Explaining the Product Range Effect in Purchase Data

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Outline

- the purchase behavior - issues in data analysis
- new measures to represent the personal utility function
- introducing the range effect
- conclusions

What drives customer behavior?

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generic utility function (rationality)

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generic utility function (rationality)

personal utility function (diversity)

What about personal utility function?

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- how often and in which quantity do I need that good?

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- how often and in which quantity do I need that good?

- how much do I desire that good?
- how useful is that good for me?
- how "unique" is that good? (can I replace it with other goods satisfying the same need?)

What about personal utility function?

QUANTITY PURCHASED

SOPHISTICATION DEGREE

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What is sophistication?

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- neither the price

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- nor the functional feature of the product

What is sophistication?

- the sophistication of a good is strongly related to the need that the good satisfies

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- the sophistication of a good is strongly related to the need that the good satisfies

- to be considered "sophisticated" a product needs to satisfy two constraints:
  - it has to be sold to few customers
  - the customers buying it have to buy all products that are less sophisticated than it

Data

- largest italian retail distribution Company
- time window: 2007-01-01 / 2012-12-31
- 1,066,020 active and recognizable customers
- 138 stores over the whole Italy's west coast
- 345,208 different items
- 2 Billions purchases

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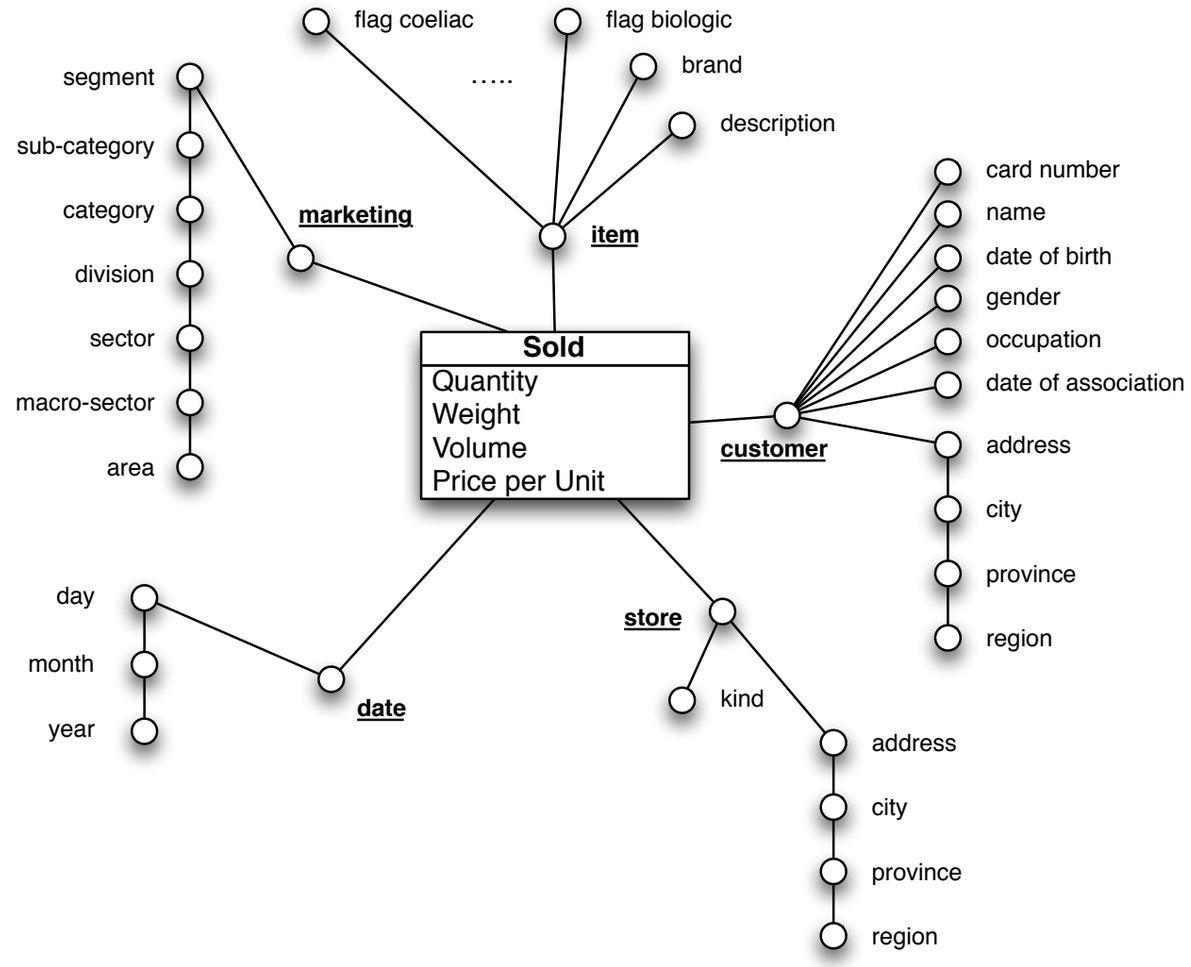

