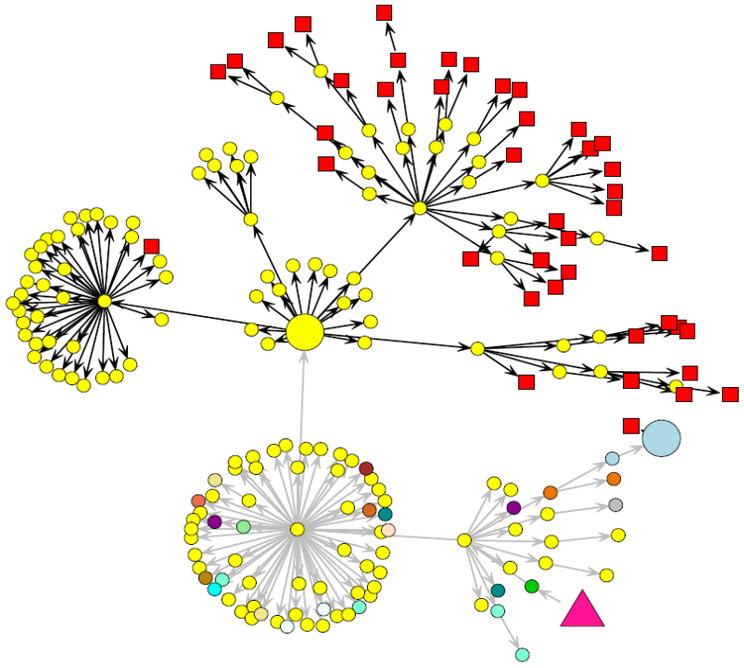
Bundesinstitut für Risikobewertung

FEDERAL INSTITUTE FOR RISK ASSESSMENT

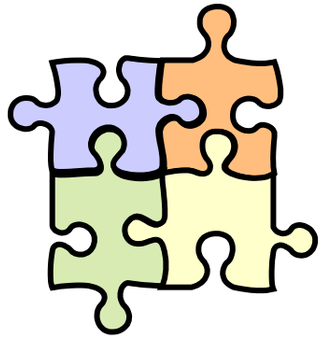
# FoodChain-Lab: Tracing software supporting food-borne disease outbreak investigations



Food Chain Lab

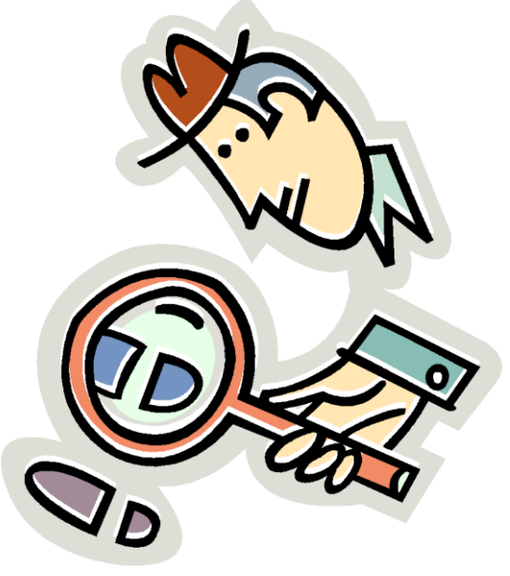
**Armin Weiser, Christian Thöns, Alexander Falenski, Matthias Filter, Annemarie Käsbohrer, Bernd Appel**

# Outline



- **Foodborne Outbreak Investigation**
- **Tracing - Software: FoodChain-Lab**
- **Summary & Outlook**

# Investigations along the Food Chain

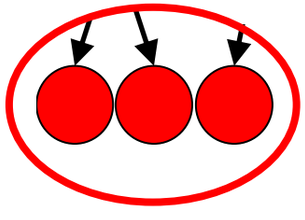


- Epidemiological Investigation
  - Case-control study
  - Who ate what, when and where?
- Microbiological Investigation
  - Business inspections
  - Taking/Testing samples
- Backtracing (and Forward Tracing if necessary)
  - Step-by-step following the supply chain
  - Where does the contamination come from?
  - Collecting delivery data for contaminated products and its ingredients

