BMTRY 763   Spatial Epidemiology: methods and Applications
SPRING 2023

Time: M/W 1.30 -3.00
Room: 301
(special virtual classes: to be notified)
First Class: January 11th 2023

Description: A comprehensive introduction to the statistical methods used in the analysis of geo-referenced spatial health data. The course covers the topics of disease mapping (relative risk estimation), disease clustering, putative health hazard assessment, ecological analysis and mixed aggregation levels, and prospective surveillance. The methods covered are mainly in the area of generalized linear models and mixed models. The course addresses the use of appropriate software packages for the analysis of disease incidence data. The progression of methods begins with simple Poisson regression (log linear models) and logistic linear models and moves to Bayesian hierarchical modeling for mapped data and finally to models with spatially-correlated prior distributions only available in advanced software. If time permits, we also examine space-time modeling.

Objectives: A student who successfully completes this course will: 1) be able to analyze the variety of data found in spatial epidemiological studies, (2) be able to apply the R software packages to spatial epidemiological analyses, and (3) be able to demonstrate an understanding of the theory underlying the appropriate concepts and methods.

SYLLABUS

Basic spatial epidemiological concepts; Basic spatial statistical concepts;
Overview of GIS systems: demo of QGis
Disease Mapping: statistical concepts
Disease Clustering: general clustering analysis
Disease Clustering: non-focused and focused clustering
Disease Clustering: use of SatScan for cluster alarms.
Ecological analysis: basic issues; statistical models*;* case study*;* focused clustering on R
Advanced methods: random effects and confounding
Bayesian models
BRugs/INLA/CARBayes/Nimble
Space-time disease mapping; Space-time infectious diseases
Student Case Study Laboratory

Pre-requisite: BMTRY 700, 701 (Methods I and II)

Grading: 1 Midterm exam 50%
1 student case study 50%

Homework: A case study will be undertaken which is summative in nature and will rely on various aspects of the delivered course.

Grades: the MUSC standard raw score- merit score conversion will apply (as defined in https://musc.policytech.com/dotNet/documents/?docid=12510&public=true

Course Notes: All course material, such as homework, course notes, data sets will be posted on **http://people.musc.edu/~abl6.** Announcements will be emailed.

Software: Students will become acquainted with OpenBUGS, and R using Nimble and INLA on this course. Additional R packages will be suggested also.

BASIC BIBLIOGRAPHY

Lawson, A. B. (2021) *Using R for Bayesian Spatial and Spatio-Temporal Health Modeling* CRC Press, New York (UsingR)
Lawson, A. B. (2018) *Bayesian Disease Mapping: hierarchical modeling in Spatial Epidemiology,* CRC Press, New York**.** 3rd Ed (BDM)
Lawson, A. B. et al. eds. (2016) *Handbook of Spatial Epidemiology*, CRC Press, New York (HSE)
Lawson, A. B. (2006) *Statistical Methods in Spatial Epidemiology*, Wiley, New York 2nd ed (SMSE)
These books are recommended background reading for different parts of the course:

For general support for BUGS/NIMBLE-type coding the following books and article are useful:

Ntzoufras, I. (2009) *Bayesian Modeling Using WinBUGS*. Wiley, New York
Lunn, D. et al (2012) *The BUGS Book.* CRC Press, New York
Also the paper:
Lawson, A. B. (2020) NIMBLE for Bayesian Disease Mapping,
Spatial and Spatio-temporal Epidemiology,
33, https://doi.org/10.1016/j.sste.2020.100323 .