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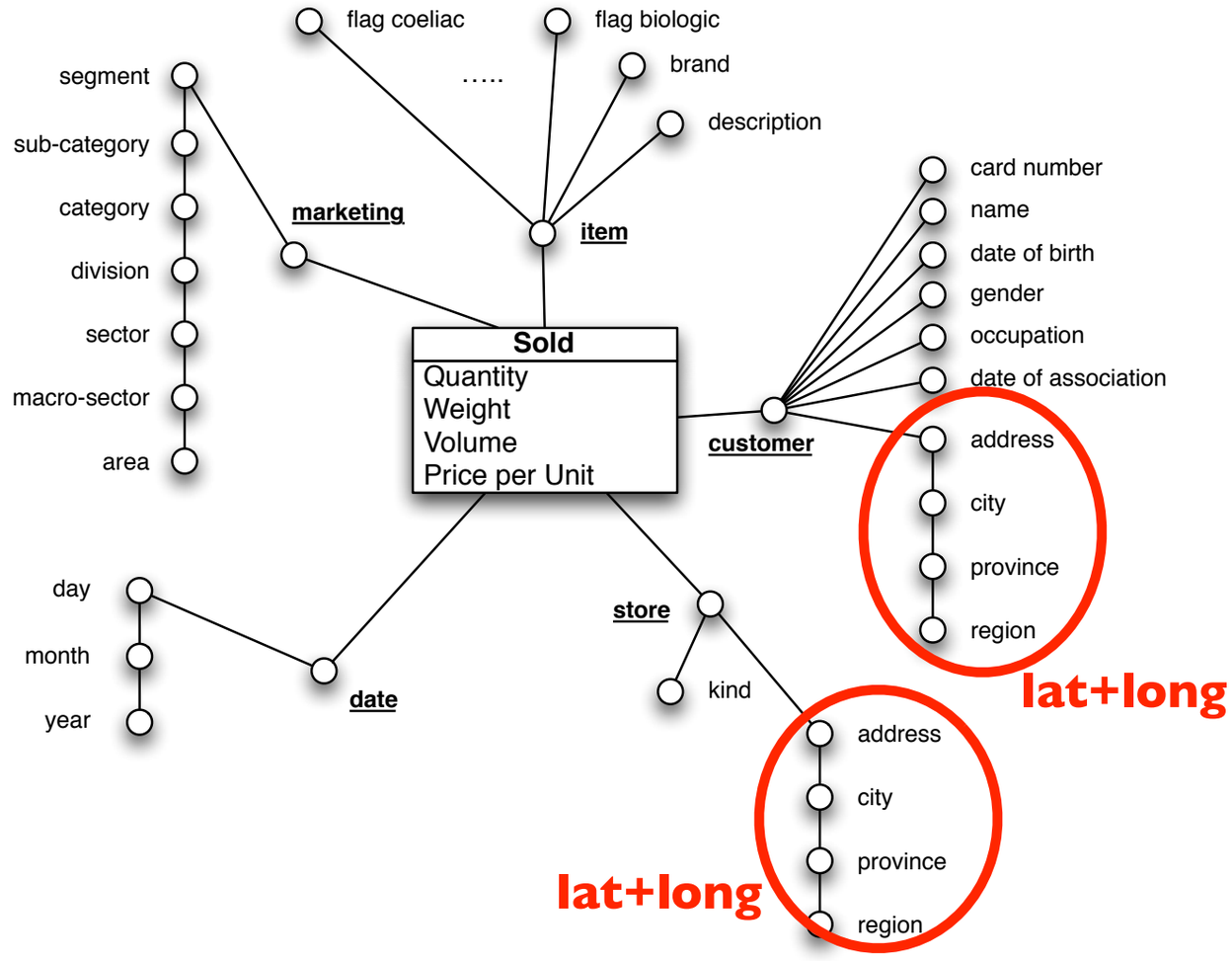

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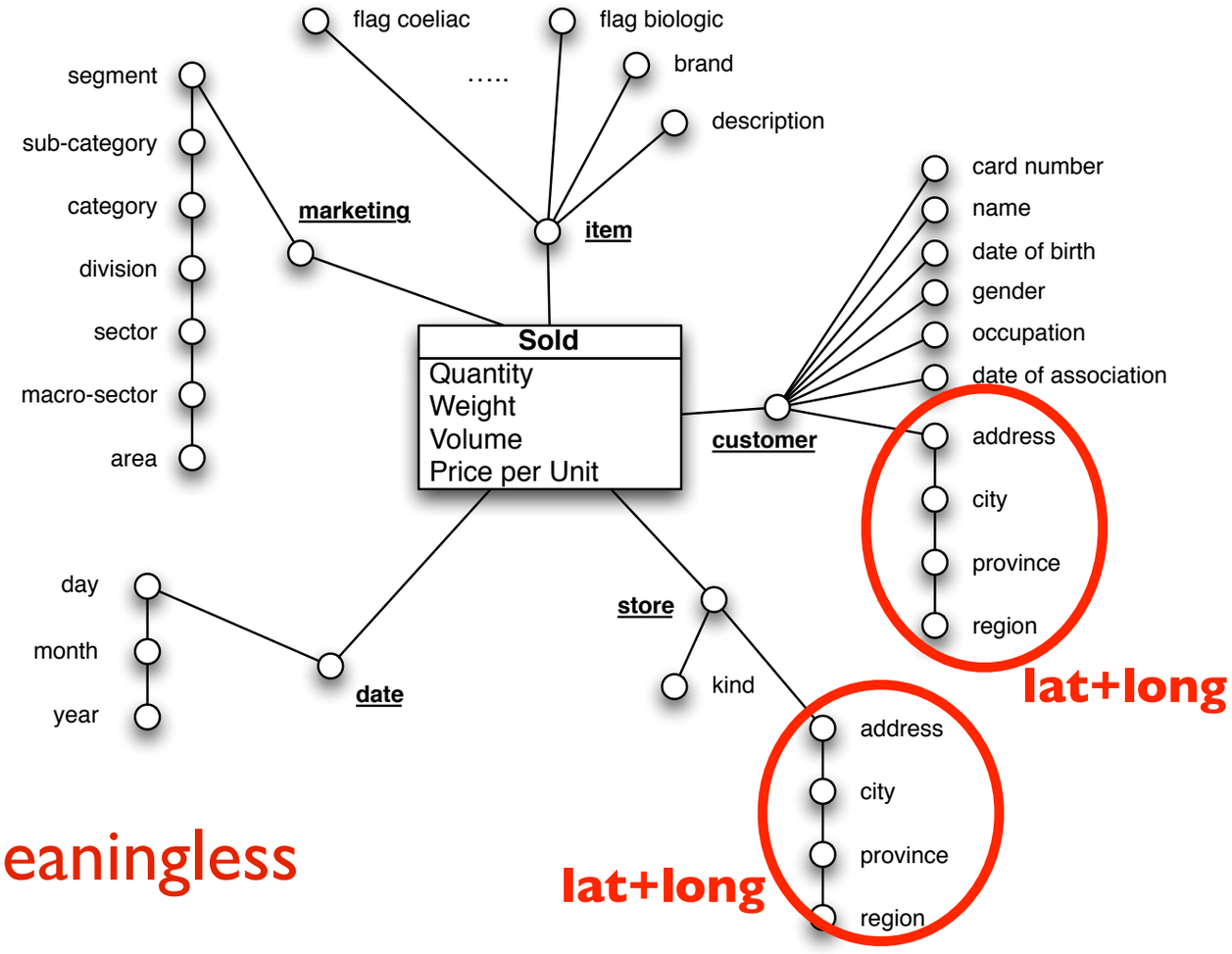
FILTER:

- one city (Leghorn)
- customers within 5km from a store
- segment, not item
- removed products too frequent and meaningless



Data

After the filter:

- 60,366 customers
- 4,567 segments
- 107,371,973 total purchases

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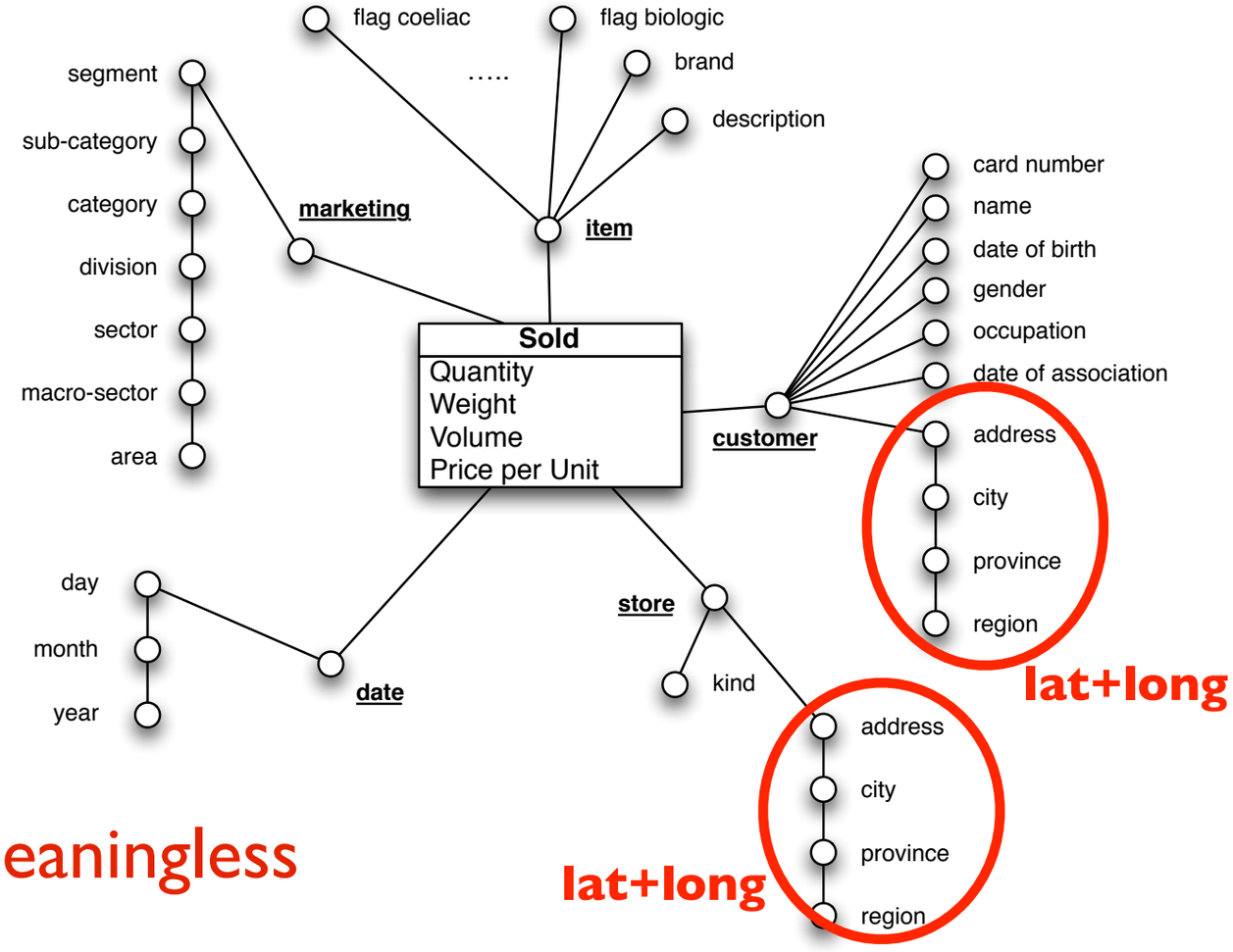

The data model

- Bipartite Network (customer-segment)
- not all purchases, just the ones *"meaningful" (lift)*
- *sort products and customers by quantities*

