APPLICATION OF THE "ECOMETRICS" APPROACH TO VALIDATE NEIGHBORHOOD-LEVEL MEASURES OF WALKABILITY

The "Problem"

Need for New Measures ⟷ **Unique Aspects of Environmental Measures**

Ecometrics: The Science Of Assessing Ecological Settings

Context of the Investigation: The Montreal MARCHE Project

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Goal of the Presentation

- … to examine the validity and reliability of an environmental measure of neighborhood walkability through application of the novel *ecometrics* approach …

Need for New Measures of Environmental Features

Why Not Adopt Classic Psychometric Approaches ?

Sources of Data for Development of New Environmental Measures

- Surveys of Users of Settings
  - park users
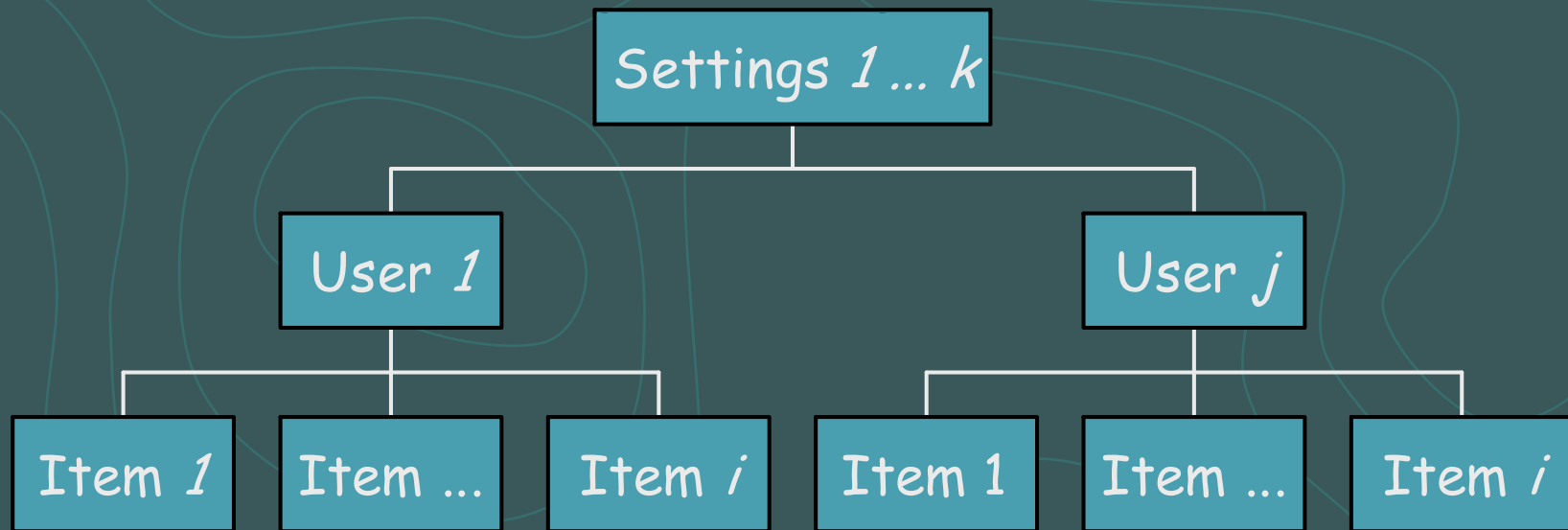 - neighborhood residents
  - ...

- Direct Observation of Settings
  - environmental audits
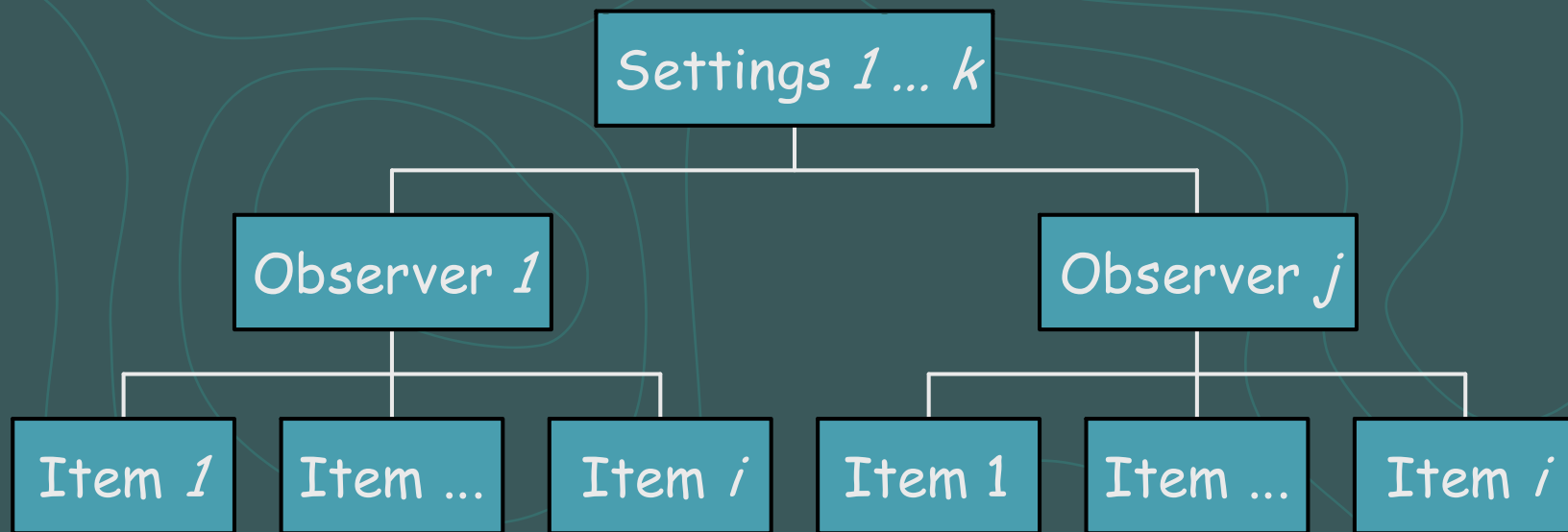 - systematic social observation
  - ...

Unique Data Structures ...

Surveys of Users of Settings

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                  ┌─────────────────┐
                  │  Settings 1 ... k │
                  └─────────────────┘
            ┌───────────┴───────────┐
     ┌──────────┐              ┌──────────┐
     │  User 1  │              │  User j  │
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   ┌─────┼─────┐             ┌─────┼─────┐
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│Item 1││Item..││Item i│  │Item 1││Item..││Item i│
└──────┘└──────┘└──────┘  └──────┘└──────┘└──────┘
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Direct Observation of Settings

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      │  Observer 1  │          │  Observer j  │
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So, what's the problem?

Potential Pitfall

- "… focus strictly on the <u>psychometric properties</u> of ecological measures …"

  (p. 3, Raudenbush & Sampson, 1999, <u>Sociological Methodology, 29</u>, 1-41)

