Estimating anti-retroviral treatment coverage using facility level data

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UNAIDS Reference Group Meeting

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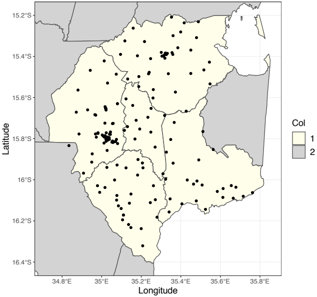
Estimating ART Coverage

- Reallocation model
  - Crude solution to the problem
  - Matches data from district to district
  - Doesn't factor in where people live; size and location of facilities.
- Challenge lies in combining
  - Number people living with HIV
  - Number of people taking ART
  - Choice of facilities (Distance, facility characteristics etc.)
- Probabilistic modelling



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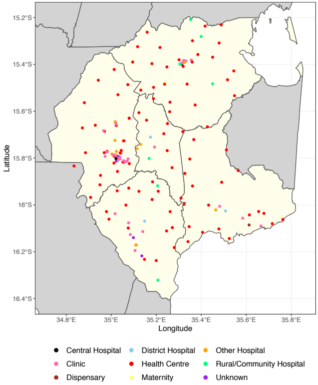

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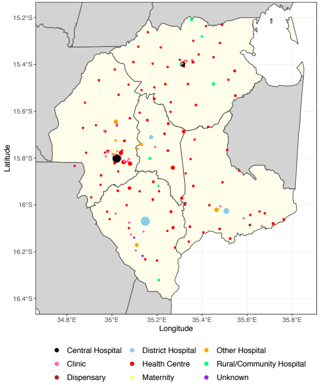

Motivating Example

- A household
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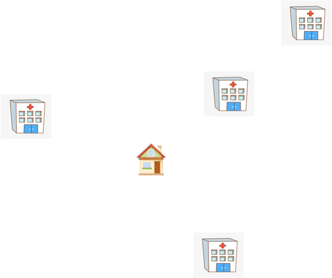

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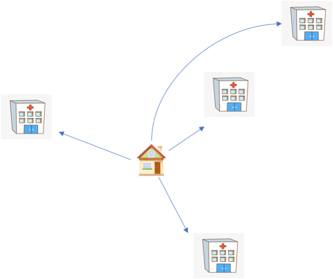
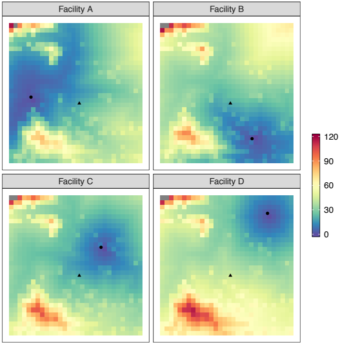
- Choice in which facility to attend



Motivating Example

- Choice in which facility to attend
- "Distance" to each facility

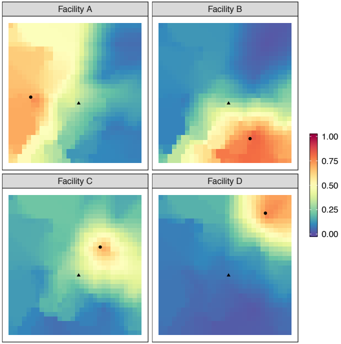


Facility	A	B	C	D
Time	19	18	21	43

Motivating Example

- Choice in which facility to attend
- "Distance" to each facility
- Probability of attending facility j from household i

$$C_{ji} \propto exp(-d_{ji})$$



Facility	A	B	C	D
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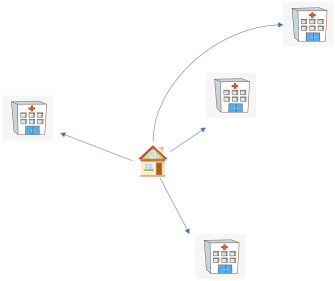
Probability	0.32	0.33	0.28	0.06

Motivating Example

- Distance is not the only factor influencing movement



Motivating Example

- Distance is not the only factor influencing movement
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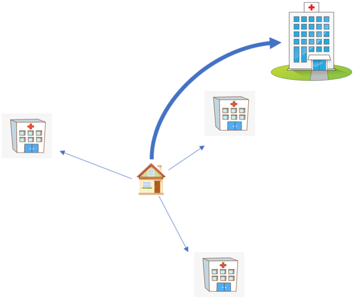
$$C_{ji} \propto M_j \cdot exp(-d_{ji})$$