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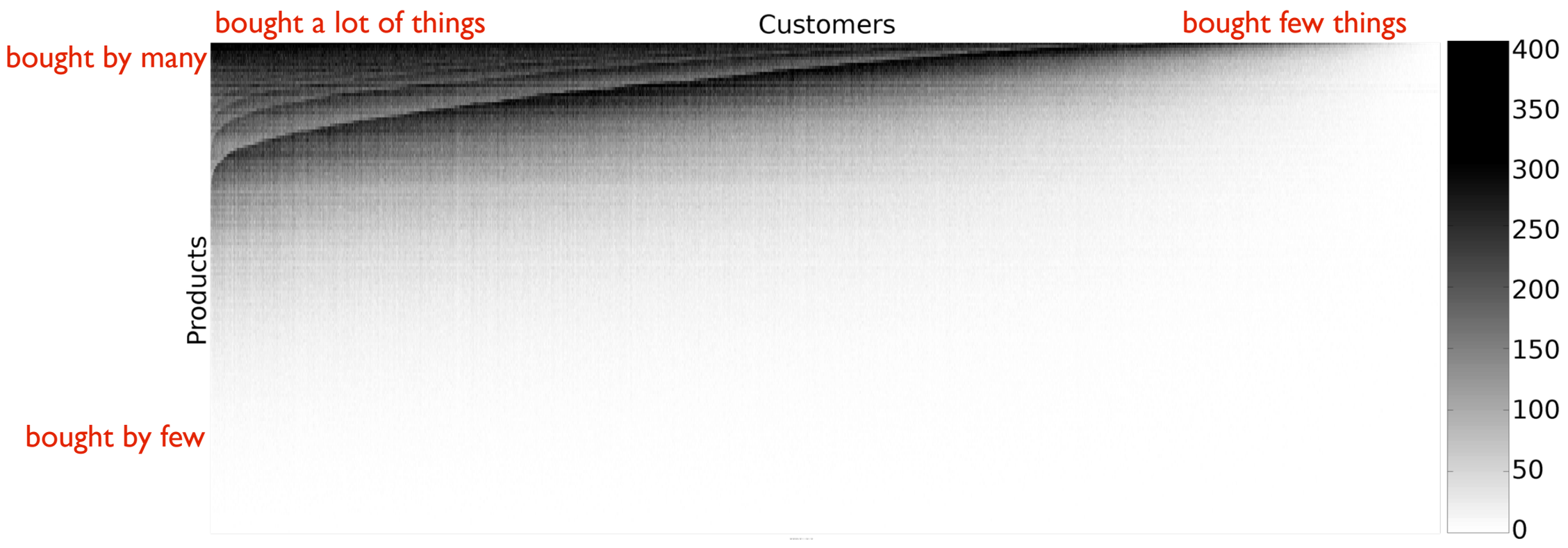


The product sophistication

- we calculate the sums of the purchase matrix for each product and customer
- we need to **correct these sums recursively**: we need to calculate the avg level of sophistication of the **customers**' needs by looking at the avg sophistication of the **products** that they buy, and then use it to **update** the avg sophistication of these products
- so, we take the eigenvector associated with the second largest eigenvalue (that is associated with the variance in the system) [HITS variation]

The product sophistication

less sophisticated

p_i	PS
Regular Bread	0.252
Red Meat	0.266
Artichokes	0.275
Pasta	0.275
Rabbit Meat	0.278

more sophisticated

p_i	PS
Winter Suit 3-12yo	0.796
TV 29”	0.769
DVD Readers	0.754
Hair Spray	0.742
8mm Cameras	0.739

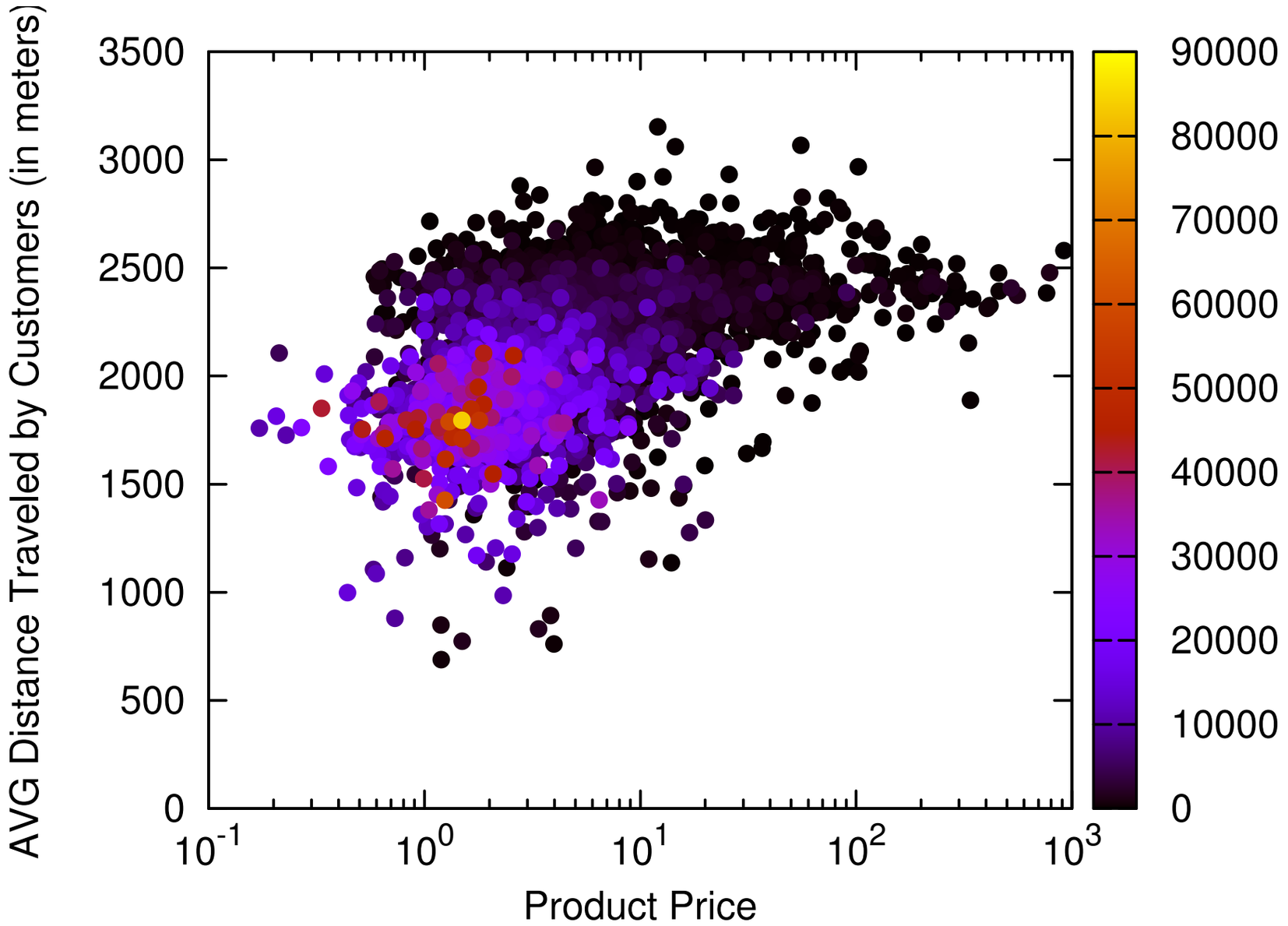
...and what about distance to travel?