- and ignore other features that are <u>unique</u> to data bases pertaining to environmental measures.
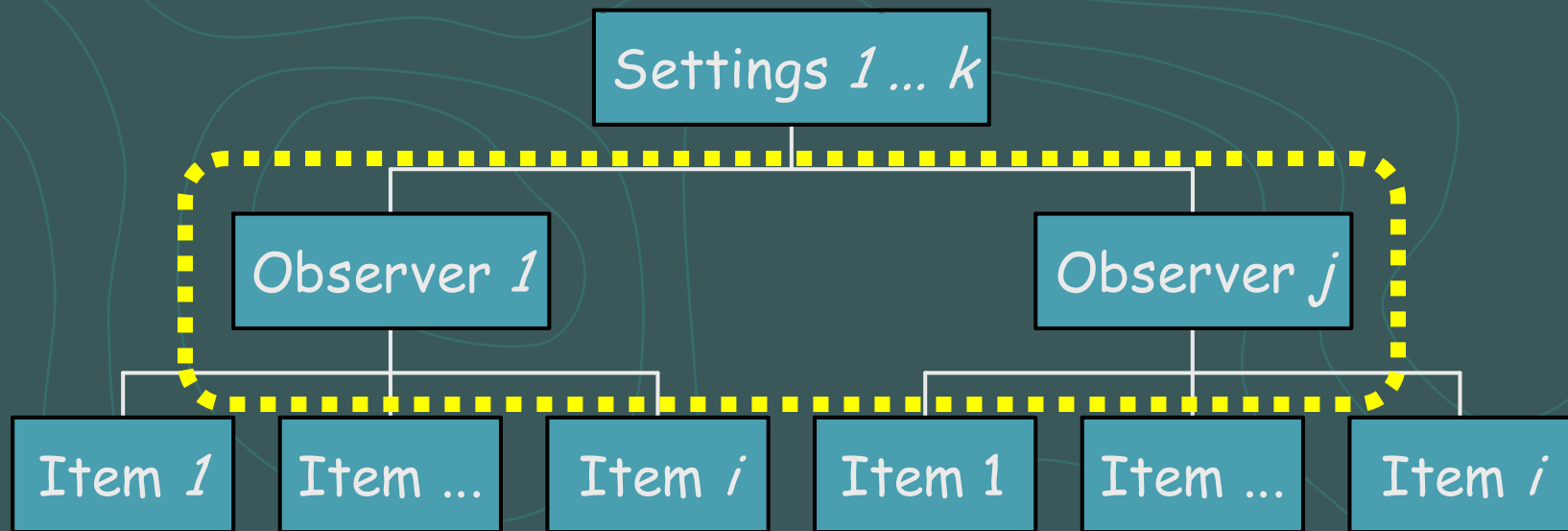
… aggregation is predicated on the notion that items are equally useful in distinguishing settings on a given trait …
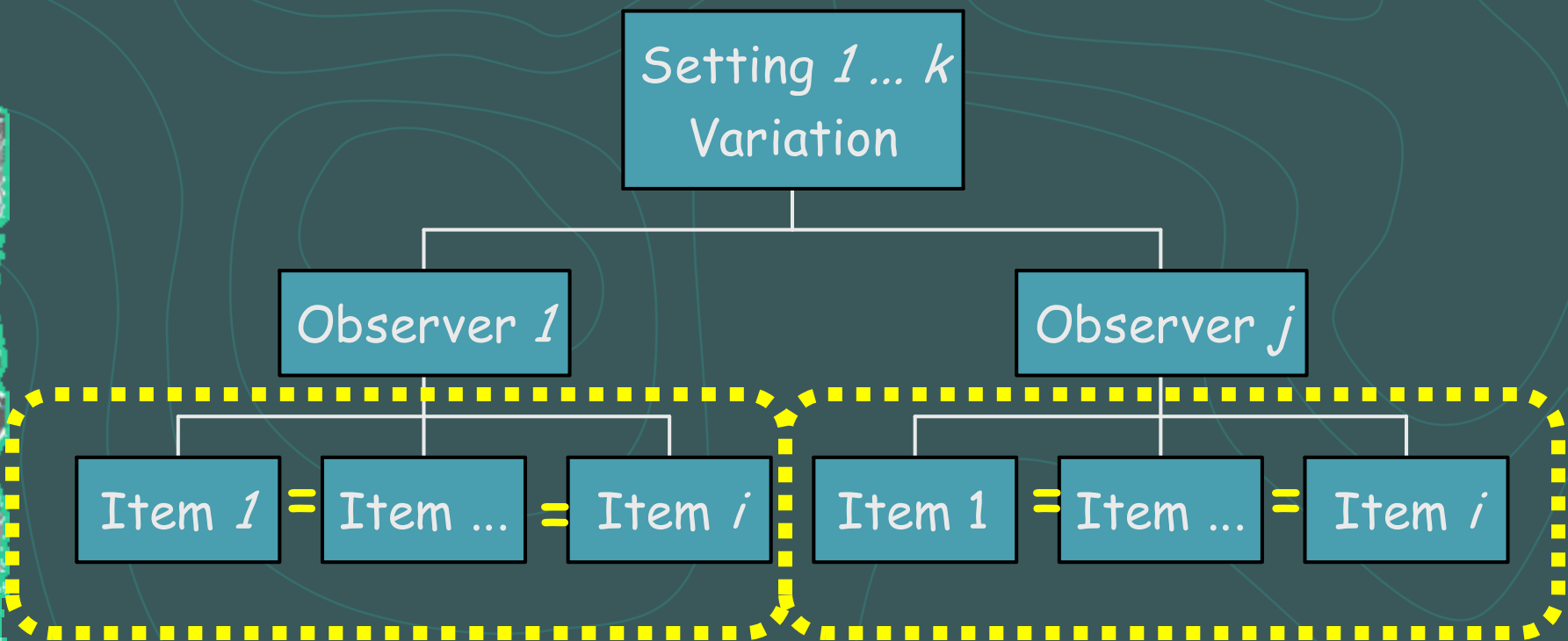
... aggregation is predicated on the notion that users in different settings share similar characteristics ...
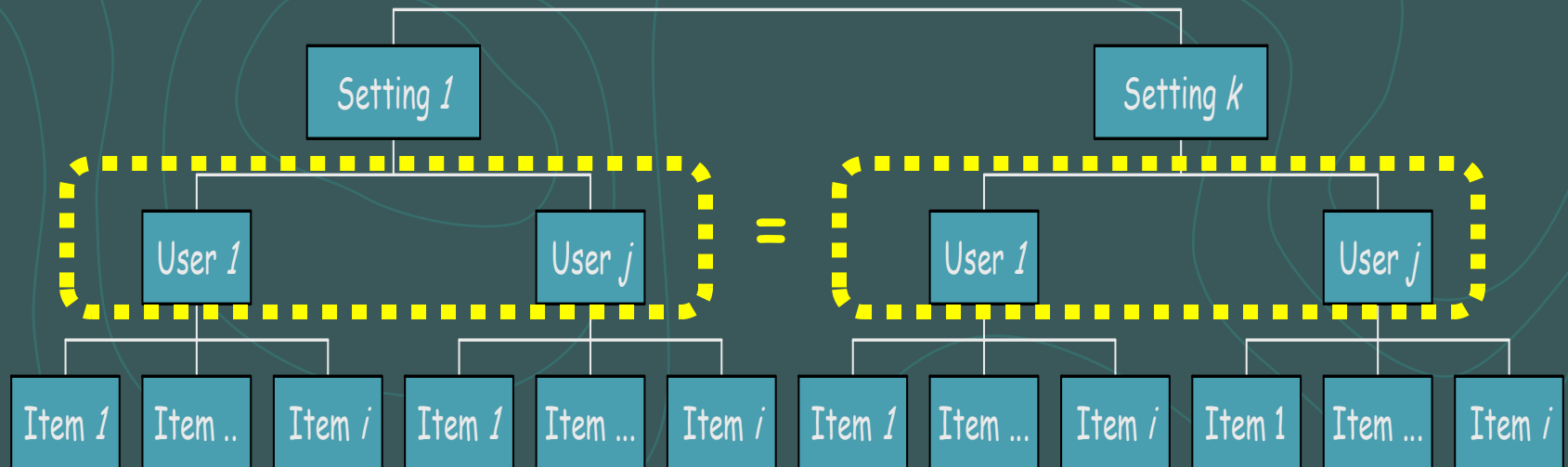
… aggregation is predicated upon inter-observer agreement …

If these premises are violated, then resulting aggregate measures may be replete with error.

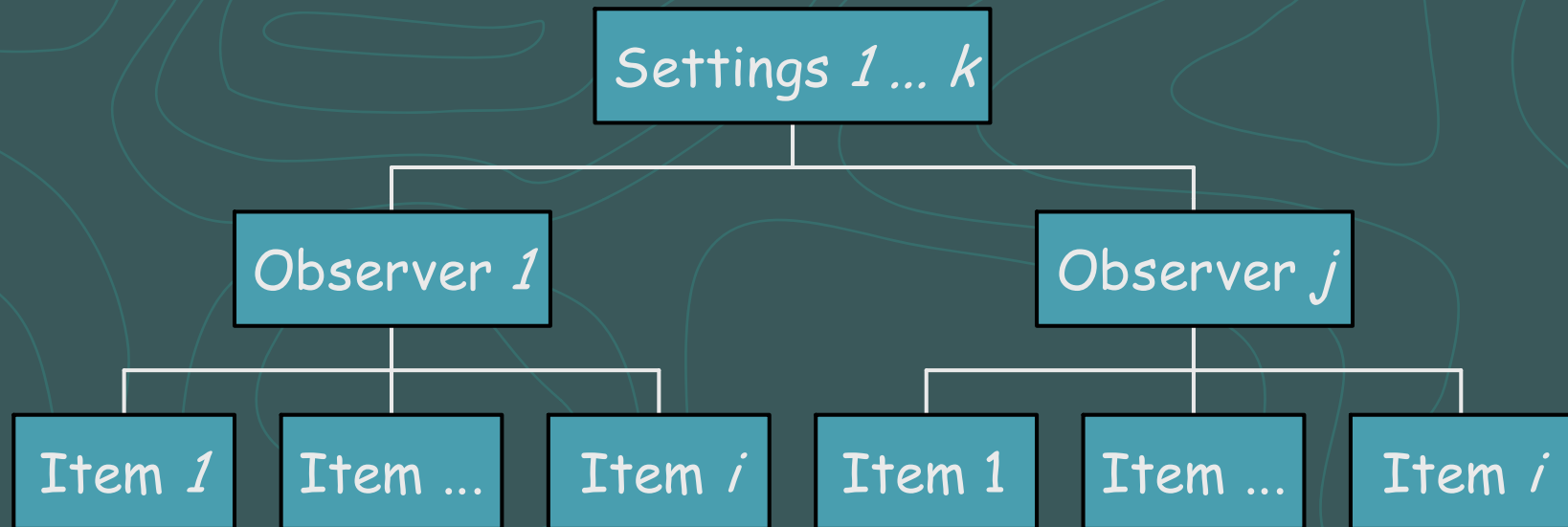# Need for an Integrated Solution for Validating Measures of the Environment
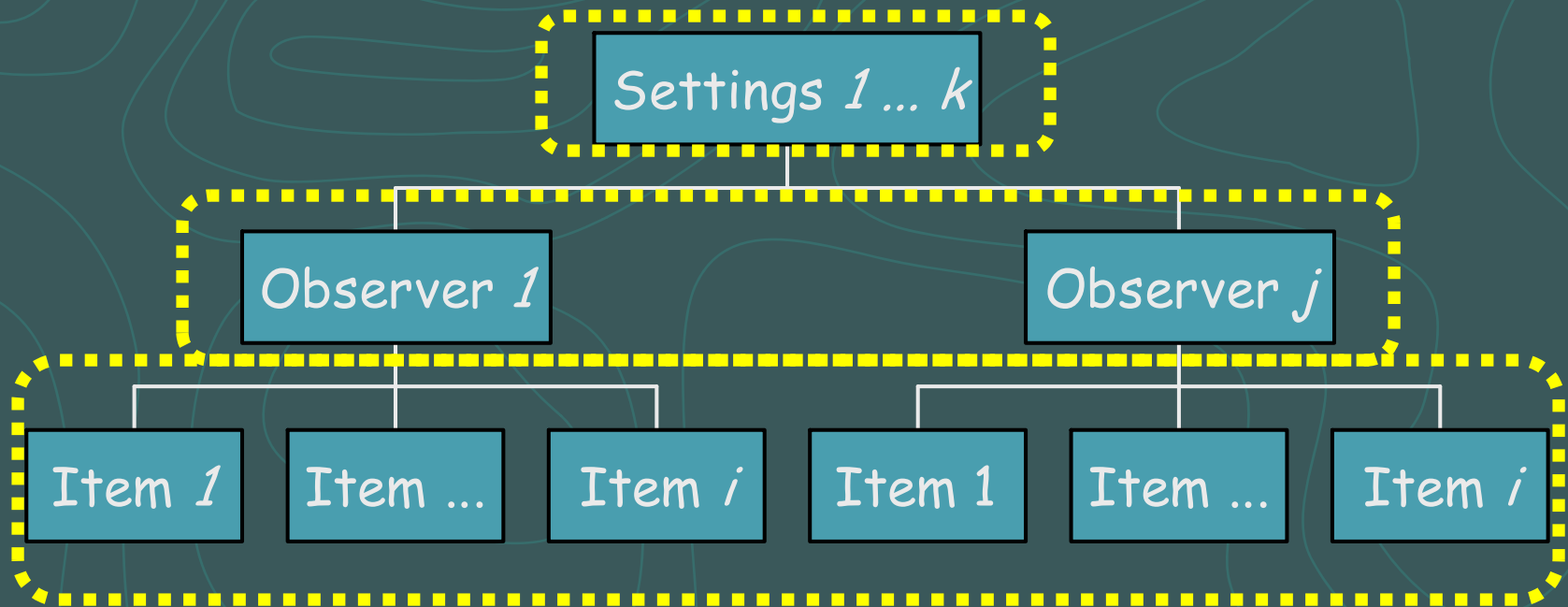
Ecometrics