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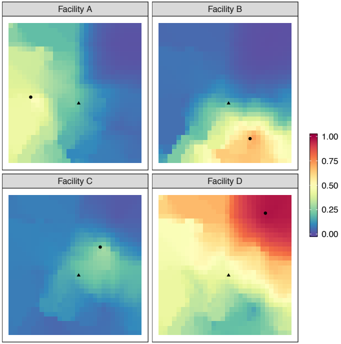

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Motivating Example

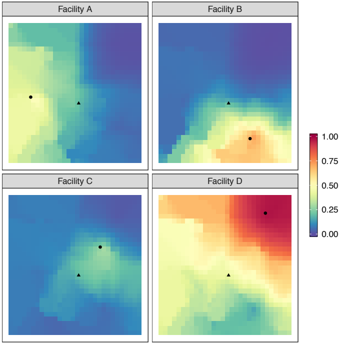
- Distance is not the only factor influencing movement
- Probability of attending facility j from household i

$$C_{ji} \propto M_j \cdot exp(-d_{ji})$$

- The number of people in household i attending facility j for ART with favourability

$$C_{ji} \cdot \alpha_i \cdot \rho_i \cdot N_i$$

- Sum across households to obtain the number of patients attending facility.



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Modelling ART Coverage

- Estimate ART coverage using

$$\hat{Y}_i^{ART} \sim Bin(\rho_i \cdot N_i, \alpha_i)$$

- People move from moving to facility j from region i with probability C_{ji}
- Therefore we are observing

$$Y_j^{ART} = \sum_i C_{ji} \hat{Y}_i^{ART}$$

- How do we fit this in practice?
  - Sum of a binomial is not a binomial
  - How do we get the C_{ji} (catchments)?

MODELLING ART COVERAGE

- ART coverage in region i modelled as

$$\hat{Y}_i^{ART} \sim Poisson(\rho_i \cdot N_i \cdot \alpha_i)$$

- People move from region j to facility i with probability C_{ji}

$$Y_j^{ART} = \sum_i C_{ji} \hat{Y}_i^{ART}$$

$$Y_j^{ART} \sim Poisson\left(\sum_i C_{ji} \cdot \rho_i \cdot N_i \cdot \alpha_i\right)$$

EXAMPLE: MALAWI

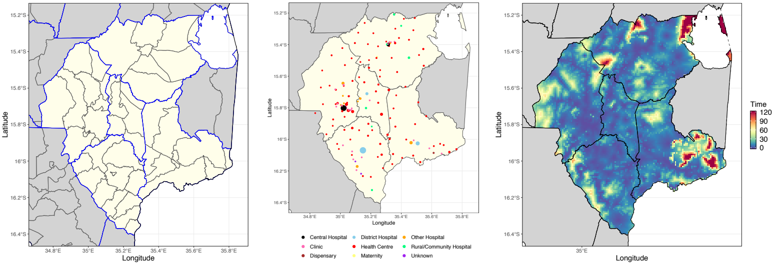

Figure: (Left) Map of Traditional Authorities in South-eastern Malawi, (Center) Map of Facilities administering ART South-eastern Malawi and (Right) Travel time to nearest facility, by grid cell (1km · 1km resolution).

DATA

- Prevalence
  - HIVE
  - Population-based HIV impact assessment survey (PHIA)
  - Demographic and household surveys (DHS)
  - Antenatal care facilities (ANC)
- Population
  - worldpop
  - Age and sex categorised
- Anti-retroviral therapy (ART)
- Travel times

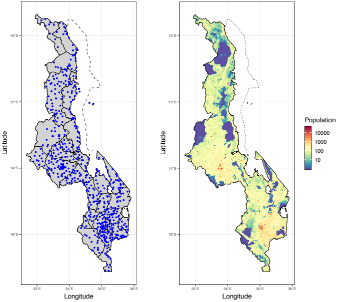

Figure: (Left) Locations of facilities administering ART. (Right) Estimates of population, by grid cell (1km · 1km resolution).