# Outbreak Scenario:

## Affecting Multiple Locations/Countries

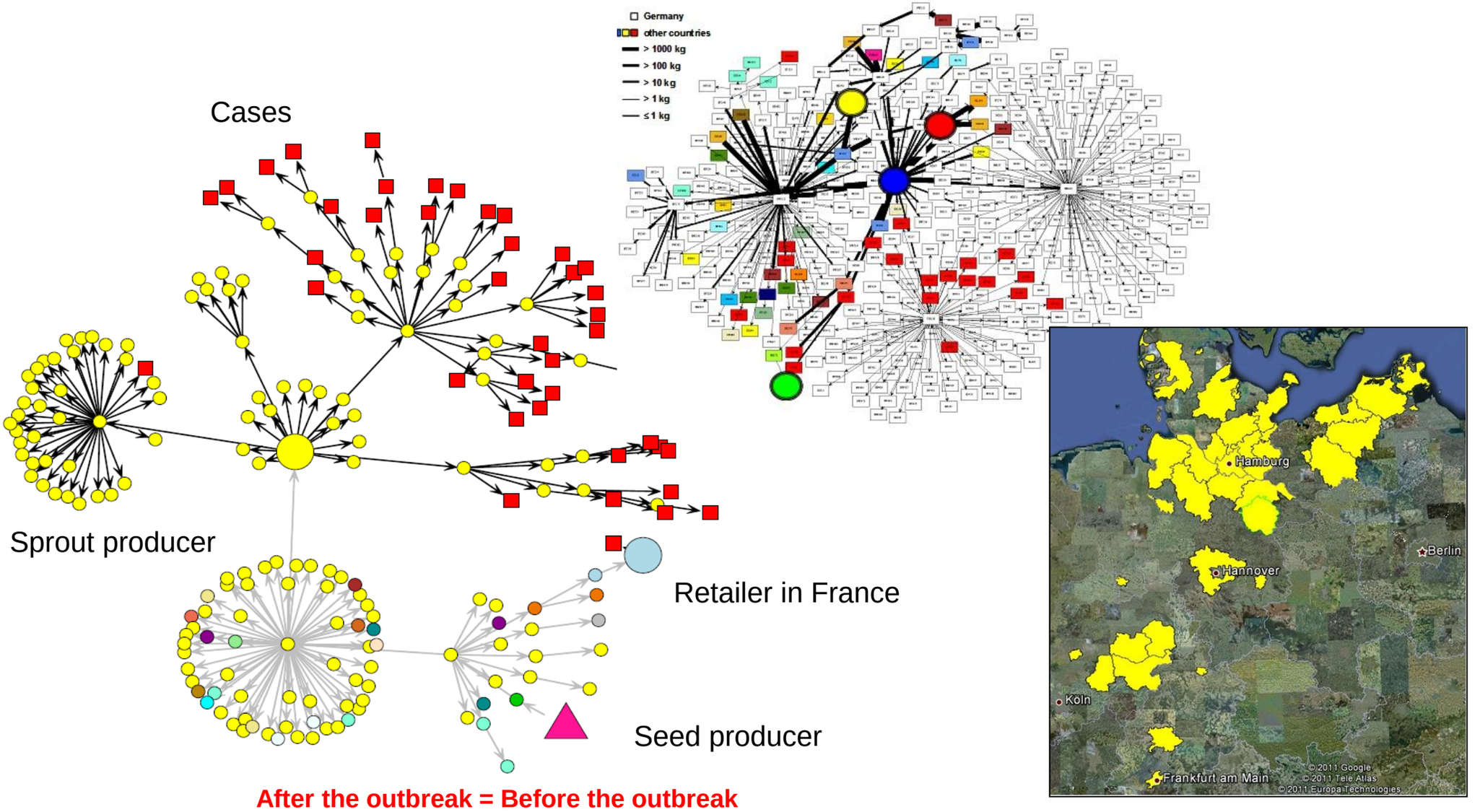
- **Contamination during production/processing**
- **Diffuse distribution of cases**
- **Low dose**
- **Low infection rate**
- **Complex investigation**



**The outbreak investigation teams can only see Cases**

SN Braunschweiger grob
(S. Muenchen)
TH Knackwurst (Brutwurst)
(S. Muenchen)
Rückruf 6kg per Ausgang
Schinken-
SN Teewurst
(S. Muenchen)
SN Zwiebelmettwurst
(Salmonella Gr. C)
Mettbrötchen
Schweinehack
Brustspitzen-fleisch
(negativ)
Hackepeter

# FoodChain-Lab – ad hoc

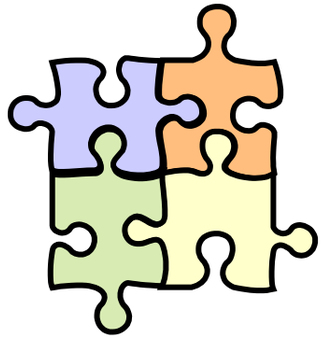



**After the outbreak = Before the outbreak**

**Weiser et al., 2013**: “Trace-Back and Trace-Forward Tools Developed Ad Hoc and Used During the STEC O104:H4 Outbreak 2011 in Germany and Generic Concepts for Future Outbreak Situations“, **Foodborne Pathog Dis**.

**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**.

# Outline



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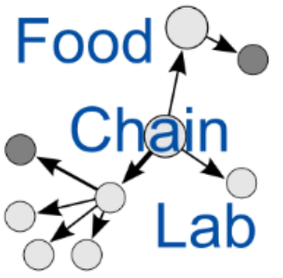
# What is FoodChain-Lab?




- Open source software

  https://foodrisklabs.bfr.bund.de

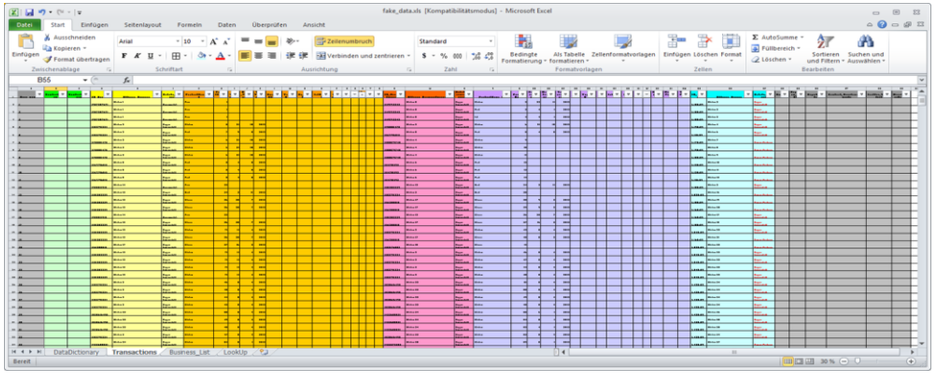
- Database for managing food tracing data