Ecometrics

- … refers to the scientific assessment of settings or environments through systematic social observation (and/or survey questions) and analysis of resulting data through multilevel modeling procedures which build on item-response theory and generalizability theory …

- Raudenbush, S. W. & Sampson,R. J. (1999). Ecometrics: Towards a Science of Assessing Ecological Settings, … . Sociological Methodology, 29, 1-41.

- Raudenbush, S. W. (2003) The quantitative assessment of neighborhood social environments. In I. Kawachi & L. F. Berkman (Eds.), Neighborhoods & Health. NY:Oxford.

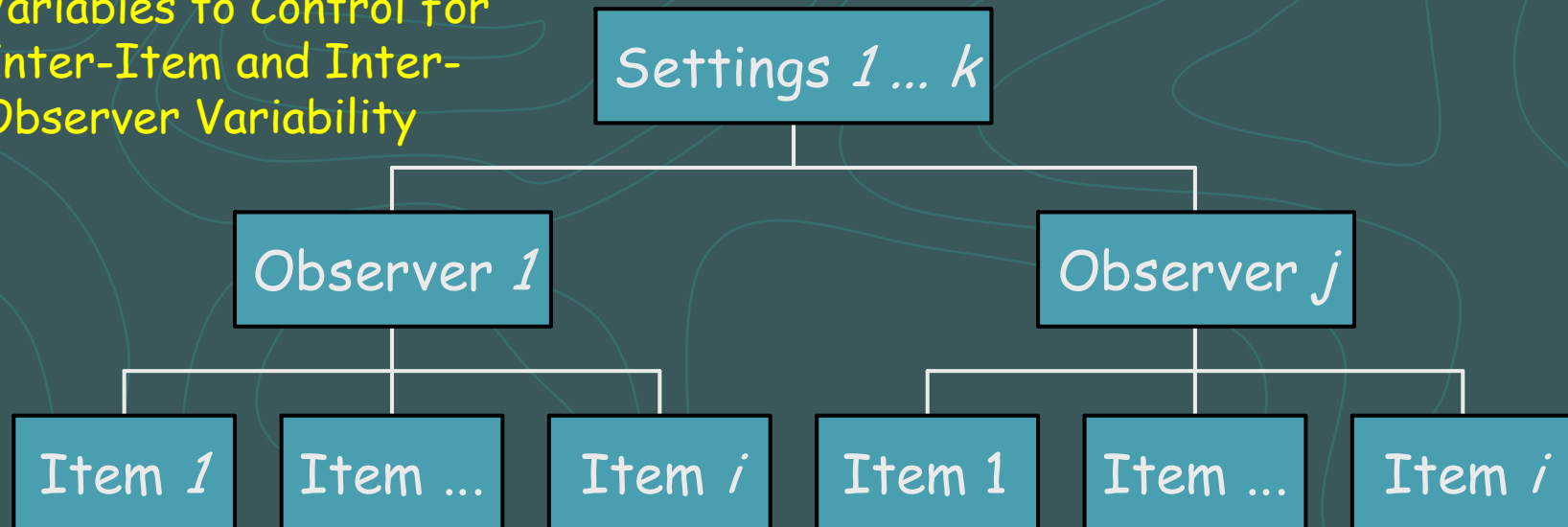# Ecometric Conceptualization of an Environmental Data Set

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                    │  Settings 1 … k │
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       ┌──────────────┐         ┌──────────────┐
       │  Observer 1  │         │  Observer j  │
       └──────────────┘         └──────────────┘
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 ┌────────┐┌────────┐┌────────┐┌────────┐┌────────┐┌────────┐
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Ecometric Conceptualization of a Data Set

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                    │   Settings 1 ... k  │
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     ┌───────────┐                           ┌───────────┐
     │ Observer 1│                           │ Observer j│
     └─────┬─────┘                           └─────┬─────┘
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 │Item 1││Item..││Item i│                │Item 1││Item..││Item i│
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-partitioning sources of variation

Ecometric Conceptualization of a Data Set

Addition of Dummy Variables to Control for Inter-Item and Inter-Observer Variability

Settings *1 ... k*

Observer *1*

Observer *j*

Item *1*

Item *...*

Item *i*

Item 1

Item *...*

Item *i*

-partitioning sources of variation

-controlling for known sources of variation

Ecometric Conceptualization of a Data Set

Construction of Item
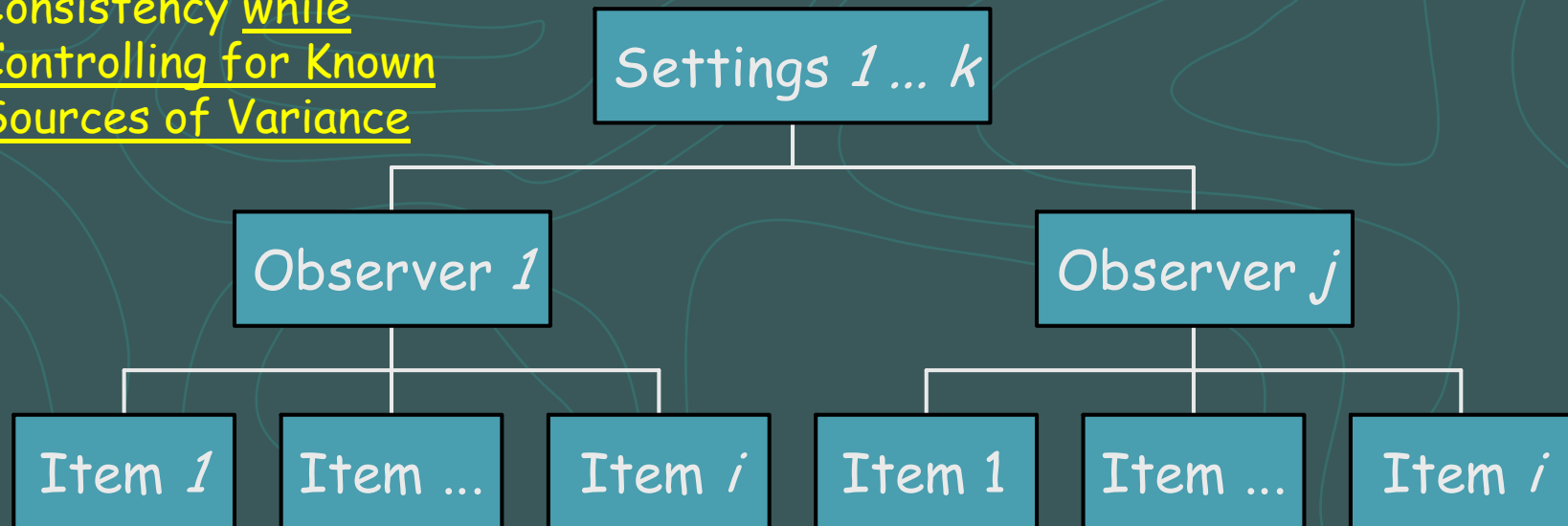Severity Maps as in
Item-Response Theory

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                        │  Settings 1 ... k │
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              ┌──────────────────┴──────────────────┐
      ┌──────────────┐                      ┌──────────────┐
      │  Observer 1   │                      │  Observer j   │
      └──────────────┘                      └──────────────┘
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│ Item 1 ││ Item ...││ Item i │       │ Item 1 ││ Item ...││ Item i │
└────────┘└────────┘└────────┘       └────────┘└────────┘└────────┘
```

-partitioning sources of variation
-controlling for known sources of variation
-evaluating value of items in overall setting estimates

Ecometric Conceptualization of a Data Set

Estimating Internal Consistency while Controlling for Known Sources of Variance

Settings *1 ... k*

Observer *1*

Observer *j*

Item *1*

Item ...

Item *i*

Item 1

Item ...

Item *i*

-partitioning sources of variation
-controlling for known sources of variation
-evaluating value of items in overall setting estimates
-evaluating internal consistency of items

Ecometric Conceptualization of a Data Set

Estimating Associations
with Relevant Variables
and/or Testing
Hypotheses

