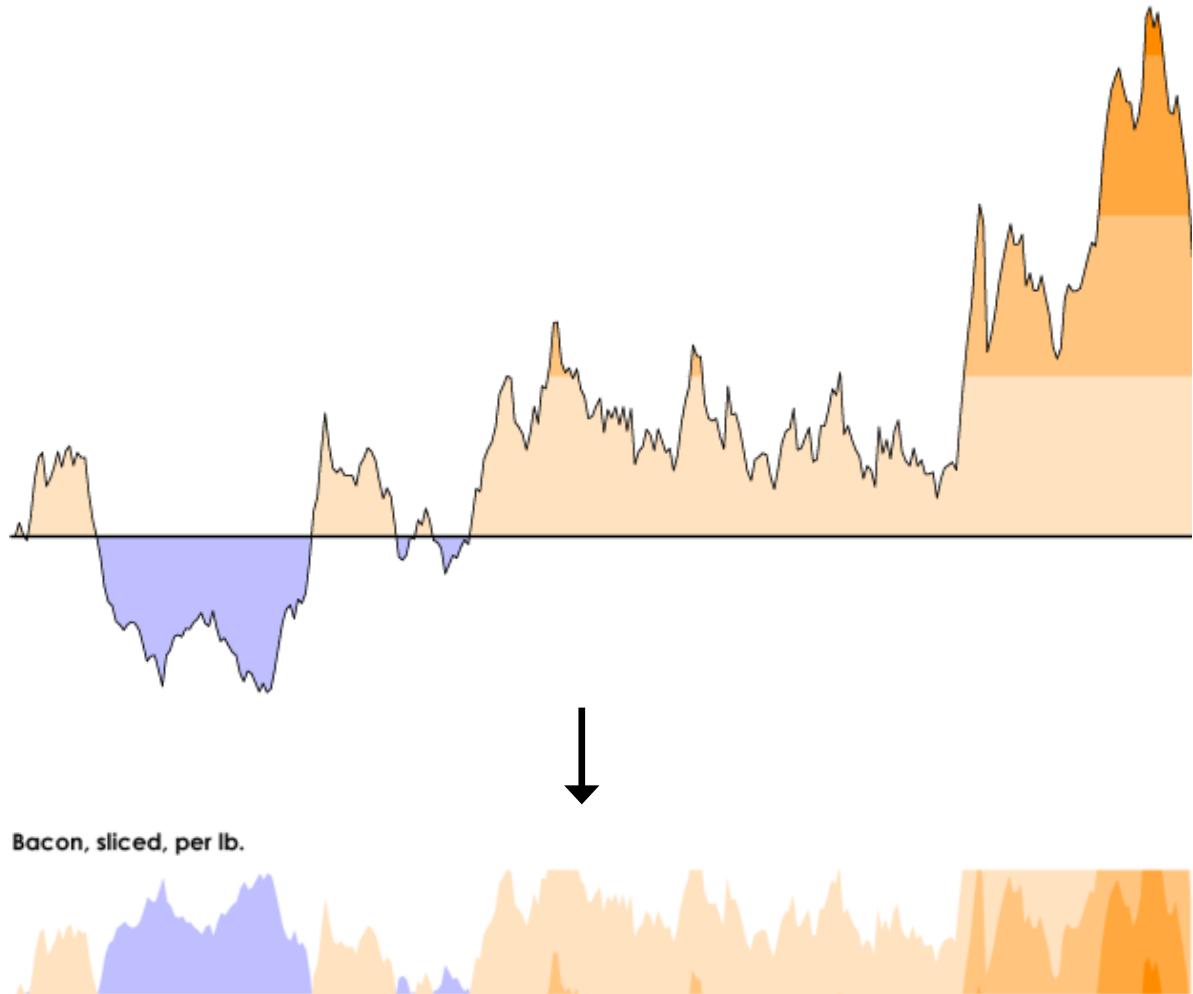
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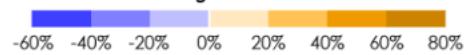


Horizon graphs: squishing a time series

<https://flowingdata.com/2015/07/02/changing-price-of-food-items-and-horizon-graphs/>



Price change since 1990



Flour, white, all purpose, per lb.

Jan. 1990 May 2015

Bread, white, pan, per lb.

Eggs, grade A, large, per doz.

Bananas, per lb.

Potatoes, white, per lb.

Sugar, white, all sizes, per lb.

Peanut butter, creamy, all sizes, per lb.

Ground chuck, 100% beef, per lb.

Round roast, USDA Choice, boneless, per lb.

Steak, sirloin, USDA Choice, boneless, per lb.