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

- Tool for visualization and interactive reasoning

# Data gathering – Development of a new “simple” template

**old:**



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

->

Endless supply chains with arbitrary complexity realizable

**new:**

Backtrace_request_3001_Caterer 01.xlsx - Microsoft Excel

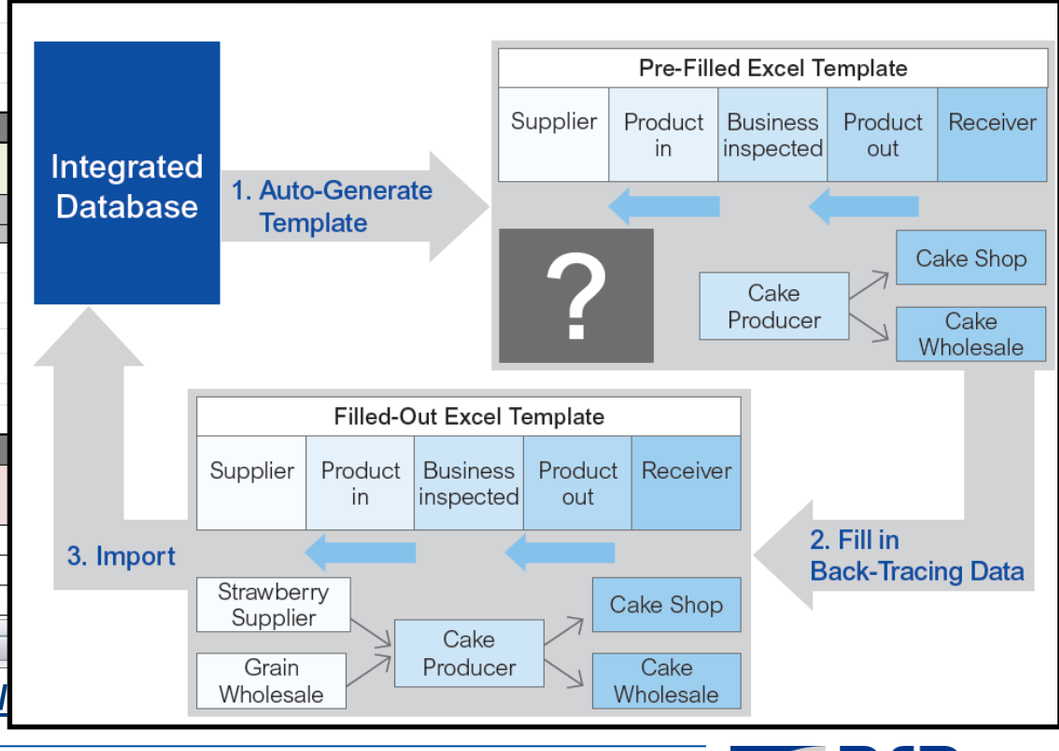
Datei | Start | Einfügen | Seitenlayout | Formeln | Daten | Überprüfen | Ansicht

E30

| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Reporter Information | | | | | | | | | | | | |
| 2 | Reporting Officer | Reporting Date | Reporting Remark | | | | | | | | | | |
| 3 | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | |
| 5 | Station in Focus: | 3001 | Caterer 01 | | | | | | | | | | |
| 6 | | | | | | | | | | | | | |
| 7 | Products Out | | | | | | | | | | | | |
| 8 | Product Name | Lot Number | Delivery Date Departure | | | Delivery Date Arrival | | | Unit weigt/vol./pck. | | Recipient | | |
| 9 | | | Day | Month | Year | Day | Month | Year | Quantity | Type / Unit | | | |
| 10 | Menü 1 | M01 | 3 | 9 | 2014 | 3 | 9 | 2014 | 62 | Portionen | 9012 | | |
| 11 | Menü 2 | M02 | 3 | 9 | 2014 | 3 | 9 | 2014 | 101 | Portionen | 9008 | | |
| 12 | | | | | | | | | | | | | |
| 13 | Lot Information | | | | | | | | | | | | |
| 14 | Lot Number of "Product Out" | Lot size | | | | | | | | | | | |
| 15 | | Quantity | Type / Unit | | | | | | | | | | |
| 16 | M01 | 900 | Portionen | | | | | | | | | | |
| 17 | M02 | 900 | Portionen | | | | | | | | | | |
| 18 | | | | | | | | | | | | | |
| 19 | Ingredients for Lot(s) | | | | | | | | | | | | |
| 20 | Ingredient Name | Lot Number of Ingredient | Delivery Date Departure | | | Delivery Date Arrival (if departure unknown) | | | Unit weigt/vol./pck. | | Supplier | | |
| 21 | | | Day | Month | Year | Day | Month | Year | Quantity | Type / Unit | | | |
| 22 | | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | |

Stations | BackTracing | ForwardTracing_Opt | LookUp | Help

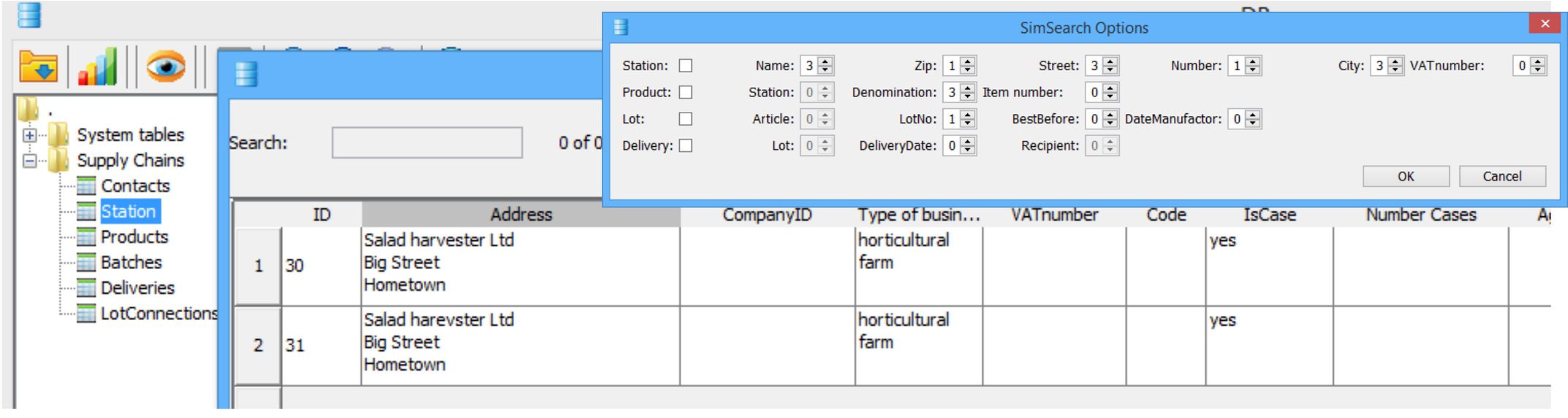
Bereit




**Online Validation:** https://foodrisklabs.bfr.bund.de/templatevalidator/

# FoodChain-Lab

## Data cleaning




## Levenshtein distance

| M | A | Y | O | N | N | A | I | S | E |
|---|---|---|---|---|---|---|---|---|---|
| = | = | = | = | = | - | = | = | = | = |
| M | A | Y | O | N | | A | I | S | E |

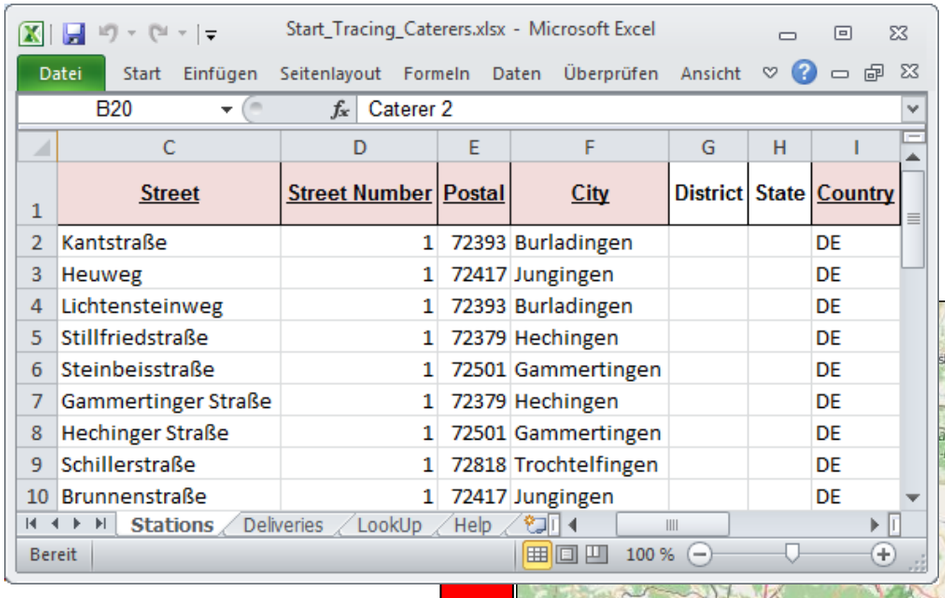
| B | I | O | M | R | A | K | T |
|---|---|---|---|---|---|---|---|
| = | = | = | = | - | - | = | = |
| B | I | O | M | A | R | K | T |

| E | L | E | P | H | A | N | T |
|---|---|---|---|---|---|---|---|
| = | = | = | **O** | - | = | = | = |
| E | L | E | F | | A | N | T |