```
                    Settings 1 ... k
                    /              \
          Observer 1                Observer j
         /    |    \               /    |    \
   Item 1  Item ...  Item i    Item 1  Item ...  Item i
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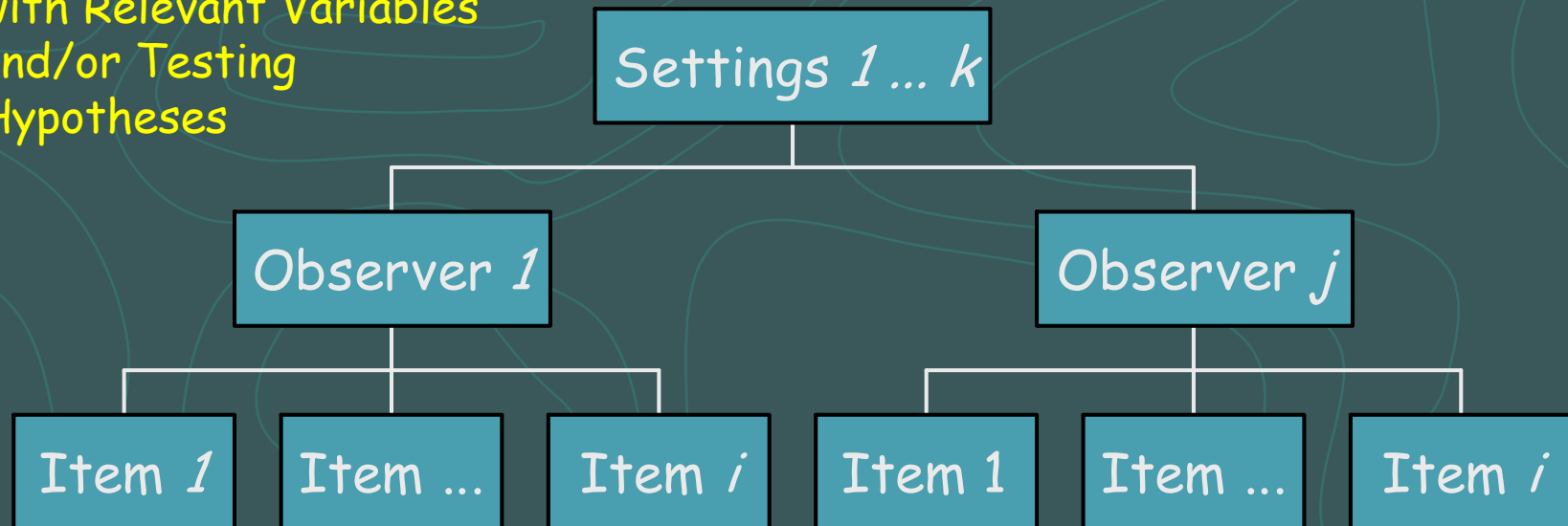
-partitioning sources of variation
-controlling for known sources of variation
-evaluating value of items in overall setting estimates
-evaluating internal consistency of items
-establishing construct / concurrent validity
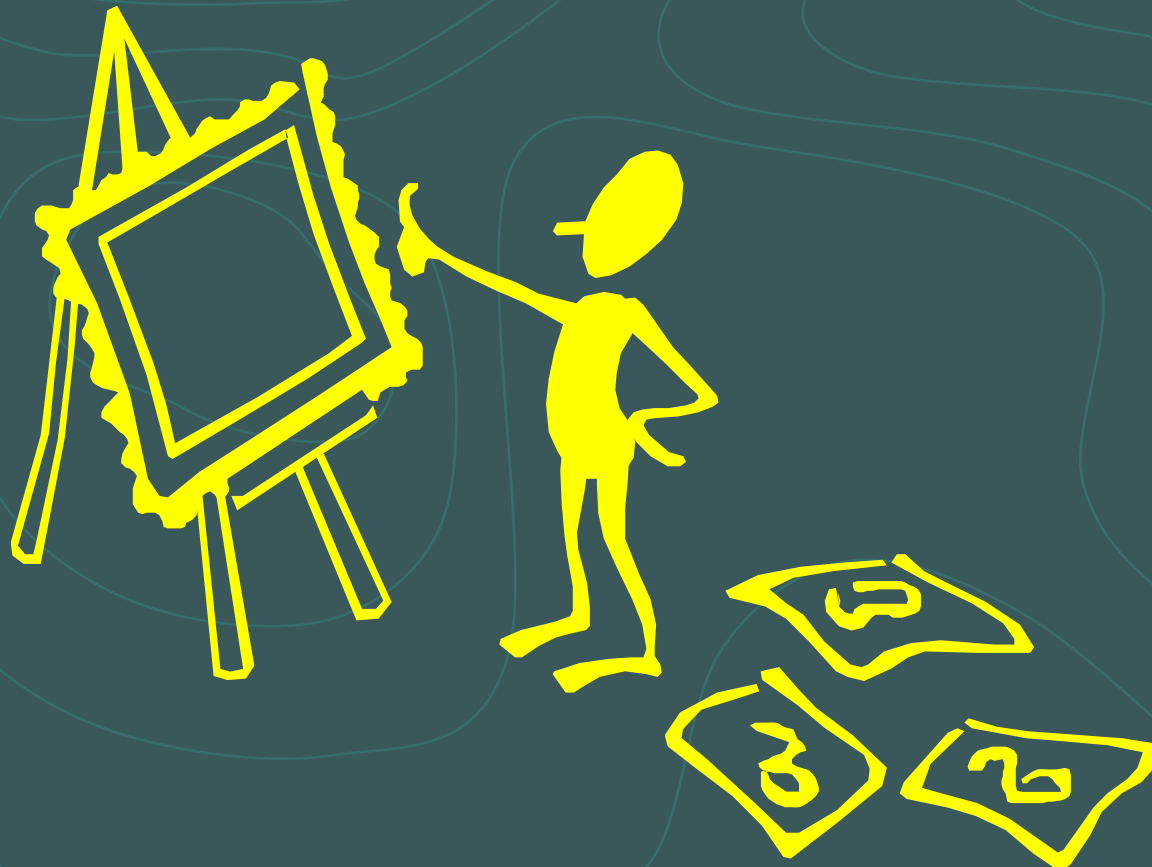
Some Data from the Montreal MARCHE Project

Montreal: A City Built on an Island and around a Mountain

Census tracts

0 1 2   4 Kilometers

Census tracts
Boroughs
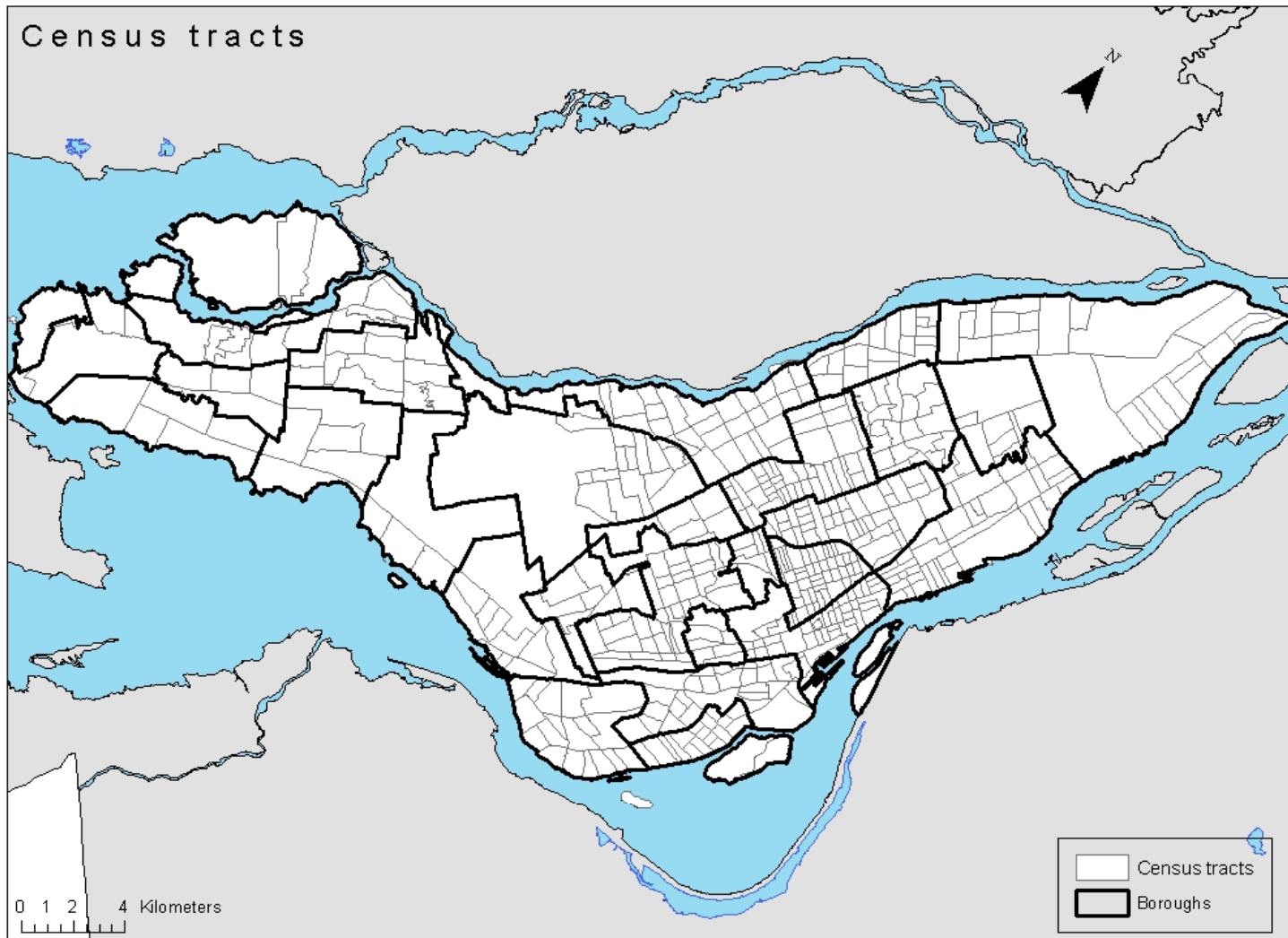
Our Focus

- Creating a Data Base of Direct Observations of the *Walkability* of Neighborhoods on the Island of Montreal;

- *Walkability* :

  - ... an emergent property of the environment which can either increase or decrease the likelihood of walking; ... is a function of ...

