

# Methods related to risk ranking

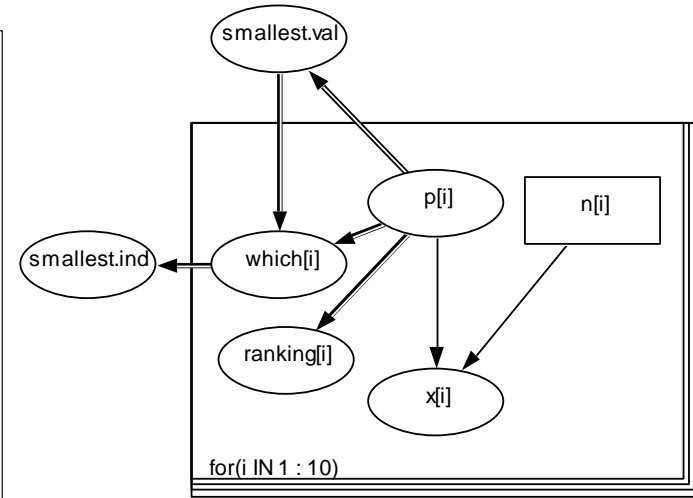
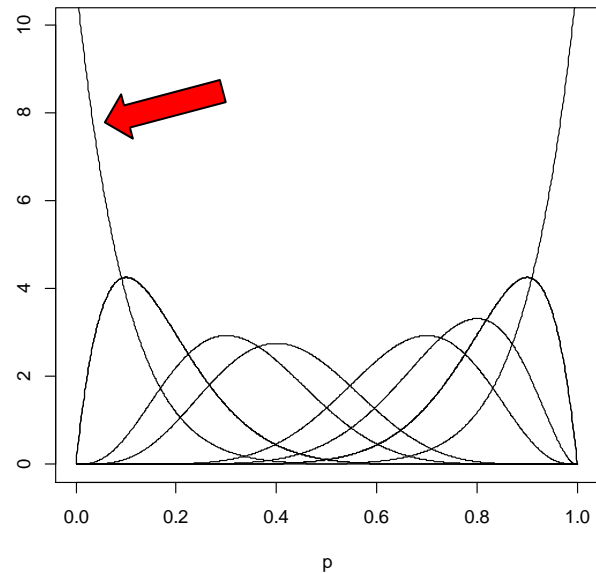
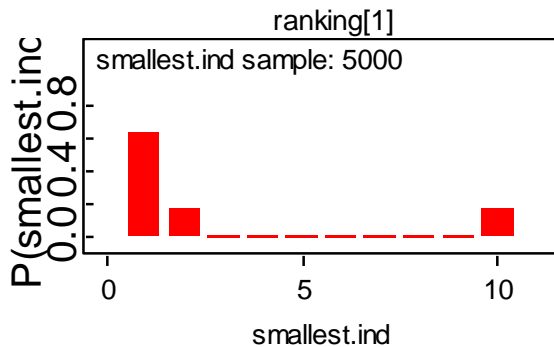
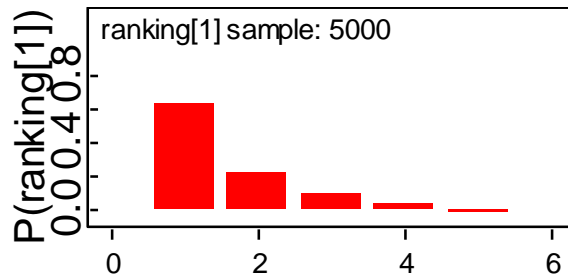
- EFSA report: ranking of biological hazards in food
  - <https://www.efsa.europa.eu/en/efsajournal/pub/3939>
- Evira projects in quantitative microbial food safety risk assessment:
  - Farm-to-fork (F2F) risk assessment models.
  - source attribution models.
  - Analysis of microbial criteria.
  - Probability of rank by simulation.