- Intuitively...
  - higher prices mean longer distances to travel
  - higher quantities mean shorter distances to travel
  - higher sophistication means longer distances to travel

distance VS prices

- each dot is a purchase representative
- if a customer bought products of the same price in different shops, than the distance is weighted with the price

$$d(c_i, p_j) = \sum_{\forall s \in S} \frac{p_j(c_i, s) \times d(c_i, s)}{p_j(c_i, *)}$$



log-normal regression f(x) = a log x + b $R^2 = 17.25\%$

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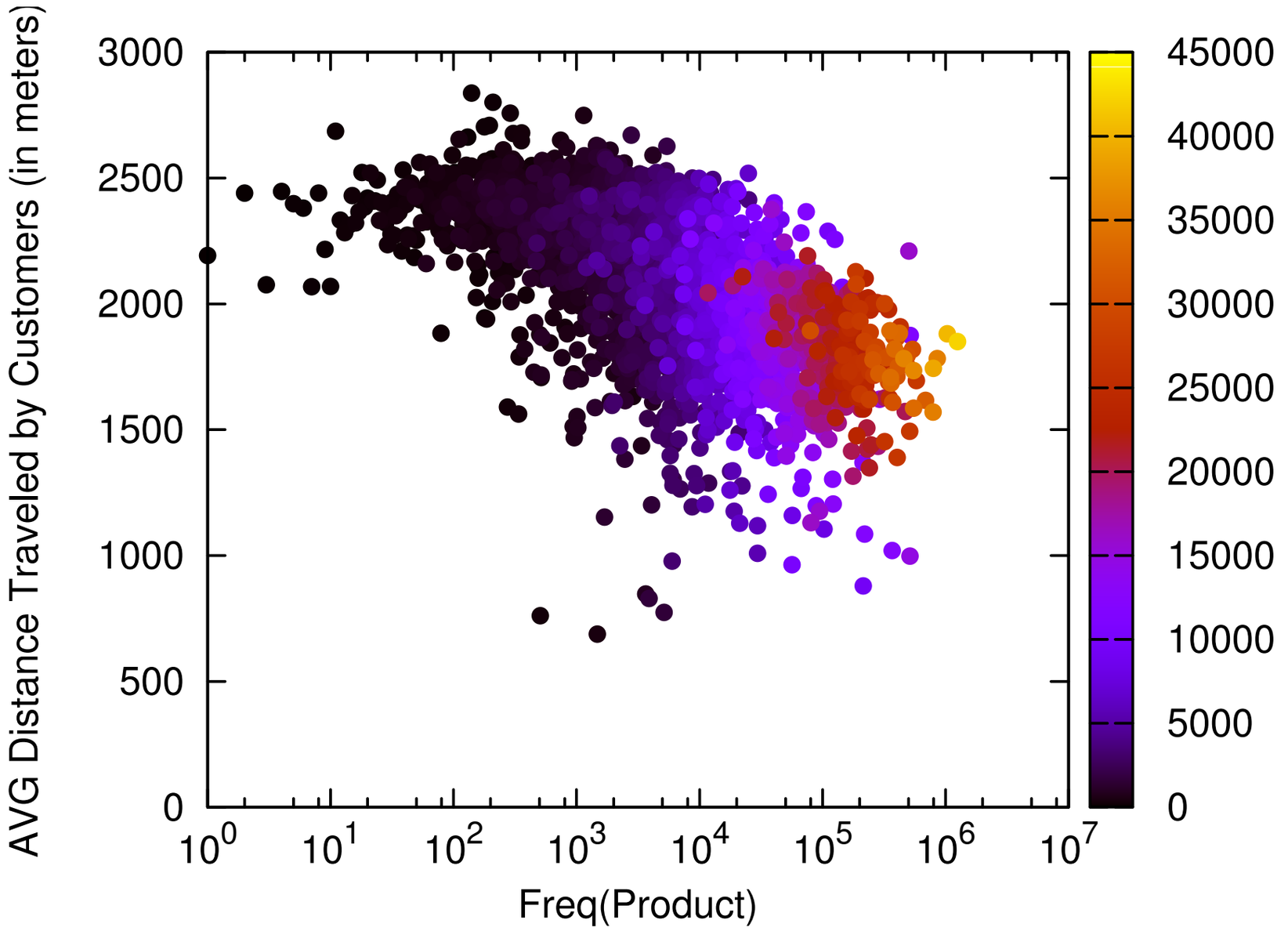
distance VS "popularity"