    - user-friendliness;
    - safety;
    - number/variety of destinations;
    - simplicity of stimuli.

Craig et al. (2002). Promoting Active Communities: The Relationship between Physical Activity and the Environment. AJ PM, 23(2) Supplement, 36-43.

Methods

- 112 neighborhoods on the island of Montreal
  - Sampling in each of the 27 boroughs
  - Proportional sampling of census tracts
    - based on socio-demographic characteristics of population;
    - number of census tracts per borough.

Selected census tracts

Average income
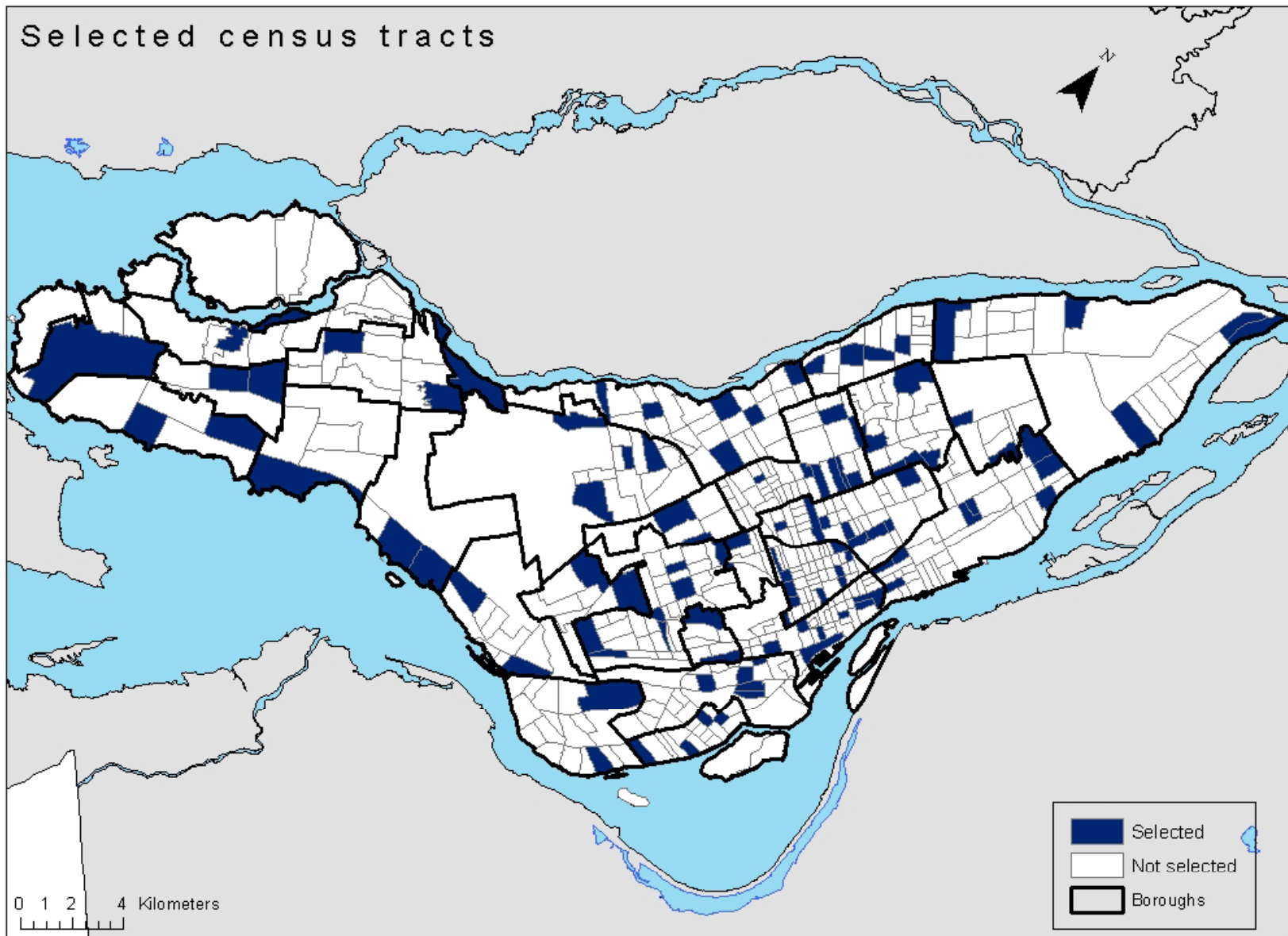
Average income
- 1
- 2
- 3
- Not selected
- Boroughs

0 1 2   4 Kilometers

Methods

- 3-day training session
- 4 pairs of observers (total n=8)
  - 50% female
  - Varied educational backgrounds
  - Aged 18 to 32 years

Methods

- 18-item grid assessing overall census tract characteristics; 18 items pertaining to *Walkability*;

- Other items assessing neighborhood-level and street-level characteristics (Caughy et al., 2001; Pikora et al., 2002).

Walkability

- **User-Friendliness** (6 items)
  - Pedestrian system addresses pedestrian needs (+)
  - Pedestrian system has limits to pedestrians (-)
  - Effort to walk around (-)

- **Safety** (4 items)
  - Safety / feeling comfortable with the potential for crime (+)
  - Safety / feeling threatened with the potential for crime (-)
  - Threat of traffic to pedestrians (-)

- **Number and Variety of Destinations** (5 items)
  - Variety of destinations (+)
  - Inclusive of people (+)
  - Socially dynamic / static (+)

- **Simplicity of Stimuli** (3 items)
  - Complex environmental stimuli (-)
  - Overwhelming stimuli (-)
  - High visual interests (+)

Example of a Neighborhood Map

SR 149.00 : Plateau Mont-Royal
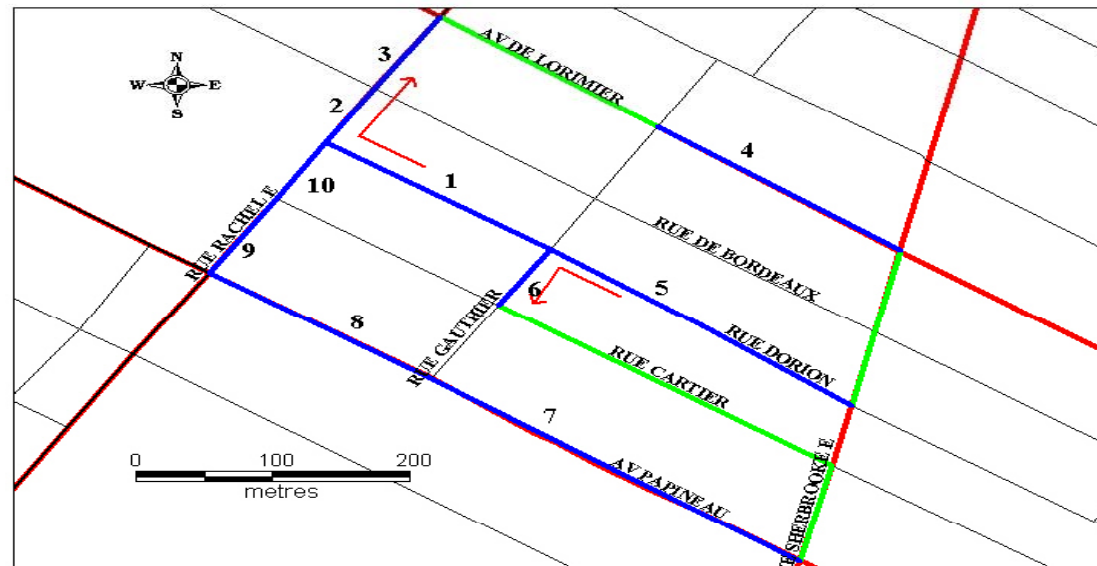
Mylène Riva, 2003