Chops, center cut, bone-in, per lb.

Chicken, fresh, whole, per lb.

Spaghetti and macaroni, per lb.

Cookies, chocolate chip, per lb.

Ice cream, prepackaged, bulk, regular, per 1/2 gal.

Lemons, per lb.

Orange juice, frozen concentrate, 12 oz. can, per 16 oz.

Sugar, white, 33-80 oz. pkg, per lb.

Potato chips, per 16 oz.

Chuck roast, USDA Choice, boneless, per lb.

Steak, round, USDA Choice, boneless, per lb.

Bacon, sliced, per lb.

Bologna, all beef or mixed, per lb.

Chicken legs, bone-in, per lb.

Flour, white, all purpose, per lb.

Bread, white, pan, per lb.

Eggs, grade A, large, per doz.

Bananas, per lb.

Potatoes, white, per lb.

Sugar, white, all sizes, per lb.

Peanut butter, creamy, all sizes, per lb.

Ground chuck, 100% beef, per lb.

Round roast, USDA Choice, boneless, per lb.

Steak, sirloin, USDA Choice, boneless, per lb.

Chops, center cut, bone-in, per lb.

Chicken, fresh, whole, per lb.

Spaghetti and macaroni, per lb.

Cookies, chocolate chip, per lb.

Ice cream, prepackaged, bulk, regular, per 1/2 gal.

Lemons, per lb.

Orange juice, frozen concentrate, 12 oz. can, per 16 oz.

Sugar, white, 33-80 oz. pkg, per lb.

Potato chips, per 16 oz.

Chuck roast, USDA Choice, boneless, per lb.

Steak, round, USDA Choice, boneless, per lb.

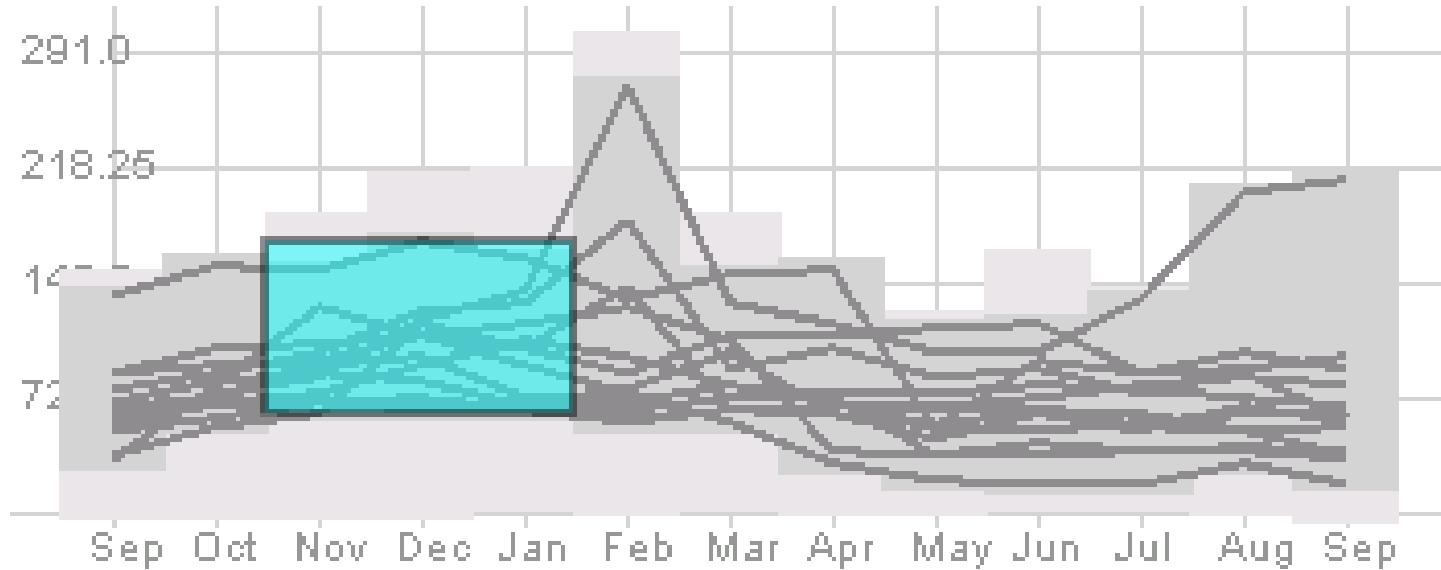
Bacon, sliced, per lb.

Bologna, all beef or mixed, per lb.

Chicken legs, bone-in, per lb.