# Statistical method

- In statistics, "ranking" refers to the data transformation in which numerical or ordinal values are replaced by their rank when the data are sorted.
  - For example, the numerical data 3.4, 5.1, 2.6, 7.3 are observed, the ranks of these data items would be 2, 3, 1 and 4 respectively.
- Ranking of uncertain risk, prevalence, etc. is about uncertain ranking.
  - Distribution of ranks; probability:  $P(r_1 = 2) = ?$

# Probability of the rank

- Example: prevalence estimation in several populations, based on samples.
- What is the probability that the rank of the  $i$ th population is 1?
- Samples:  $n=c(10,10,10,10,10,10,10,10,10,10), x=c(0,1,3,4,7,8,9,9,10,1)$



Applications in e.g. health care assessment, ranking of hospitals (mortality rates).

# Farm-to-fork: bottom-up approach

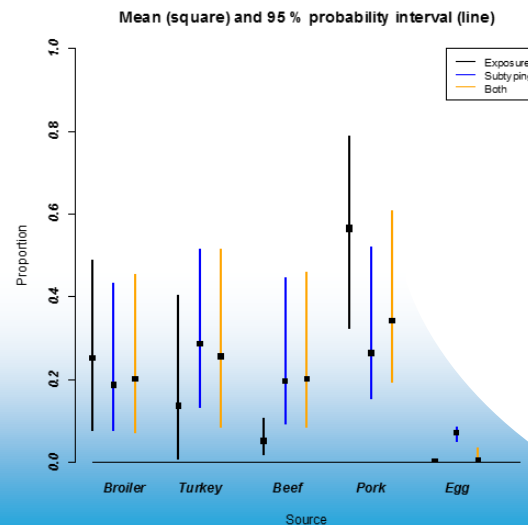
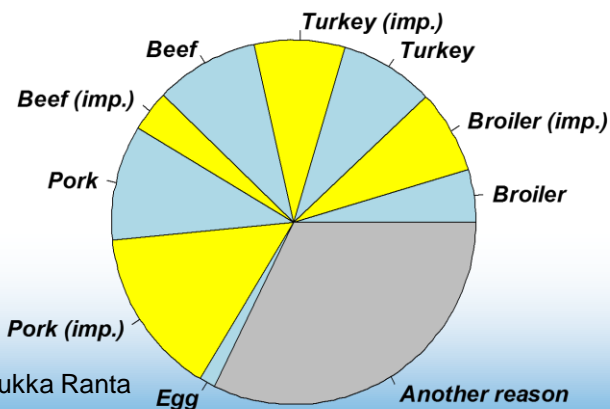
- Describe prevalence and/or concentration over the production chain, step-by-step
  - Primary production
  - Processing
  - Retail
  - Consumer
  - Dose-response
- More detailed foodpaths, e.g. different raw meats into different products?
- Many uncertainties → wide prediction intervals for absolute number of cases. Estimates of relative differences more robust?  
→ ranking of food chain risks.

# Source attribution: top-down approach

- Describe the reported human cases based on bacteria types (e.g. subspecies, genotypes).
- Look for the same types in food production chains.
  - Key type: only seen in a particular production chain.
  - Common types: seen in several production chains.
  - Attribute human cases into relative proportions, based on evaluating  $P(\text{source} \mid \text{type})$ .
  - Needs less data about production chain, but more isolate samples with detailed typing.
  - Possible to combine with exposure estimates based on F2F models.
    - ranking of attributable proportions.