Tronçons à évaluer
Trajet à suivre
Limite du SR

Resulting Data Set

112 Neighborhoods

Observer 1

Observer 2

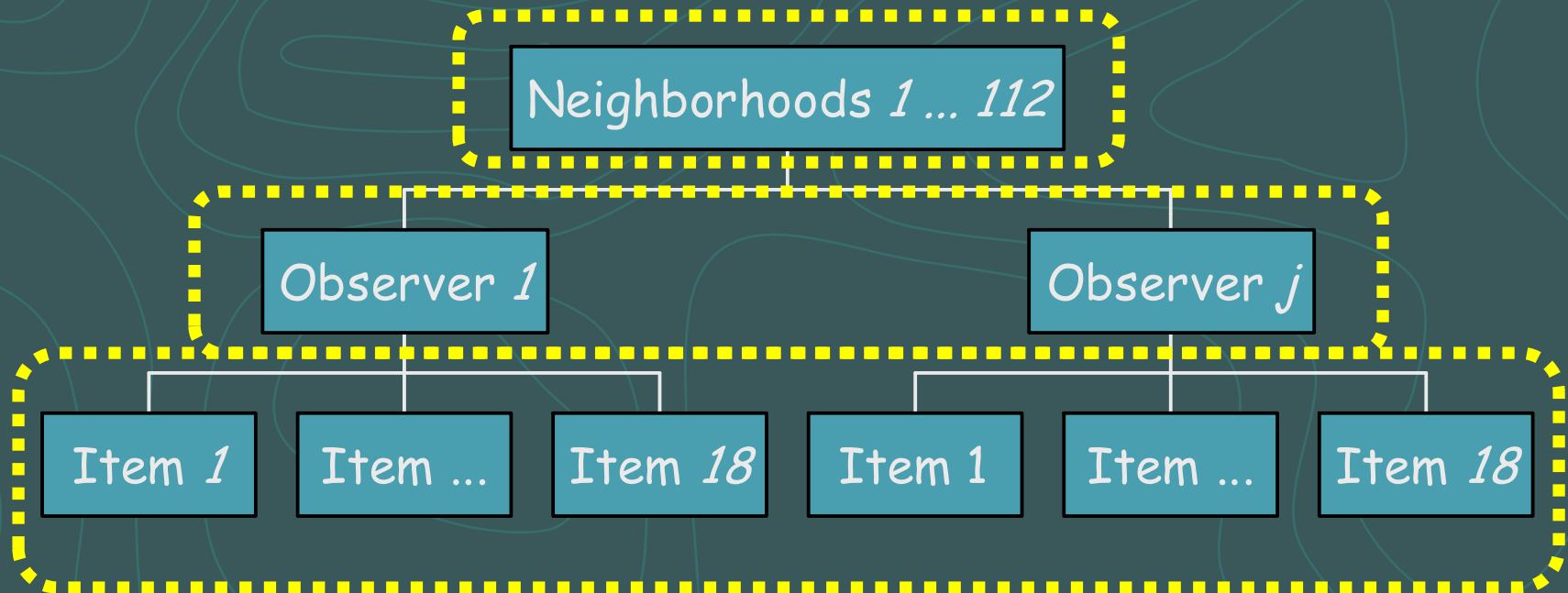**Item 1** | **Item ...** | **Item 18** | **Item 1** | **Item ...** | **Item 18**
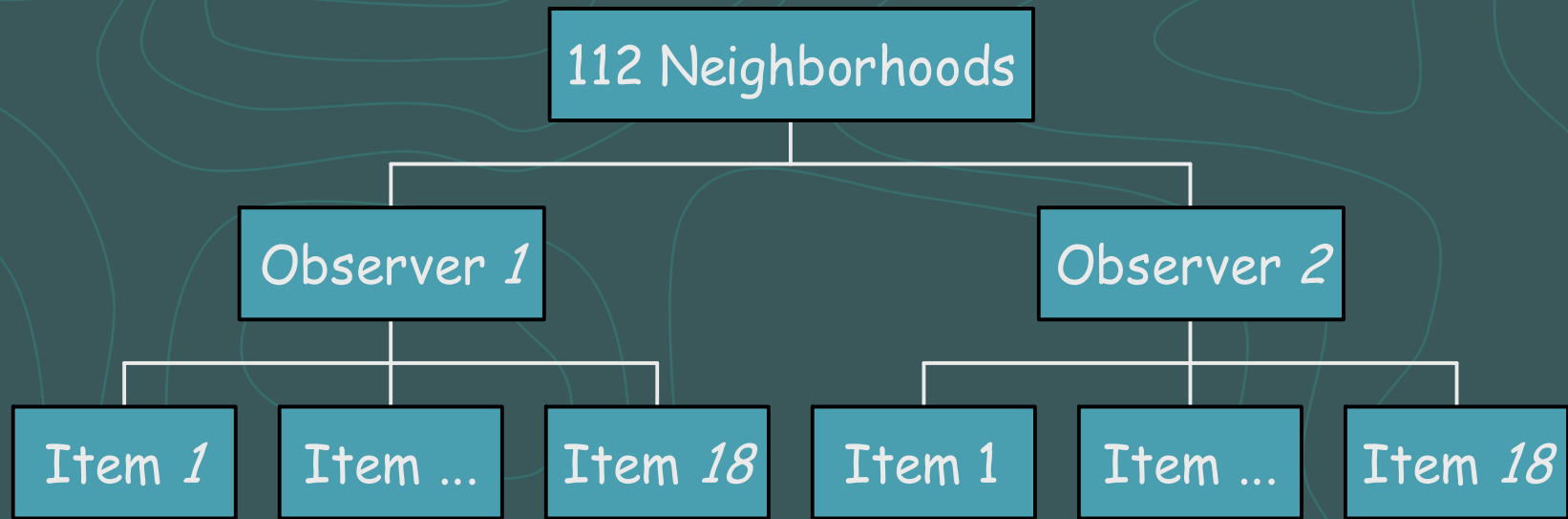
4032 observations =
112 neighborhoods X 2 observers per neighborhood X 18 items

Some Results

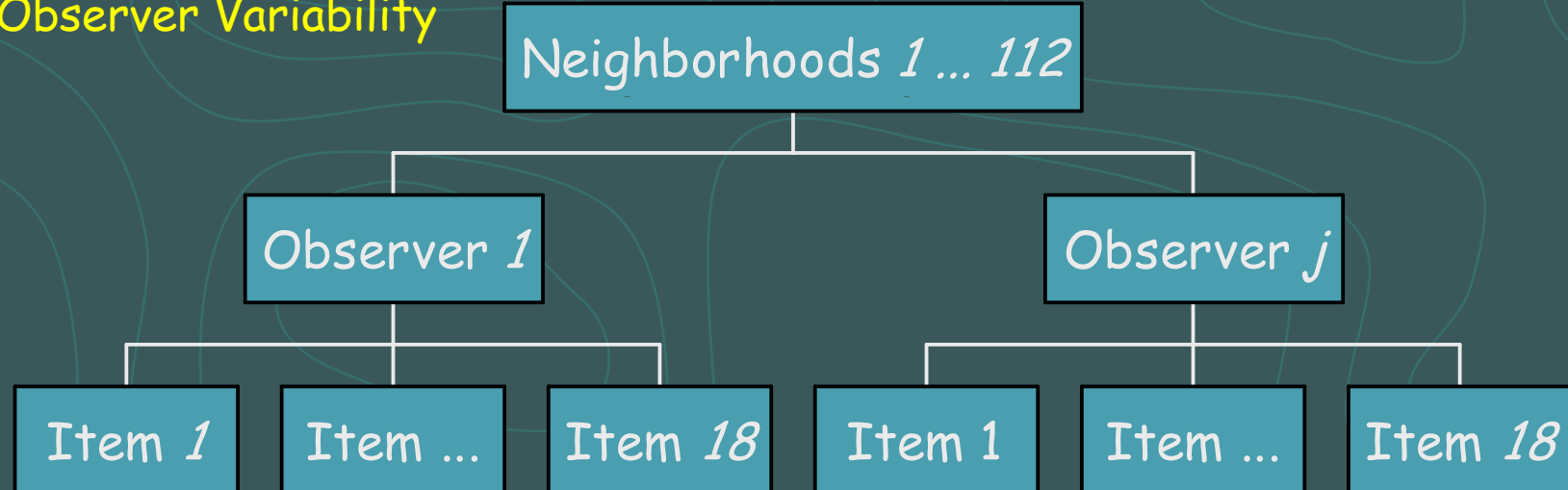# Ecometric Conceptualization of a Data Set

-partitioning sources of variation

Decomposing Sources of Variance in Observations
(before controlling for known sources of variability)

	Between neighborhood	Between observer	Between item
User-friendliness	0.43 (26.9%)	0.24 (14.8%)	0.92 (58.2%)
Safety	0.48 (31.3%)	0.09 (5.6%)	0.96 (63.1%)
Number & variety of destinations	0.66 (29.7%)	0.01 (0.4%)	1.55 (69.9%)
Simplicity of Stimuli	0.37 (15.3%)	0.001 (0.0%)	2.05 (84.7%)

Ecometric Conceptualization of a Data Set

Addition of Dummy Variables to Control for Inter-Item and Inter-Observer Variability

Neighborhoods *1 ... 112*

Observer *1*	Observer *j*

Item *1*	Item ...	Item *18*	Item *1*	Item ...	Item *18*

-partitioning sources of variation
-controlling for known sources of variation

Decomposing Sources of Variance in Observations
(<u>after</u> controlling for between-item and between-observer variability)

	Between neighborhood	Between observer	Between item
User-friendliness	0.44 (32.5%)	0.12 (8.8%)	0.80 (58.7%)
Safety	0.45 (33.3%)	0.08 (5.7%)	0.83 (61.0%)
Number & variety of destinations	0.64 (37.3%)	0.09 (5.4%)	0.99 (57.3%)
Simplicity of Stimuli	0.41 (21.1%)	0.001 (0.0%)	1.53 (78.9%)

Ecometric Conceptualization of a Data Set

Construction of Item Severity Maps as in Item-Response Theory

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                    │  Neighborhoods 1 ... 112 │
                    └─────────────────────────┘
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     ┌─────────────┐                  ┌─────────────┐
     │  Observer 1 │                  │  Observer j │
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┌────────┐┌────────┐┌────────┐  ┌────────┐┌────────┐┌────────┐
│ Item 1 ││ Item ..││ Item 18│  │ Item 1 ││ Item ..││ Item 18│
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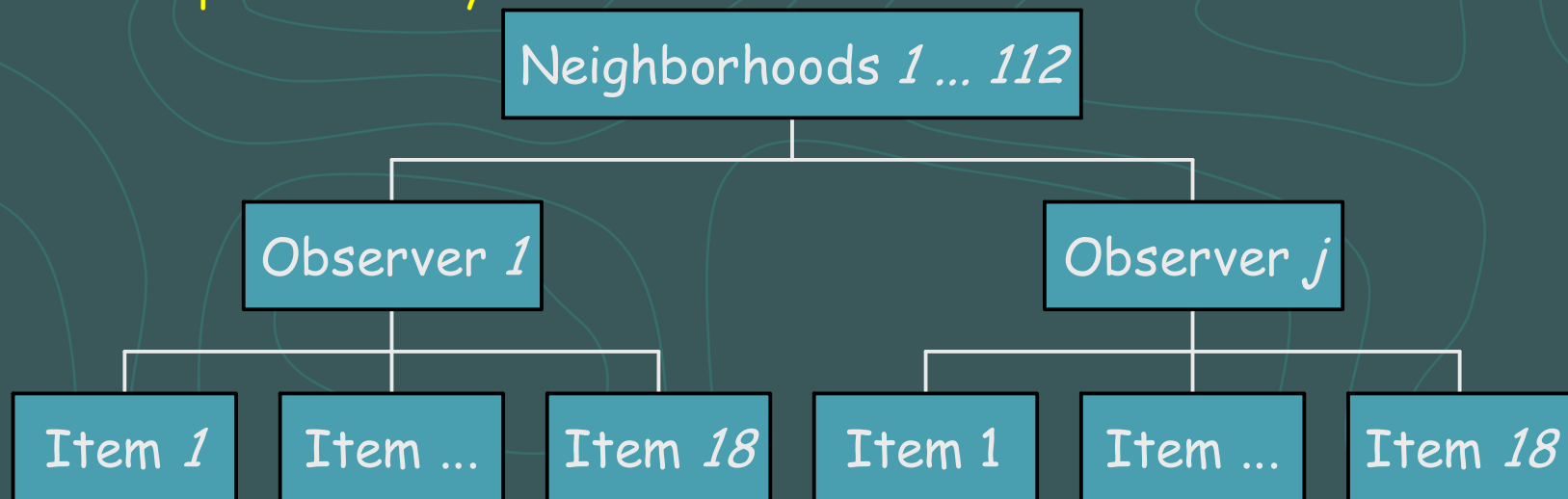
-partitioning sources of variation
-controlling for known sources of variation
-evaluating value of items in overall setting estimates