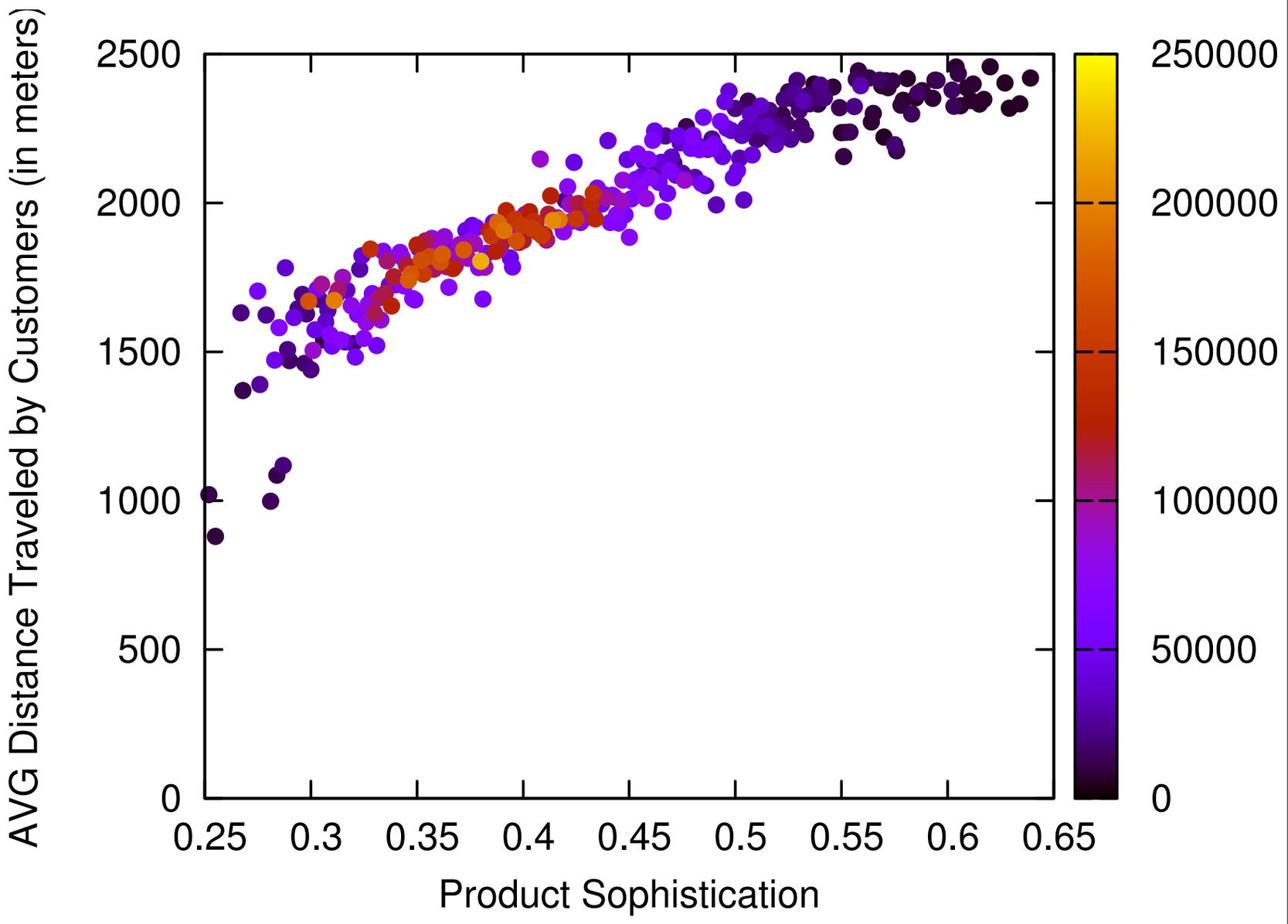
- each dot is a purchase representative
- if a customer bought products of the same frequency in different shops, than the distance is weighted with the frequency



log-normal regression $f(x) = a \log x + b$ $R^2 = 32.38\%$

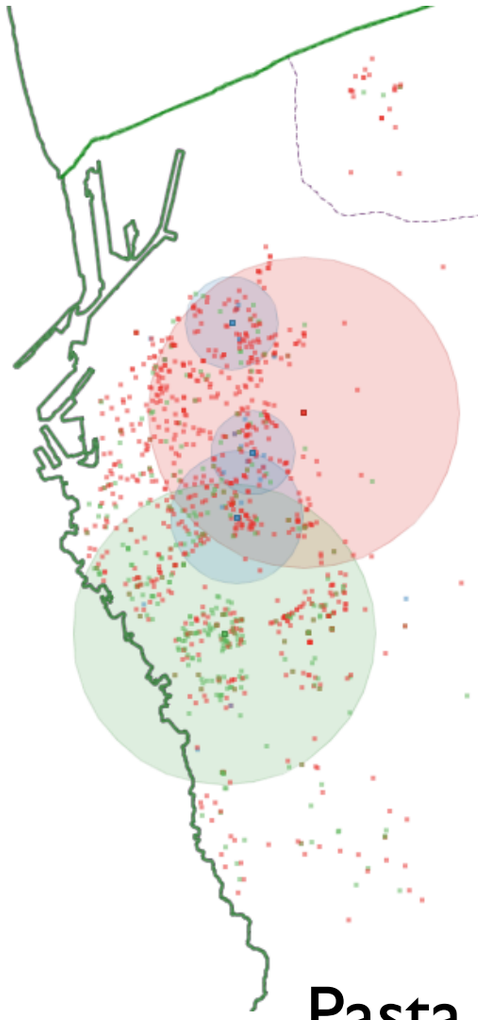
distance VS sophistication

- each dot is a purchase representative
- if a customer bought products of the same sophistication in different shops, than the distance is weighted with the sophistication

