FoodChain-Lab: Tracing software supporting foodborne disease outbreak investigations

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Outline

● Introduction

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

● Outlook
Outbreak Scenario 1: Restricted to one Location

- Often caused by mistake during food preparation
- Acute outbreak
- High dose
- High infection rate
- Local investigation
Outbreak Scenario 2:
Affecting Multiple Locations/Countries

Primary Production

Processing

Distribution

Food Preparation

Contamination

- Contamination during production/processing
- Diffuse distribution of cases
- Low dose
- Low infection rate
- Complex investigation

The outbreak investigation team see:
Cases
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
Database – Structure for Food Chains

“one step back-one step forward” - principle of REGULATION (EC) No 178/2002, Article 18
->
Endless supply chains with arbitrary complexity realizable
Principle of tracing back – Data gathering

Receiver  Product out  Business inspected

Primary producer  Supplier  Supplier  Raw material Wholesale

Cake  Wholesale

Retail  End customer

End customer

Cake consumer

Primary producer  Supplier  Supplier  Supplier  Freezer

Wholesale  Cake Wholesale  Retail  Bakery

End customer

Cake consumer
Principle of tracing back – Data gathering

Receiver | Product out | Business inspected | Product(s) in | Supplier(s)
---|---|---|---|---
Primary producer | Supplier | Raw material Wholesale | Cake Wholesale | End customer
Primary producer | Supplier | Cake | Retail | End customer
Primary producer | Raw material Wholesale | Cake Wholesale | Bakery | End customer
Primary producer | Cake | Cake consumer

Principle of tracing back:
- Data gathering
- Primary producer
- Supplier
- Raw material Wholesale
- Cake Wholesale
- End customer
- Retail
- Bakery
- Cake consumer
Data gathering – Development of a new “simple” template

old:

new:

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

->

Endless supply chains with arbitrary complexity realizable

Online Validation: https://foodrisklabs.bfr.bund.de/templatevalidator/
FoodChain-Lab
Data cleaning

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!

FoodChain-Lab
Data Enrichment – Geocoding

<table>
<thead>
<tr>
<th>Station</th>
<th>ID</th>
<th>Products</th>
<th>Name</th>
<th>Street</th>
<th>House Number</th>
<th>P.O. Box</th>
<th>Zip Code</th>
<th>City</th>
<th>County</th>
<th>Country</th>
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Armin Weiser, 08.02.2016, HoA Workshop, Tools supporting food chain safety assessments → FoodChain-Lab
FoodChain-Lab
Scoring

**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:**

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

- \( s_i \): 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).
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

FoodRisk-Labs is a portal
to the following tools
developed by the Federal Institute for Risk Assessment (BfR):

FoodChain-Lab
PMM-Lab
FoodProcess-Lab
Open Food Safety Model Repository
Events
Contact
Disclaimer

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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