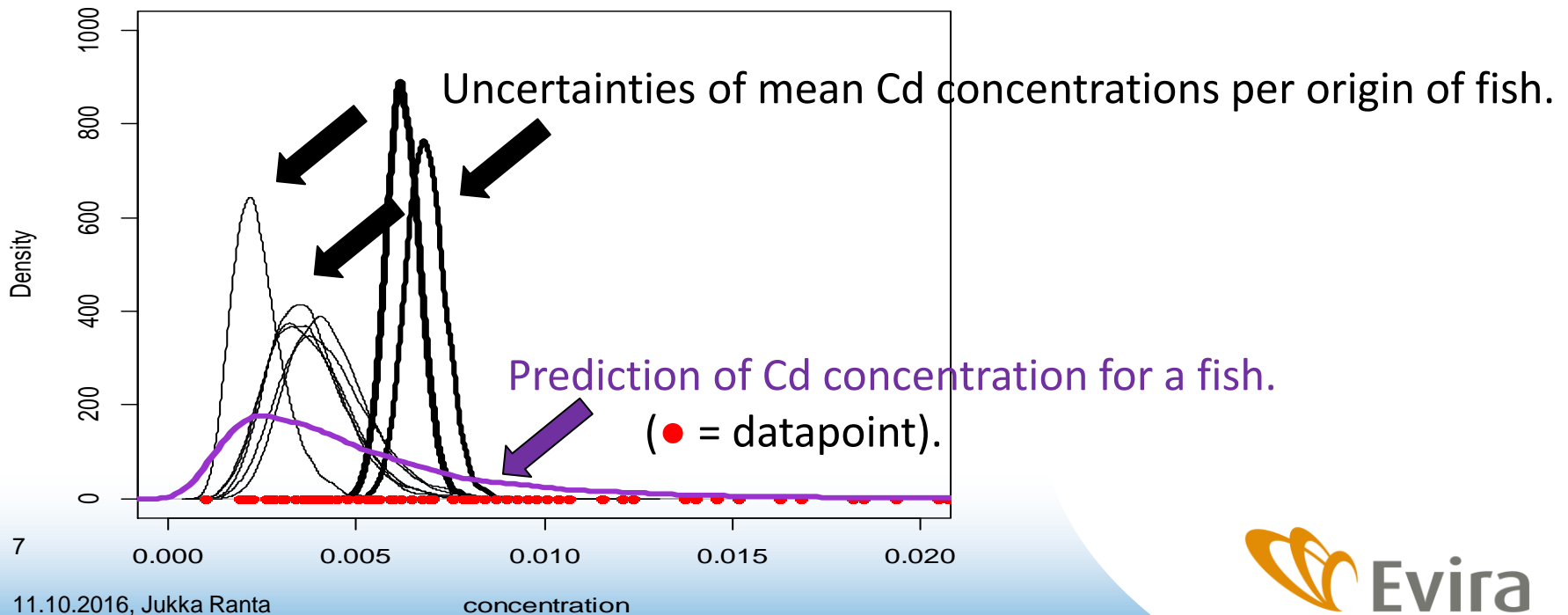
# Microbial RA and Ranking

- Models for *Salmonella* in meat production chains
  - Simplified Bayesian F2F models, posterior distributions with MCMC methods.
  - Broiler, Beef, Pork, Turkey, Eggs.
  - Prevalence estimates → estimated amount of contaminated servings.
  - Combined with a source attribution model with additional data on subtypes in humans and in infection sources (reservoirs). Domestic & imported meat separately.
- **Relative ranking of the sources as percentages of attributable cases. Uncertainty distribution of percentages → uncertain ranking.**