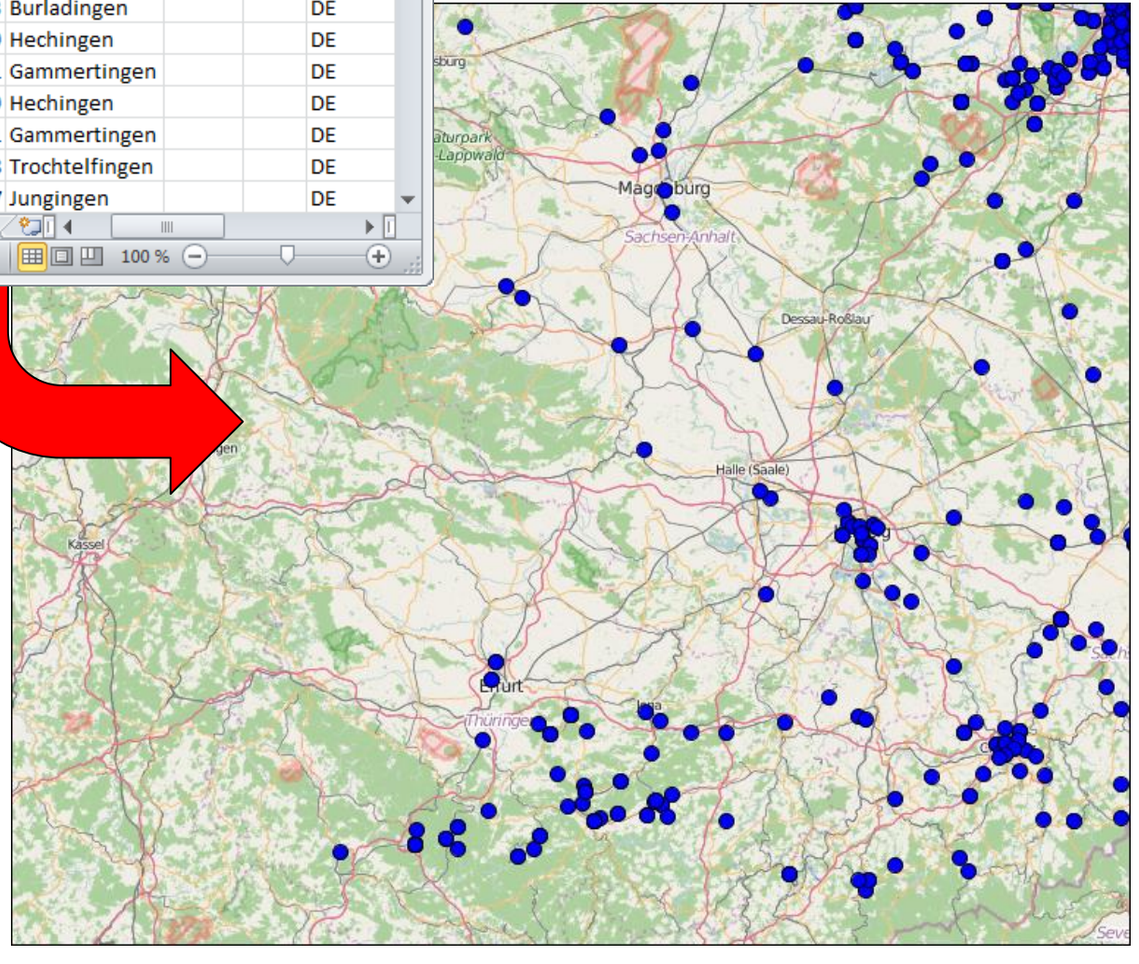
Works well for finding typos

# FoodChain-Lab

## Data Enrichment – Geocoding




| | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|
| 1 | Street | Street Number | Postal | City | District | State | Country |
| 2 | Kantstraße | 1 | 72393 | Burladingen | | | DE |
| 3 | Heuweg | 1 | 72417 | Jungingen | | | DE |
| 4 | Lichtensteinweg | 1 | 72393 | Burladingen | | | DE |
| 5 | Stillfriedstraße | 1 | 72379 | Hechingen | | | DE |
| 6 | Steinbeisstraße | 1 | 72501 | Gammertingen | | | DE |
| 7 | Gammertinger Straße | 1 | 72379 | Hechingen | | | DE |
| 8 | Hechinger Straße | 1 | 72501 | Gammertingen | | | DE |
| 9 | Schillerstraße | 1 | 72818 | Trochtelfingen | | | DE |
| 10 | Brunnenstraße | 1 | 72417 | Jungingen | | | DE |

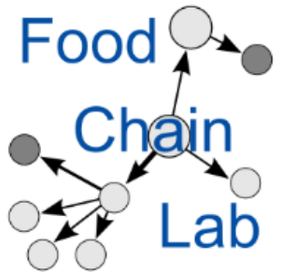



## Available Providers:

- **(Google)**
  - Web service
- **MapQuest**
  - Web service with open data
- **Gisgraphy**
  - Locally installable
  - Data stays confidential
  - Unlimited requests