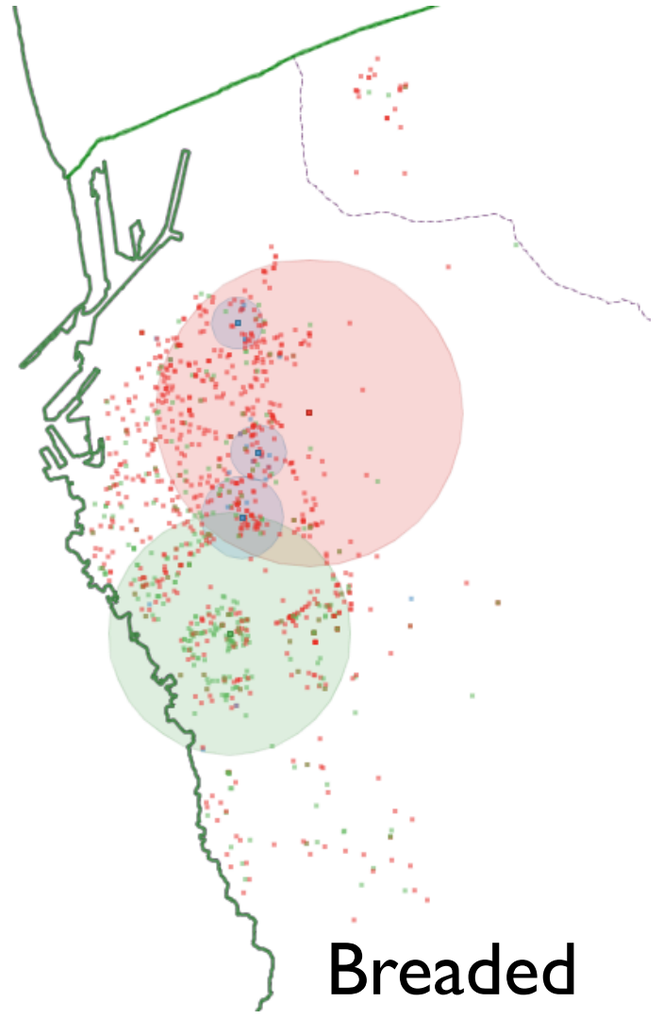


log-normal regression $f(x) = a \log x + b$ $R^2 = 85.72\%$

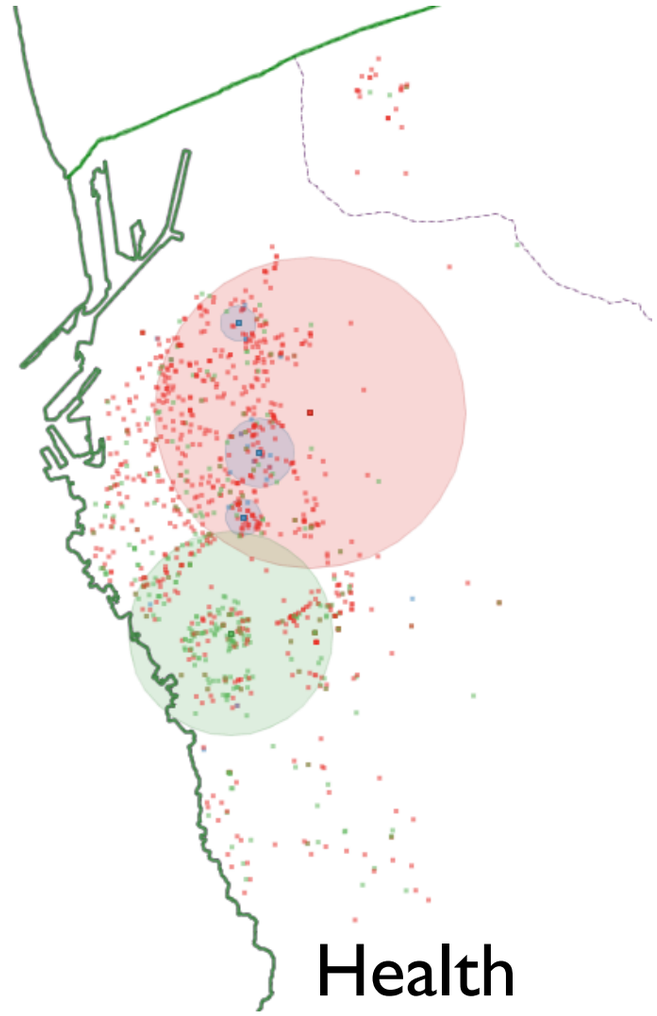
the power of shops



Pasta



Breaded
Frozen Fish



Health
Testers

- Iper
- Super
- Gestin

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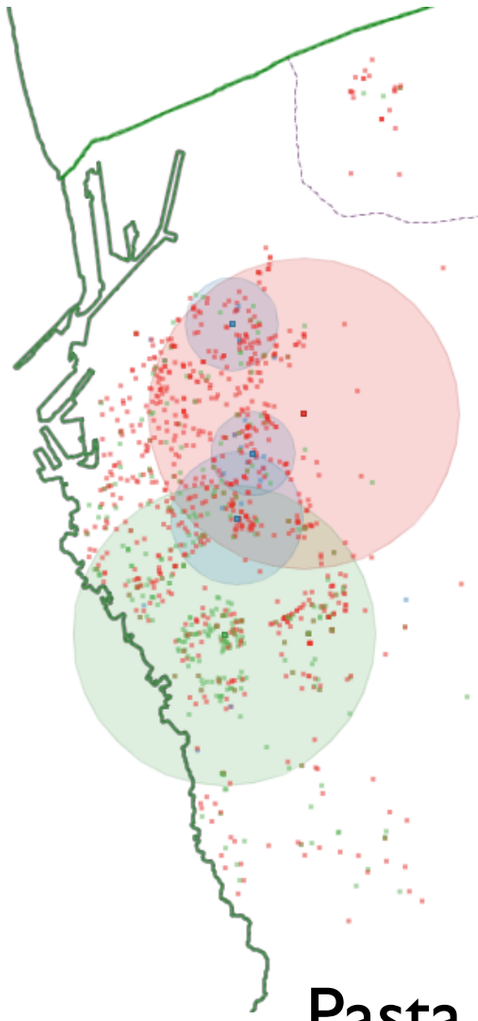