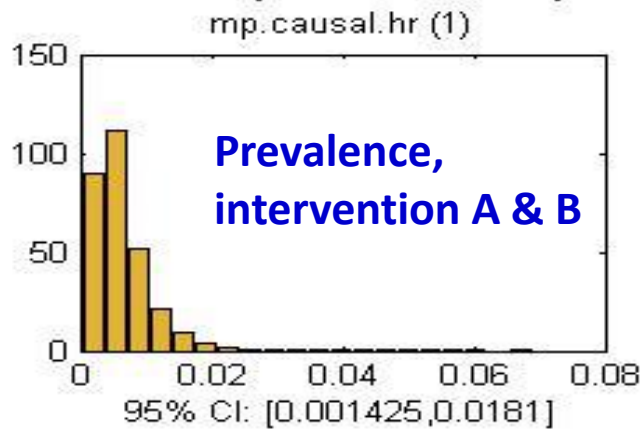
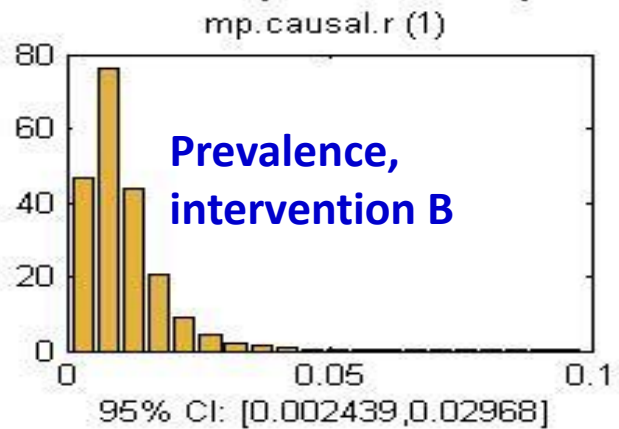
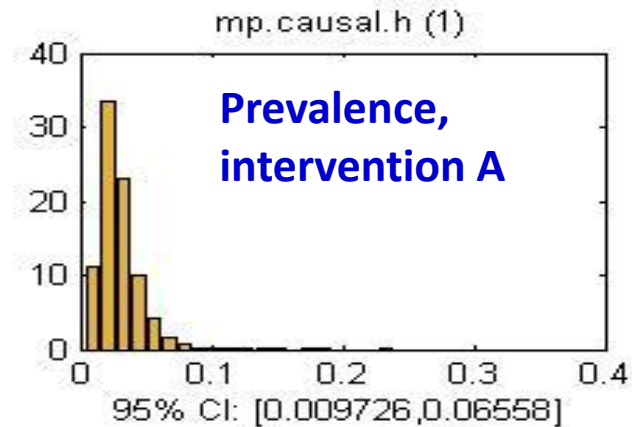
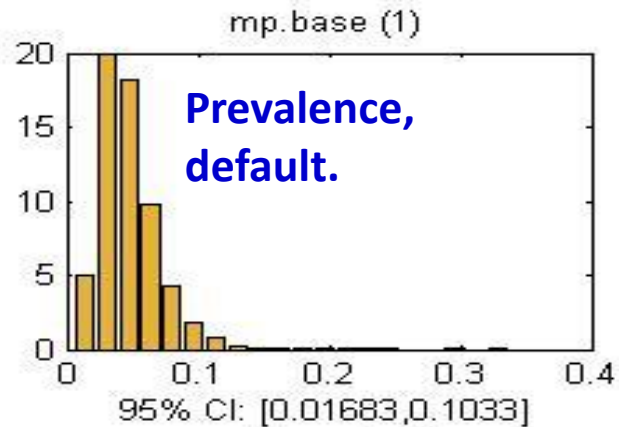


# Chemical RA and Ranking

- Intake assessment models for chemicals
  - Bayesian models of concentrations in food samples
  - Bayesian models of dietary data (frequency and amount of consumption).
  - Combined with distribution of intake per bodyweight.
- **Relative ranking of the foods as sources of exposure.**



# Ranking of interventions

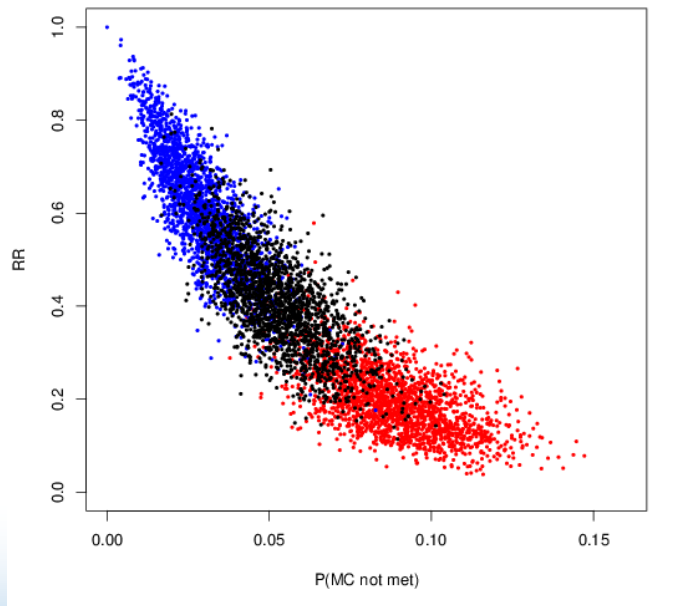


Listeria & Yersinia in pig carcasses.