Utility of Various Items
(example of User-friendliness)

Item	Coef.	S.E.
Intercept	5.75	0.143
Pedestrian system has limits to pedestrians (-)	0.58	0.09
Effort to walk around (-)	0.48	0.09
Bicycle system has limits to cyclists (-)	0.16	0.09
Pedestrian system addresses pedestrian needs	(0)	Ref.
Effort to bicycle around (-)	-0.17	0.09
Bicycle system addresses cyclist' needs	-0.32	0.09

Ecometric Conceptualization of a Data Set

Estimating Internal Consistency while Controlling for Known Sources of Variance

```
                    Neighborhoods 1 ... 112
                    /                      \
            Observer 1                      Observer j
           /    |    \                     /    |    \
      Item 1  Item ... Item 18       Item 1  Item ... Item 18
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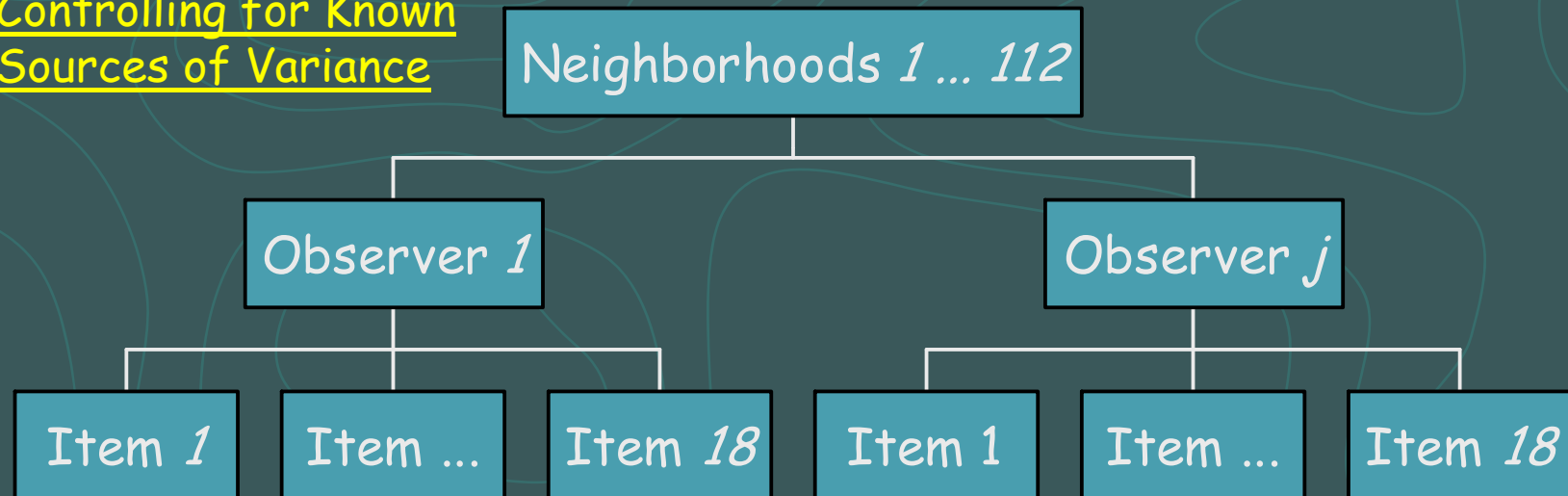
-partitioning sources of variation
-controlling for known sources of variation
-evaluating value of items in overall setting estimates
-evaluating internal consistency of items

Overall Estimate of Reliability of Neighborhood Measure

(after controlling for between-item and between-observer variability)

- User-Friendliness
  - .78
- Safety
  - .76
- Number & Variety of Destinations
  - .82
- Simplicity of Stimuli
  - .62

Summary Measures of Each Neighborhood

Distribution of Estimated Scores

Histogram of Predicted Scores on Places to Go, Things to Do
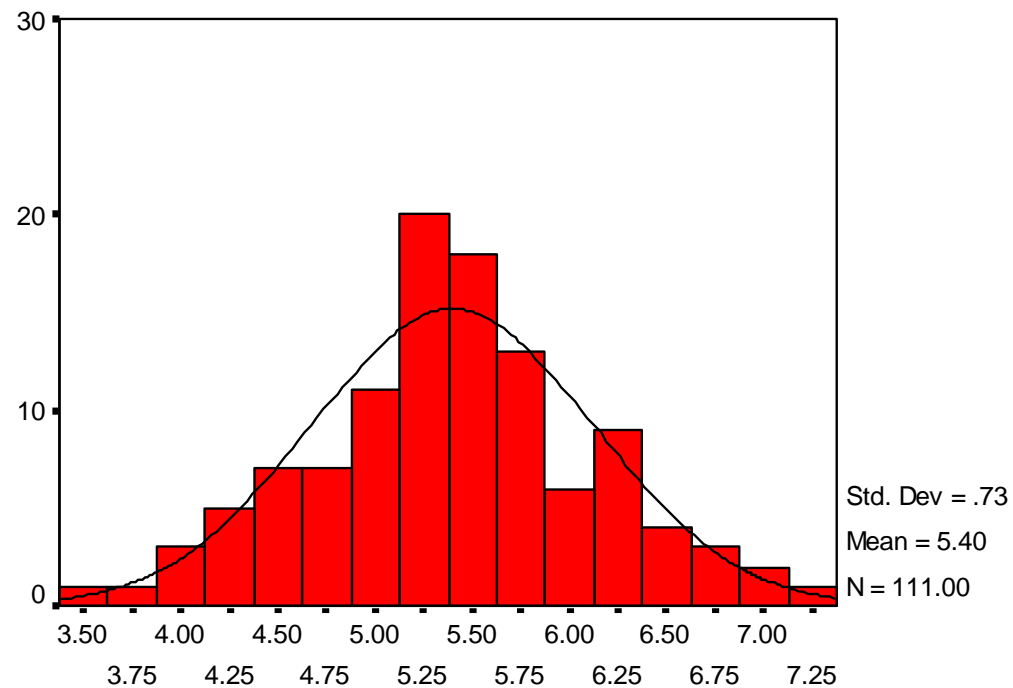
Std. Dev = .73
Mean = 5.40
N = 111.00

Ecometric Conceptualization of a Data Set

Estimating Associations
with Relevant Variables
and/or Testing
Hypotheses

Neighborhoods *1 ... 112*

Observer *1*   Observer *j*

Item *1*   Item *...*   Item *18*   Item *1*   Item *...*   Item *18*
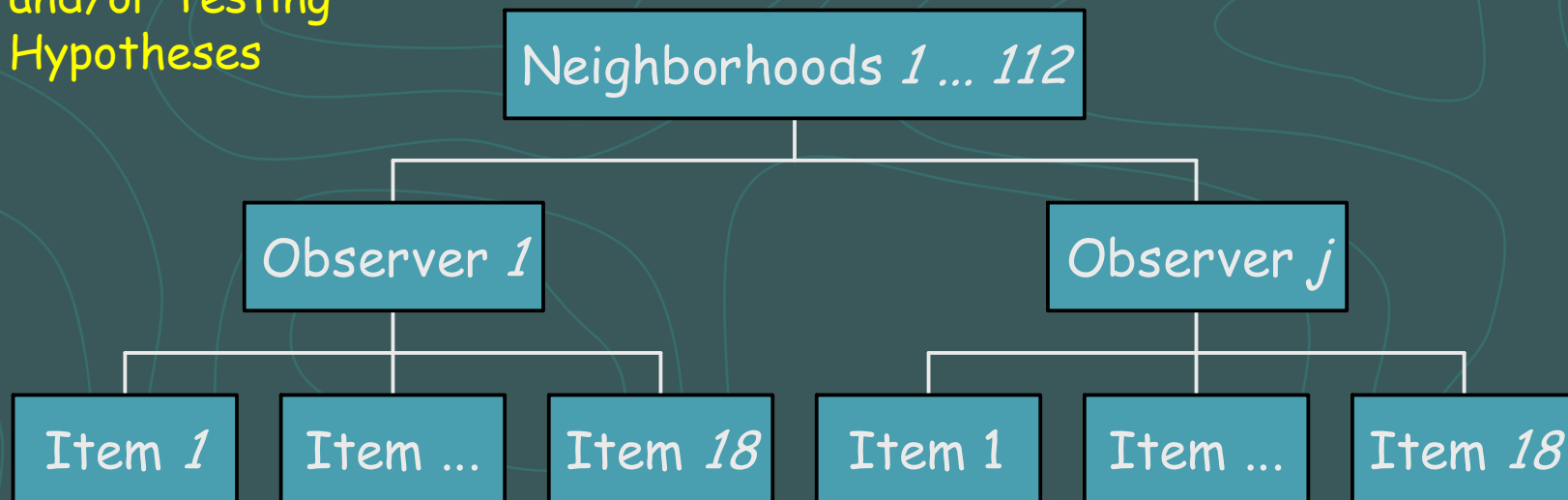
-partitioning sources of variation
-controlling for known sources of variation