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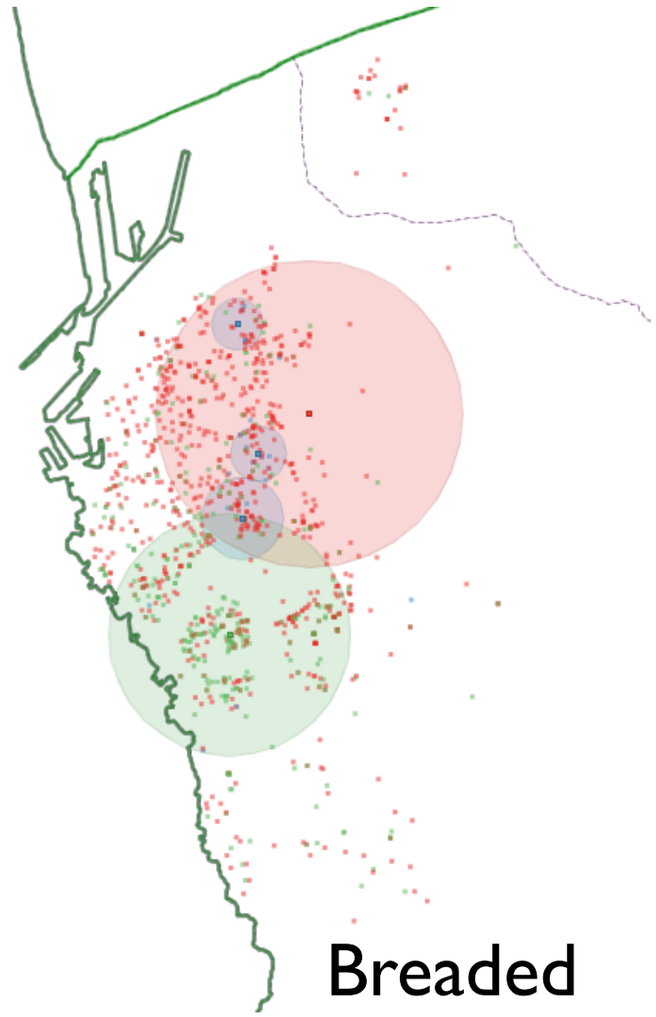

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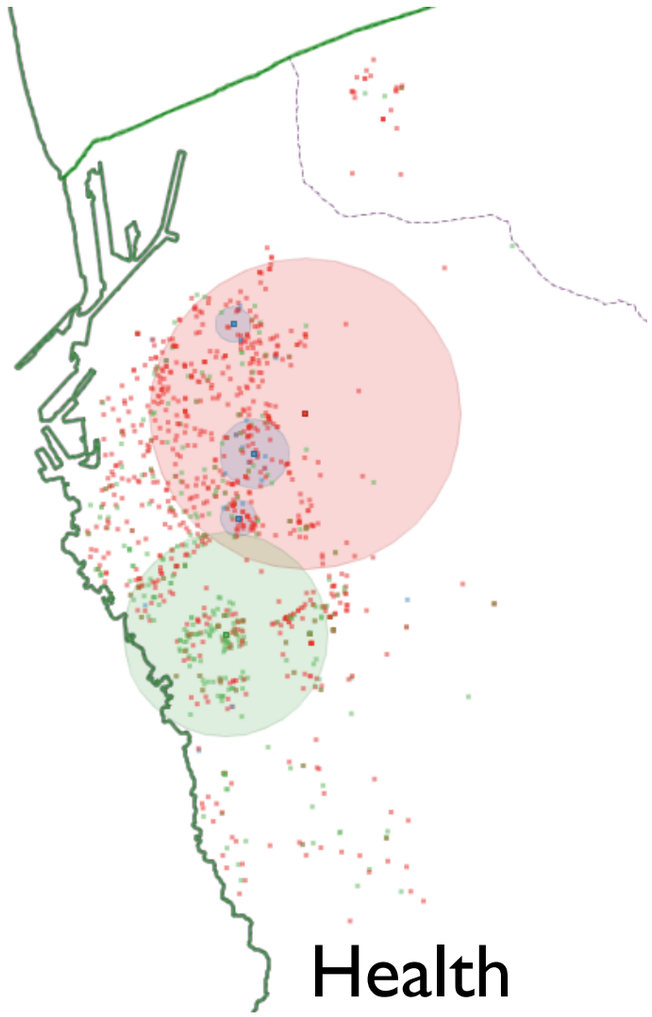

Health
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Shop Type	AVG PS	AVG Distance
Iper	0.49	2,392
Super	0.46	1,721
Gestin	0.43	869

Conclusions and Future Work

- introduced the concept of "range effect"
- shown the interplay with prices (low), popularity (medium) and sophistication (high)
- ...and if we use the distance as proxy for desire

- distance "as the crow flies" vs viability
- what about classification?
- ...and more complex measures?

Thank you for your attention!

Questions?

The product sophistication

- this formulation is very sensitive to noise (products bought by a very narrow set of customers)
  - Three-step strategy:
    - calculate eigenvectos of a restricted number of popular products
    - we use the estimate of the sophistication of these products to estimate the sophistication of all customers
    - we use the estimated sophistication of customers to have the final sophistication of the entire set of products
- at the end, we normalize $$PS(p) = \frac{\vec{K}(p) - \min(\vec{K})}{\max(\vec{K}) - \min(\vec{K})}$$