# Ranking of microbiological criteria: Campylobacter

- Expected reduction of risk?
- Expected cost (as rejected batches)?
- Ranking:
- $P(\mathbf{RR}_1 < \mathbf{RR}_2 < \mathbf{RR}_3 \mid \text{data}) = ?$  ,  $RR_i = \text{risk ratio under criterion } i$ .

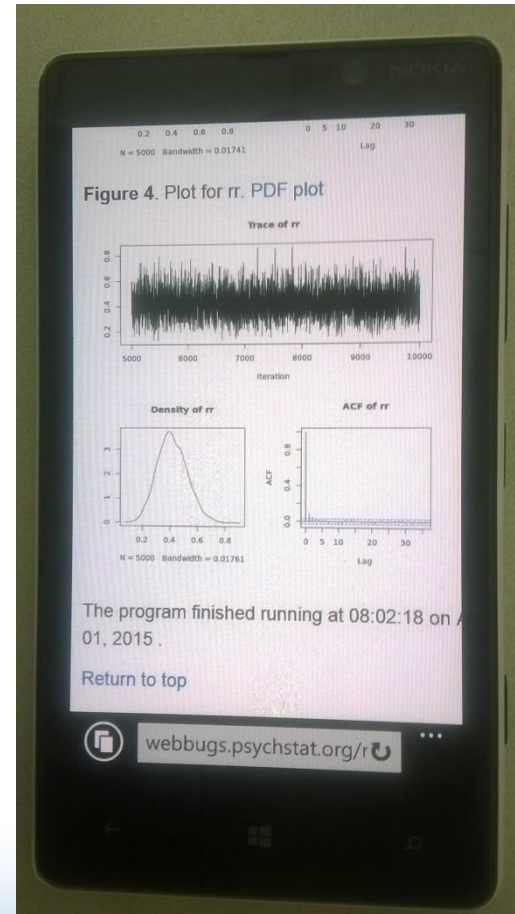
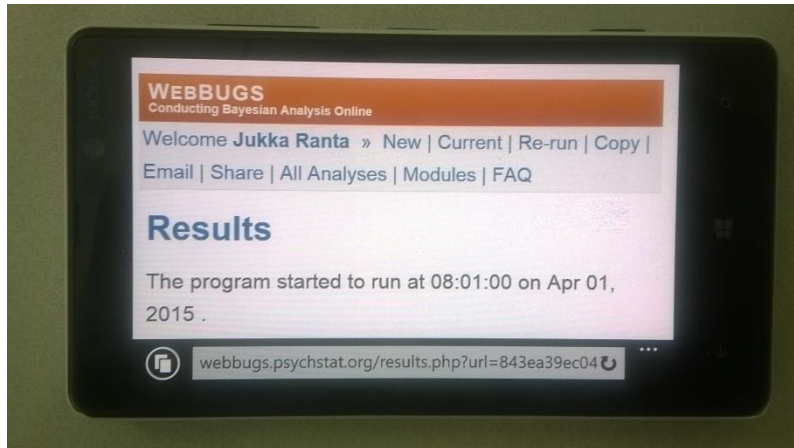


What to choose: criterion **1,2** or **3** ?

*Multicriteria ranking?*

# Online analysis, results in your mobile phone

Sharing models in WebBUGS <http://webbugs.psychstat.org/login.php>



	Mean	SD	ESS	M/SD	Percent CI		Median	HPD CI	Geweke
PMCmet	0.947*	0.014	3855	0	0.918	0.972	0.948	0.921 0.974	-0.2357
mrrr	0.397*	0.106	3898	0.019	0.206	0.62	0.389	0.197 0.604	0.0404
rr	0.418*	0.108	3875	0.019	0.222	0.643	0.412	0.211 0.625	0.0355

Note. \* represents a significant parameter;  
M/SD is the ratio of Monte Carlo error and standard deviation

# *Menu*

*Systematic reviews  
Meta-analysis  
Evidence synthesis  
Hierarchical models  
Mixed models  
Bayesian inference  
Uncertainty  
Probabilistic ranking*

*Bon appétit!*

**If it can be  
quantified,  
it can be  
ranked !**