Modelling ART Coverage

$$Y_j^{ART} \sim Poisson\left(\sum_i C_{ji} \cdot \rho_i \cdot N_i \cdot \alpha_i\right)$$

- **Population of region *i*** - Fixed, obtained from worldpop

Modelling ART Coverage

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Modelling ART Coverage

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- **Population of region *i*** - Fixed, obtained from worldpop
- **Prevalence of region *i*** - Fixed, obtained from HIVE
- **ART coverage of region *i*** -

$$\text{logit}(\alpha_i) \sim N(0.7, 0.3^2)$$

Modelling ART Coverage

$$Y_j^{ART} \sim Poisson\left(\sum_i C_{ji} \cdot \rho_i \cdot N_i \cdot \alpha_i\right)$$

- **Catchment probabilities from region *i* to facility *i* -**

$$C_{ji} \propto M_j \cdot \kappa(d_{ji})$$

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  - d_{ji} average distance from region j to facility i

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  - d_{ji} average distance from region j to facility i
  - Kernel controlling the

$$\kappa(x) = \exp(-x)$$

Modelling ART Coverage

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  - 'Favourability' factor

$$log(M_j) = \beta_{0j} + \sum_k \beta_k X_{jk}$$

RESULTS

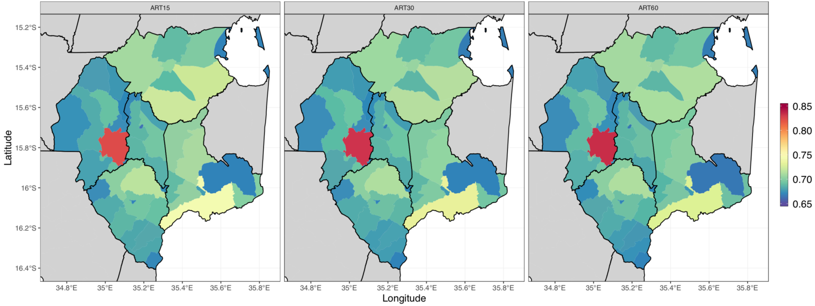

Figure: Estimated ART coverage under different scales of the kernels.

RESULTS

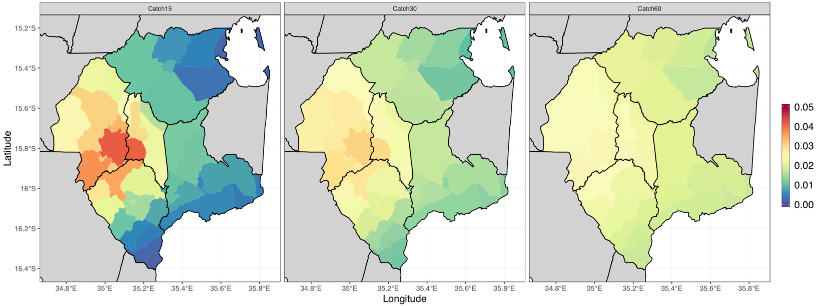

Figure: Probability of attending Bangwe Health Centre in Blantyre under different scales of the kernels.

RESULTS

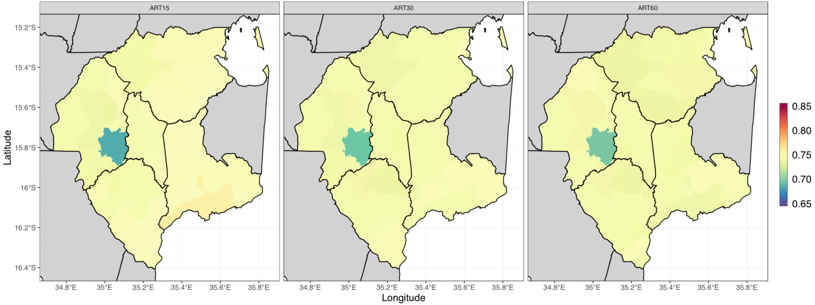

Figure: Estimated ART coverage with altered prior on the ART coverage.

Summary and Future Work

- Produced a model that estimates
  - ART coverage
  - Probabilistic catchments
- Future work
  - Incorporate other sources of data?
  - Other types of catchment?

Any Questions?