FoodChain-Lab: Tracing software supporting food-borne disease outbreak investigations

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Outline

● Introduction

● FoodChain-Lab
  ○ Data Collection
  ○ Analysis and Visualization
  ○ Live

● Outlook
FoodChain-Lab – ad hoc


Weiser et al., 2016: “FoodChain-Lab: a trace-back and trace-forward tool developed and applied during food-borne disease outbreak investigations in Germany and Europe”, PLoS ONE.
Outbreak Scenario 1: Restricted to one Location

- Often caused by mistake during food preparation
- Acute outbreak
- High dose
- High infection rate
- Local investigation

Primary Production

Processing

Distribution

Food Preparation

Contamination

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Outbreak Scenario 2: Affecting Multiple Locations/Countries

The outbreak investigation team see:

Cases

- Contamination during production/processing
- Diffuse distribution of cases
- Low dose
- Low infection rate
- Complex investigation
What is FoodChain-Lab?

- Open source software
  [https://foodrisklabs.bfr.bund.de](https://foodrisklabs.bfr.bund.de)

- Database for managing food tracing data

- Tool for data cleaning, enrichment & processing
  - Validation (also online: [https://foodrisklabs.bfr.bund.de/templatevalidator/](https://foodrisklabs.bfr.bund.de/templatevalidator/))
  - Cleaning (e.g. Duplicate Detection)
  - Enrichment (e.g. Geocoding)
  - Analysis (Clustering, Tracing, Scoring, etc.)

- Tool for visualization and interactive reasoning
REGULATION (EC) No 178/2002, Article 18, Traceability

(1) The traceability of food, feed, food-producing animals, and any other substance intended to be, or expected to be, incorporated into a food or feed shall be established at all stages of production, processing and distribution.

(2) Food and feed business operators shall be able to identify any person from whom they have been supplied with a food, a feed, a food-producing animal, or any substance intended to be, or expected to be, incorporated into a food or feed.

To this end, such operators shall have in place systems and procedures which allow for this information to be made available to the competent authorities on demand.

(3) Food and feed business operators shall have in place systems and procedures to identify the other businesses to which their products have been supplied. This information shall be made available to the competent authorities on demand.
"one step back-one step forward" - principle of REGULATION (EC) No 178/2002, Article 18

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Endless supply chains with arbitrary complexity realizable
Principle of tracing back – Data gathering
Principle of tracing back – Data gathering

Receiver | Product out | Business inspected | Product(s) in | Supplier(s)

Primary producer | Supplier | Supplier | Raw material Wholesale | Supplier
Primary producer | Supplier | Supplier | Supplier Freezer | Supplier
Primary producer | Supplier | Supplier | Raw material Wholesale | Supplier

Wholesale | Cake Wholesale | Cake | Retail | End customer
Wholesale | Cake Wholesale | Cake | Retail | End customer
Bakery | Cake Wholesale | Cake | End customer | End customer
Cake consumer | Cake Wholesale | Cake | End customer | End customer
Data gathering – Development of a new “simple” template

“one step back-one step forward”-principle of REGULATION (EC) No 178/2002, Article 18

-> Endless supply chains with arbitrary complexity realizable

Old:

New:

Online Validation: https://foodrisklabs.bfr.bund.de/templatevalidator/
Levenshtein distance

Works well for finding typos
Available Providers:

- (Google)
  - Web service
- MapQuest
  - Web service on open data
- Gisgraphy
  - Locally installable
  - **Confidentiality** of data ensured!
  - No request limit!
**Definition:**

Trace = path, a contamination can take via the food chain network

- Visualization of backward / forward “trace”
- Simulations based on
  - Cross Contamination
  - Regional Effects (e.g. environmental contamination)
  - Weights for Outbreak Stations
- Tracing score as simulation result
  
  ~ likelihood a station is involved in the outbreak

**Math:**

\[
Score(s_i) = \frac{\sum_{j=1}^{n} w_j t_{ij}}{\sum_{j=1}^{n} w_j}
\]

- \(s_i\): Station i
- \(w_j\): Weight of station j
- \(t_{ij}\): 1 if there is trace from station i to j
  - 0 otherwise
- \(n\): Number of stations
Traces of the products of the blue station. All 3 outbreak stations (red) are reached by the forward trace (green).
FoodChain-Lab
(Geo-) cluster analysis

Synchronized network- and map-view.
Manually or automatically defined regions may be treated as one station. This allows analysis of regional causes of the outbreak.
Real world applications

EHEC 2011

Norovirus 2012

HAV 2013/14
Live...
FoodRisk-Labs is a portal to the following tools developed by the Federal Institute for Risk Assessment (BfR):

- FoodChain-Lab
- PMM-Lab
- FoodProcess-Lab
- FSMR

https://foodrisklabs.bfr.bund.de
Outlook
Software

- Automation
  - Simulations for various parameters

- Integration
  - Further tools: FoodProcess-Lab, Pmm-Lab, …
  - Further data: Sample analysis data from laboratories, …

- Simplification
  - Data collection
  - Handling

- Other
  - Improved Layouts
  - New Retrospective features
  - Support, bug fixes, documentation
  - …
Outlook
Strategy

● Special enhancements on data gathering
  ● Centralizing / Cloud service (but still usable for decentral units)
  ● Direct on-site data gathering, e.g. via Tablet/Phone
  ● Establish data exchange formats between authority -> authority and business -> authority

● Dissemination
  ● Workshops with the motive “Train the trainer”
    ● MS of EU
    ● Other parties?
  ● Every day usage? Further application areas?

● Realize (pilot) projects with potential stakeholders?
● Do we need a “Rapid Deployment Team”? 
Thank you for your attention

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