# FoodChain-Lab

## Scoring




- 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:**

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

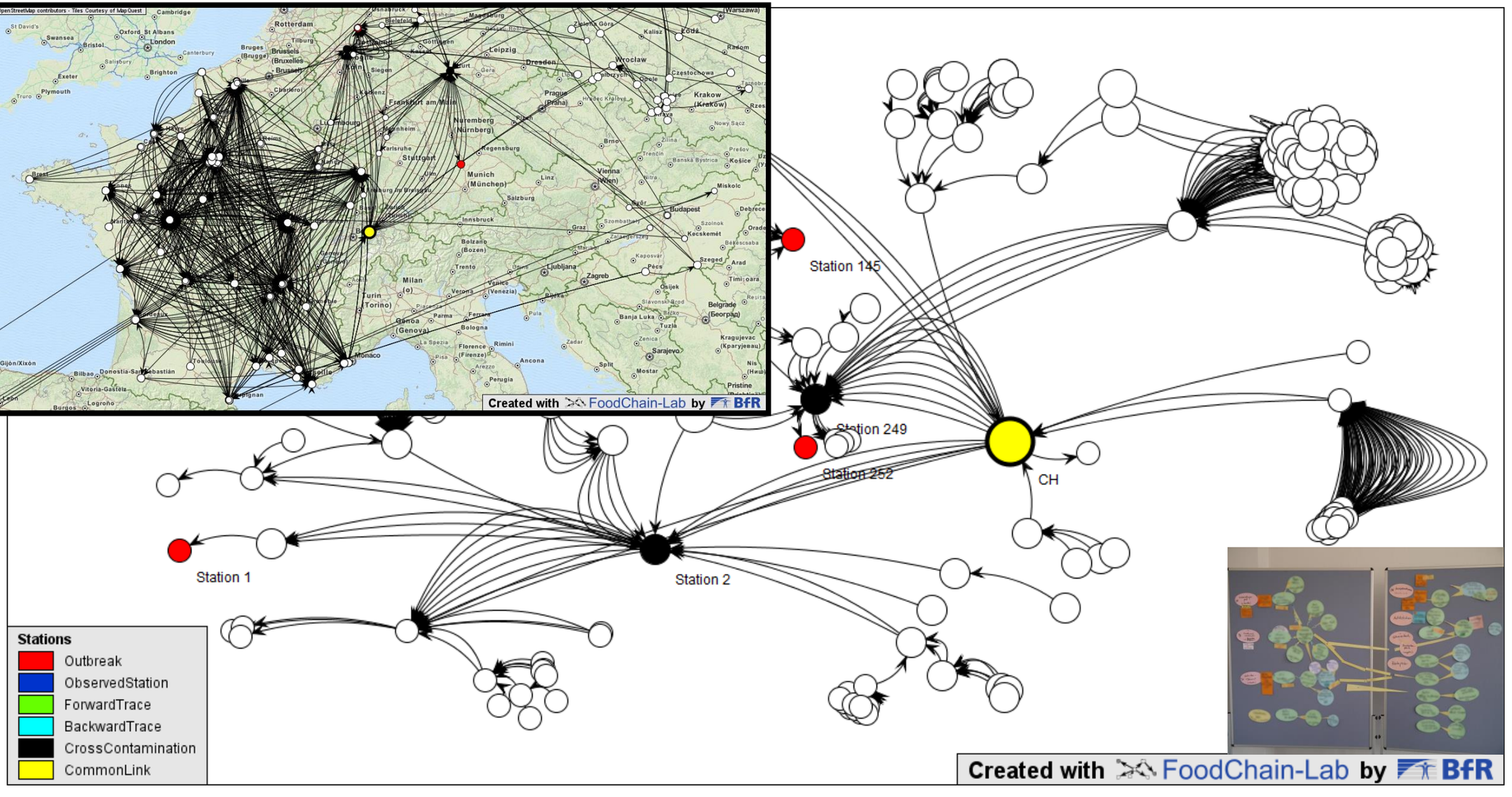
| | |
|---|---|
| $s_i$: | Station **i** |
| $w_j$: | Weight of station **j** |
| $t_{ij}$: | 1 if there is trace from station **i** to **j** |
| | 0 otherwise |
| n: | Number of stations |