Course Schedule and syllabus

(SPRING 2023)

(All documents can be found on http://people.musc.edu/~abl6)

W January 11th 1.30 – 3.00 Basic spatial epidemiological concepts; Basic spatial statistical concepts (Lecture1_basic_epid_concepts*.pdf;* Lecture2_stat_concepts*.pdf*)
W January 11th 3.00 - 4.30 Introduction to GIS systems (Quantum GIS: QGIS demo) (Lecture3_MAPPING *.pdf*);
M January 16th no class MLK day
W January 18th Disease Mapping: statistical concepts; (Lecture4_*Statmodels.pdf*)
Disease Clustering: general clustering analysis (Lecture5_*disease_clustering.pdf*)

M January 23rd Disease Clustering: non-focused clustering; use of SatScan for cluster alarms (demonstration only)

W January 25th Tutorial 1 and tutorial 2 (Satscan)
(Tutorial 1 and *Tutorial 2_satscan.pdf; Additional_Satscan_notes.pdf)*
M January 30th Ecological analysis: basic issues & Statistical models
(Lecture6_*ecological_notes.pdf*)
W February 1st Ecological analysis: case study (putative sources of hazard)
(Lecture7_*focused_clustering.pdf*; Lecture_7b_MC Hypothesis Testing.pdf)

M February 6th Focused clustering on R
(Tutorial 3_focussed.pdf)
W February 8th Log linear models for geo-referenced health data.
(Tutorial 4_R_logistic_linear.pdf)

M February 13th Advanced methods: random effects and confounding;
*(*Lecture8_*Advanced_Poisson_Bayesian.pdf;* Lecture9_*random effects.pdf)*
W February 15th Bayesian models I
(Lecture10_Bayesmodel _I_DAG.pdf)
M February 20th no class (Presidents Day)

W February 22nd Bayesian Models II*;* Lecture11_*BayesmodelII_MCMC.pdf;* Lecture12_Open_*WinBUGS_Demo.pdf*

Mid term exam (out February 27th : in March 3rd)

M February 27th NIMBLE demo (other examples: DM simple Poisson-gamma)
W March 1st BUGS lab *(tutorial 5 Open_WinBUGS.pdf)*

March 6-10th Spring Break

M March 13th Hierarchical models and random effects Lecture13_*Hierarchical_model _summary.pdf; Lecture14_random_effectsN.pdf*

W March 15th Spatial models in WinBUGS; Lecture15_*GLMMs&DiseaseMAps.pdf*
Lecture 16_*Spatial _WinBUGS_for DM.pdf*

M March 20nd Extended WinBUGS DM example
Lecture17_Simple_WinBUGS_CODE_EXAMPLES_I.pdf; Lecture17b Bugs code and BRugs.pdf WinBUGS lab (Tutorial 5 Poisson-gamma; log normal revisited; **1.30-300 and 3.0-4.30 PM**

W March 22nd Tutorial CAR models CARBayes lab (Tutorial 6 CAR models_ CARBayes)
1.30 -3.00 and 3.0-4.30pm
Case Study out
M March 27th (1.30-3 pm) Nimble lab (Tutorial 7: CAR models using Nimble) ; break (3 – 4.30 pm) Goodness of fit, diagnostics and model comparison Lecture18_*Bayesian Model Goodness of Fit*.pdf; Lecture18b_Goodness of Fit_BB_DIC.pdf;
Lecture19_*Exceedence diagnostics.pdf*

W March 29th no class

M April 3rd Bayesian Models: Space-time issues: Lecture20_*space_time modelingI.pdf*
W April 5th Infectious diseases Lecture21_*Space_time ModelingII.pdf*

M April 10th Infectious Disease WinBUGS models: Lecture 21_*Space_Time_modelingII.pdf*

W April 12th R2WInBUGS, Brugs, CARBayes: Lecture22_ *R2WInBUGS_CARBayes.pdf;*
Lecture23_Ecological Example_WinBUGS.pdf

M April 17th Laplace approximation and INLA Lecture 24a_INLA_slides.pdf;
Lecture24b_INLA extended examples.pdf; Lecture 24c_SCcongen_inla_models.pdf

W April 19th Case Event conditional logistic modeling (WinBUGS examples)
Lecture25a_Statistical Models for Case events.pdf; Lecture25b_Case_event_modeling.pdf
Surveillance of disease maps Lecture 26_Surveillance of disease maps.pdf.

M April 24nd *LAST class* revision & feedback

W April 26th *extra slot*
Case Study due

Friday 28th end of semester