-evaluating value of items in overall setting estimates
-evaluating internal consistency of items
-establishing construct / concurrent validity

Correlations Between Components of Walkability

(after controlling for between-item and between-observer variability)

|	User-friendliness	Safety	Number & Variety of Destinations	Simplicity of Stimuli
User-friendliness	1.00			
Safety	.70	1.00		
Number & variety of destinations	-.16	-.67	1.00	
Simplicity of Stimuli	.46	.95	-.84	1.00

Establishing Concurrent Validity

- Examination of Associations with

  - Proportion of people walking to get to work;
  - Socio-economic status of the neighbourhood.

Proportion of People Walking to Get to Work
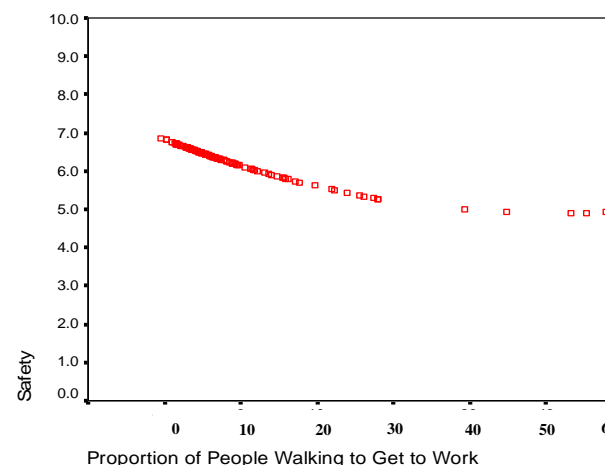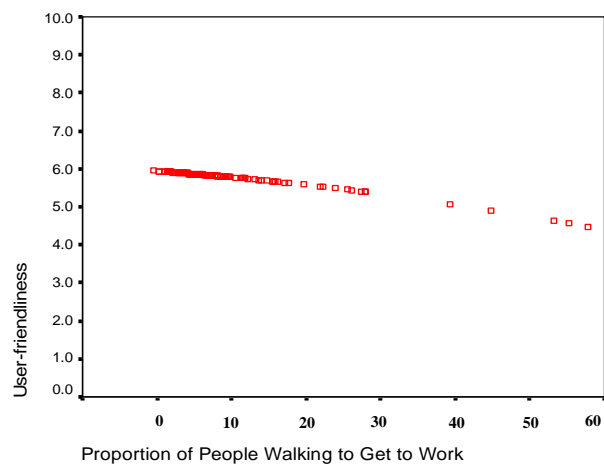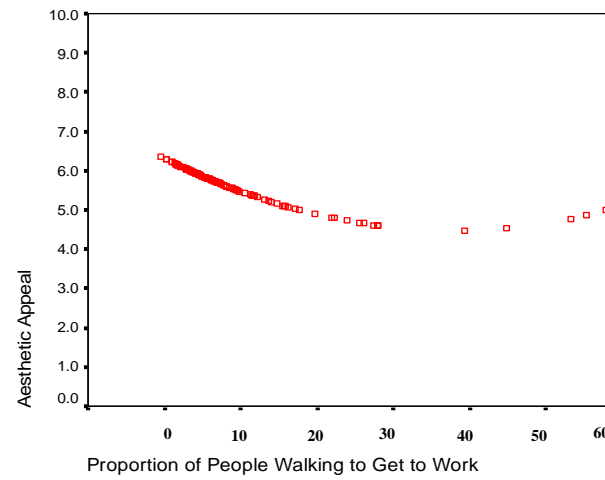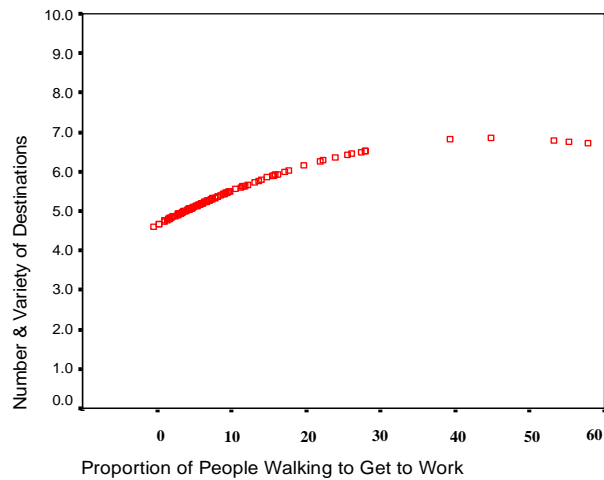
Average Income in the Neighborhood
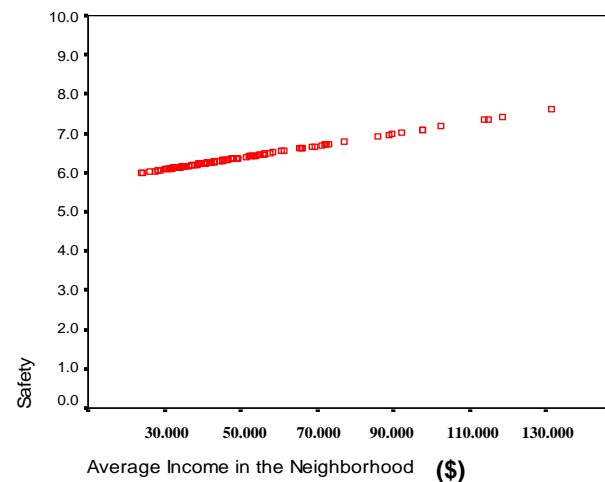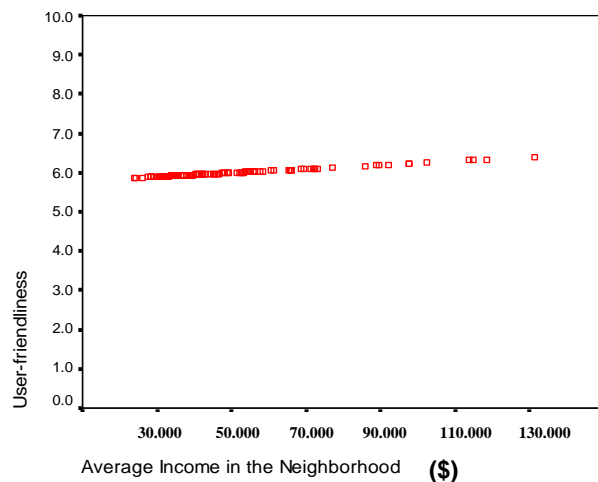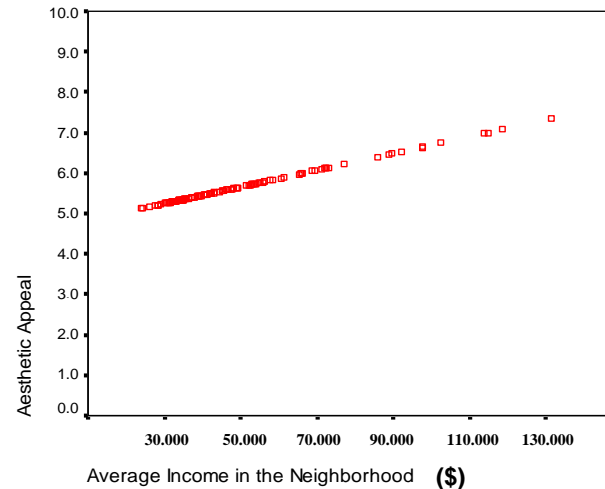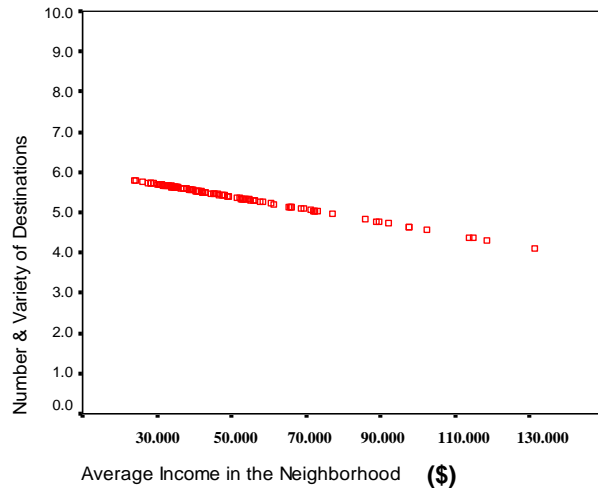
Some Overarching Conclusions

- The 4 subscales of the walkability measure have …
  - good reliability ;
  - are able to capture between neighborhood variation;
  - show good concurrent validity;
  - are not isomorphic except for safety and simplicity of stimuli that are highly correlated.
- Details about the measurement properties of this observational measure would have been difficult to ascertain without the ecometrics methodology.

Where from here ?

… From Walkability to Pedestrian Potential …

- Upcoming telephone survey of seniors living in the 112 neighborhoods;
- Meshing neighborhood-level measures and people-level data to model and conceptualize pedestrian potential.

Winter : A Powerful Environmental Intervention

- ... mon pays, ce n'est pas un pays c'est l'hiver ...
  - Gilles Vigneault

- ... MY COUNTRY IS NOT A COUNTRY IT IS THE WINTER ...

Thank You !