# 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..

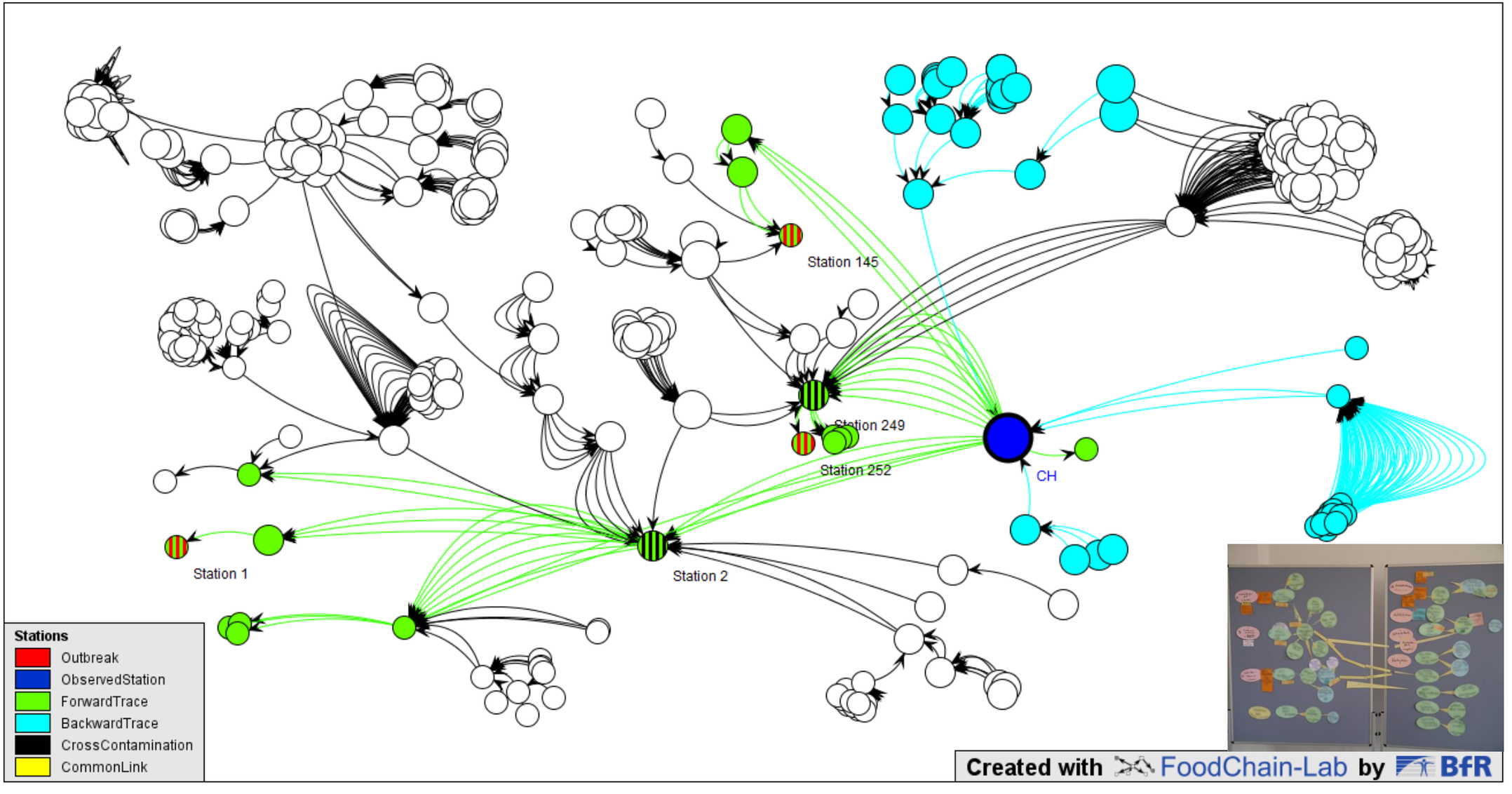


# FoodChain-Lab

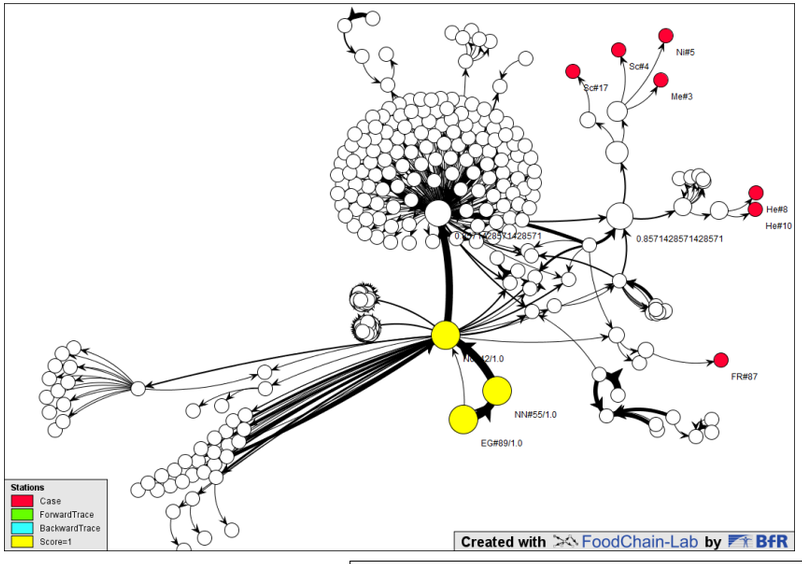
## Data visualization of Traces

Traces of the products of the blue station. All 3 outbreak stations (red) are reached by the forward trace (green).

