`eiPack`: Tools for R × C Ecological Inference and Higher-Dimension Data Management

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What is ecological inference (EI)?

- Goal: infer individual level behavior from aggregate data
- Unit of analysis: contingency table with observed marginals

	col_1	col_2	col_3	
row_1	N_{11i}	N_{12i}	N_{13i}	$N_{1\cdot i}$
row_2	N_{21i}	N_{22i}	N_{23i}	$N_{2\cdot i}$
row_3	N_{31i}	N_{32i}	N_{33i}	$N_{3\cdot i}$
	$N_{\cdot 1i}$	$N_{\cdot 2i}$	$N_{\cdot 3i}$	N_i

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- `eiPack` methods estimate unobserved internal cells (or functions thereof)

`eiPack`

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- `eiPack` data: `senc`
  - Individual level party affiliation
  - Black, White, and Native American voters
  - 8 counties (212 precincts) in SE North Carolina
  - Cell counts known

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- A common input syntax of the form:

  `cbind(col1, ..., colC)` ∼ `cbind(row1, ...,rowR)`
- Functions to calculate proportions of some subset of columns
- Appropriate `print`, `summary`, and `plot` functions

Method of bounds

- Quantity of interest: proportion of row members in each column for each unit
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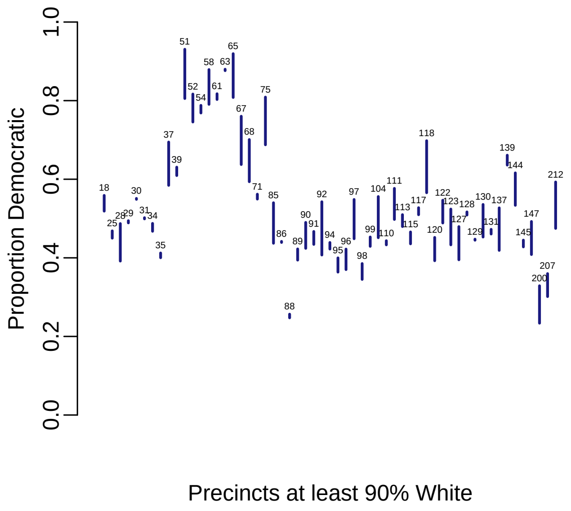
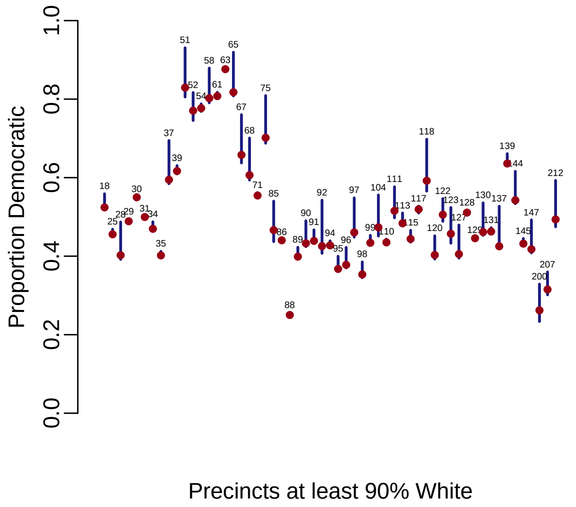
- Output:

```
 $white.dem
     lower  upper
18  0.519  0.559
25  0.450  0.469
28  0.392  0.487
```

Method of bounds



Method of bounds



Ecological regression

- Express data as proportions of row totals
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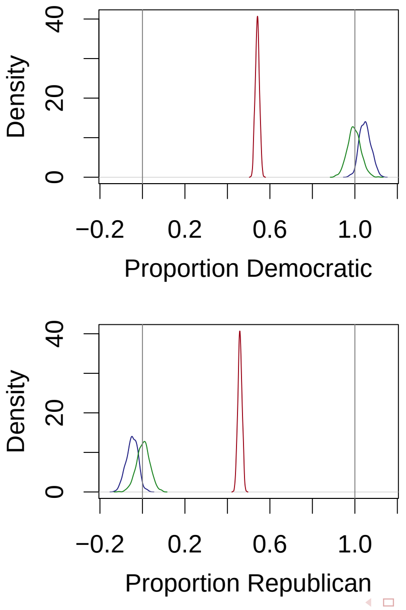
- `eiPack`: freq. and Bayesian regression
- `lambda` functions calculate shares of a subset of columns – e.g. “among Blacks, Dem. share of 2-party registration”

Ecological regression



Multinomial-Dirichlet (MD) model

- Express data as counts
- Fit hierarchical Bayesian model
  - Level 1: column marginals $\sim$ *Multinomial*, $\perp\!\!\!\perp$ across units
  - Level 2: rows of cell fractions $\sim$ *Dirichlet*, $\perp\!\!\!\perp$ across rows and units
  - Level 3: Dirichlet parameters $\sim$ *Gamma*, i.i.d.

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- `lambda` and `density.plot` functions

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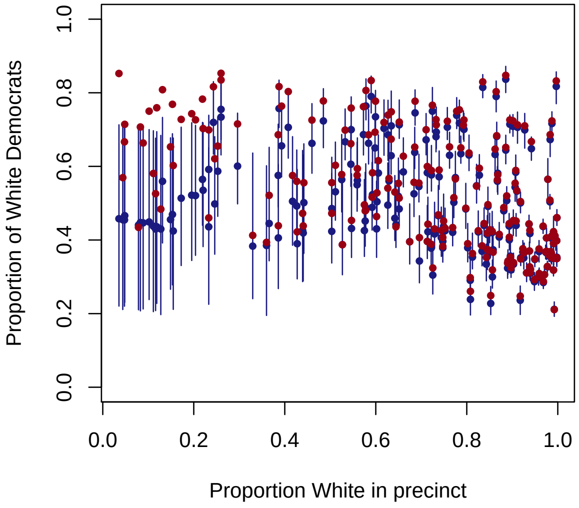

Data Management

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- Draws occupy $\approx$ 1GB of RAM; probably not enough iterations
- `eiPack` allows users to write chains to disk, or discard chains not of interest

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