Interactive exploration of multiple time series

TimeSearcher



<https://www.youtube.com/watch?v=VWx1TMcrb74>

No free lunch!

It **always** comes back to what your tasks are

Helpful to know alternatives, strengths and weaknesses

No one solution to everything!

Given my **data and abstract tasks**...

...are my encodings **expressive?**
effective? **perceptually justified?**

domain tasks

abstract tasks

encodings/
interaction

algorithm/
implementation

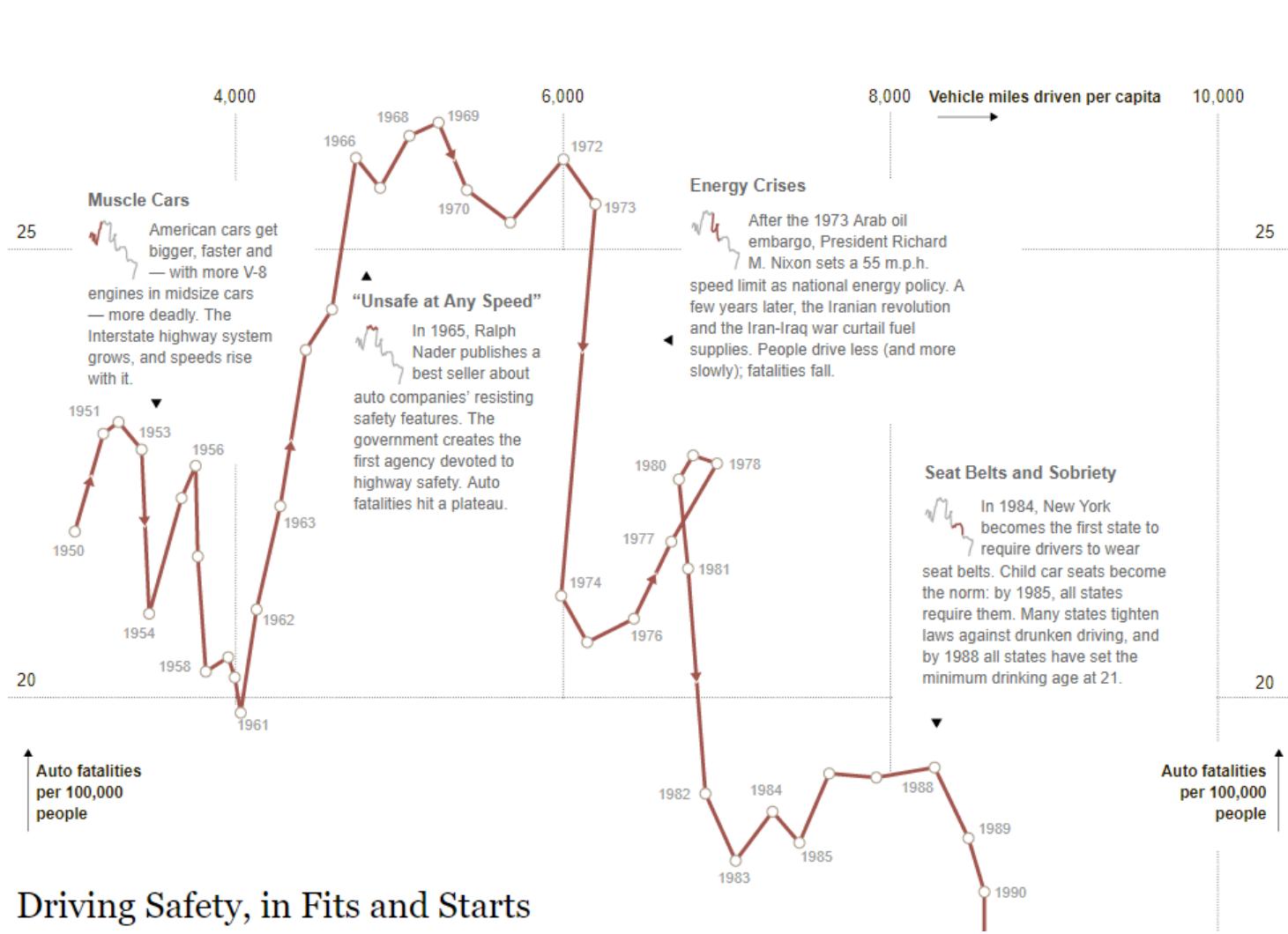


Temporal visualization

Time series variants, small multiples good place to start

Consider more complex encodings (horizon graphs, streamgraphs) or interaction if needed

It always comes back to tasks!



Driving Safety, in Fits and Starts

<http://tinyurl.com/y58qw2sc>