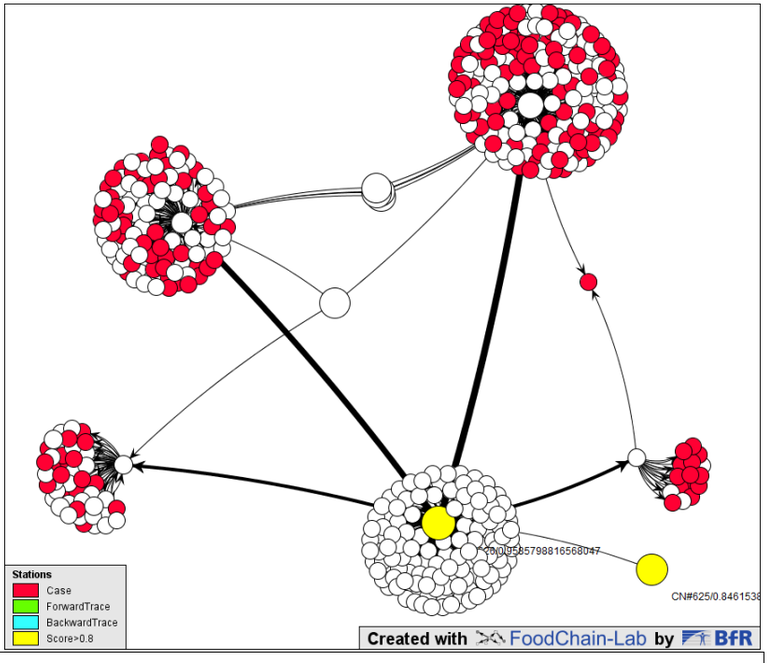


# Real world applications

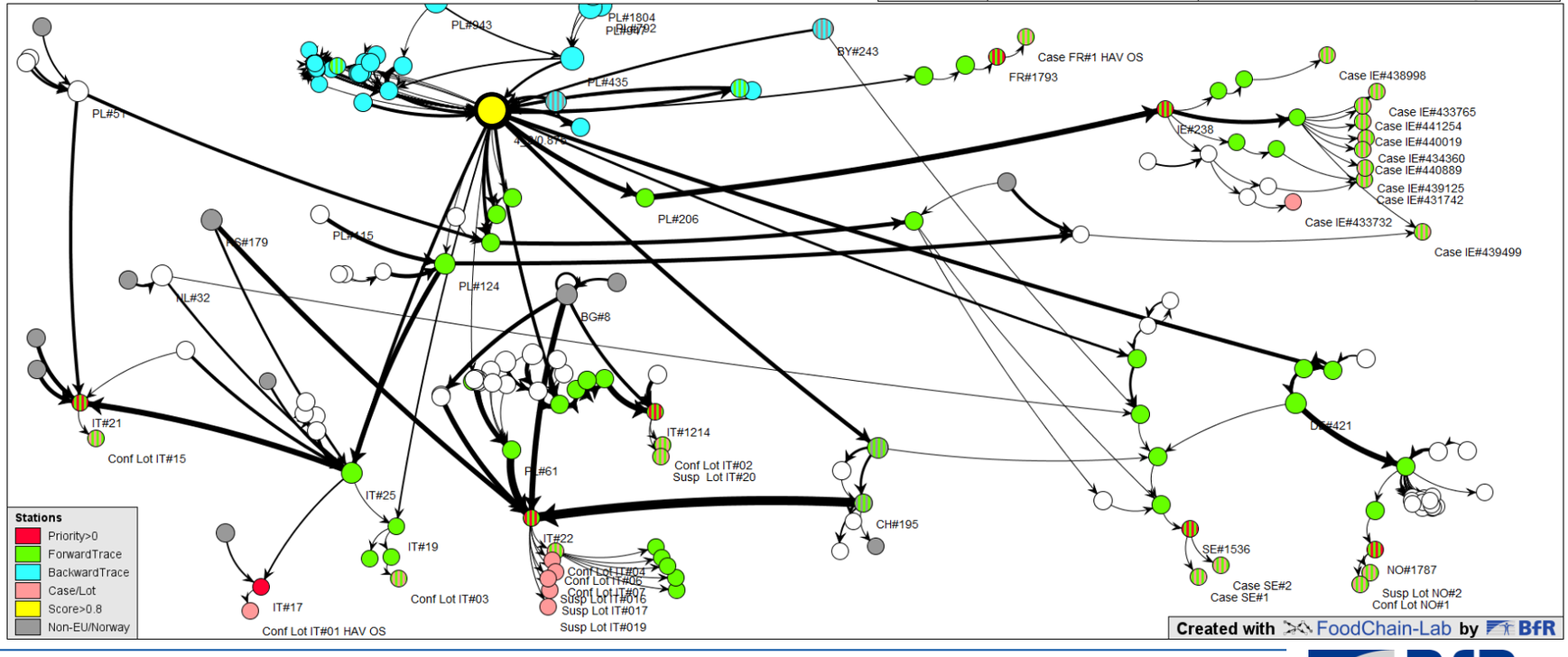
## EHEC 2011



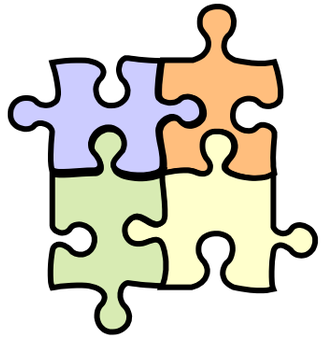

## Norovirus 2012




## HAV 2013/14



# Outline



- **Foodborne Outbreak Investigation**
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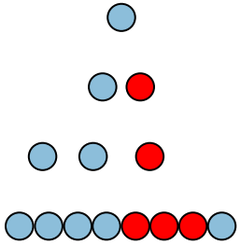
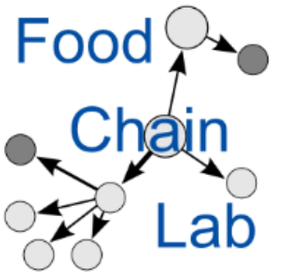
# Summary

- As soon as you are aware of the fact that you have an outbreak:
  - Ask affected persons for bought food!
  - Ask affected persons for consumed food!



- Quick data collection possible due to clear standardized definition of data needs
- Data validation and enrichment
- Assists in Outbreaks
  - Simulations
  - Brainstorming
  - Prioritizing
  - Identifies missing data
- General benefits
  - Relevant parts of analysis and reporting (tables, figures, illustrations) done quickly and automatically
  - Documentation for hearings (legal issues)

# Outlook




- FoodChain-Lab -> web-based
- Automation
- Integration
  - Further tools
  - Further data
- Further enhancements on data collection (e.g. iRASFF, exchange formats)
- Workshops
- Projects with interested parties
  - “Rapid Deployment Team”

# https://foodrisklabs.bfr.bund.de

**FoodRiskLabs**

- FoodChain-Lab
- Predictive Microbial Modeling Lab (PMM-Lab)
- FoodProcess-Lab
- Open Food Safety Model Repository
- Events
- Contact
- Disclaimer

Search …

## FoodRisk-Labs

Powered by BfR

Risiken erkennen – Gesundheit schützen

FoodRisk-Labs is a portal

to the following tools

developed by the Federal Institute for Risk Assessment (BfR):

Food Chain Lab

PMM-Lab

Food Process Lab

open FSMR

FEDERAL INSTITUTE
FOR RISK ASSESSMENT

BfR
Bundesinstitut für Risikobewertung

# Thank you for your attention


Armin Weiser

https://foodrisklabs.bfr.bund.de

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