Food fraud and prediction

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Outline

- Food fraud

- Developing a food fraud early warning system using European media monitor (EMM)

- Food fraud prediction

Food fraud, GFSI definition

'A collective term encompassing the **deliberate and intentional** substitution, addition, tampering, or misrepresentation of food, food ingredients or food packaging, labelling, production information, or false or misleading statements made about a product **for economic gain** that could impact consumer health'
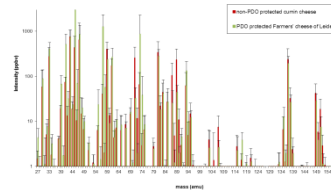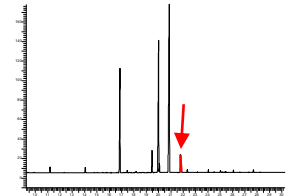
Food fraud may result in a food safety risk

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Source: Saskia van Ruth (RIKILT), 2015

Identification of fraud: research at RIKILT

- Analytical methods (chemical, physical, microscopy)

  - Targeted approach: single marker

  - Untargeted approach: Multiple markers
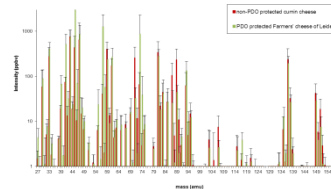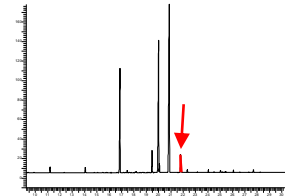
    - fingerprints

- Text mining approach (MedISys)

- Trend analysis (databases (RASFF, EMA, UPS etc) & prediction modelling (agent modelling, Bayesians network)

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European Media Monitor (EMM)

EMM; characteristics

The Europe Media Monitor (EMM) provides advanced analysis systems for monitoring of both traditional and social media.

➢ EMM applies text mining techniques to screen different types of media on the world wide web: websites, databases, blogs, ..etc.

➢ EMM is updated every 10 minutes, 24 hours per day.

➢ EMM gathers reports from news portals world-wide in 60 languages.

➢ EMM contain 3 portals: NewsBrief, NewsExplorer and MedISys

(http://emm.newsbrief.eu/overview.html)

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MedISys: public health related topics

No collection of publications on food fraud

http://medusa.jrc.it/medisys/homeedition/en/home

EMM Food Fraud Filter Design steps

Step 1: Definition of food fraud key words

| Scientific articles | Food Fraud articles | USP Database | EMA Database | RASFF |

Step 2: Validation of the keys words by Food fraud experts

| Prof. Saskia Van Ruth (RIKILT) | Dr. Hans Marvin (RIKILT) | Dr. Karen Everstine (USA) |

Step 3: The design of the food fraud filter in EMM

EMM system

Step 4: Evaluation and improvement of the filter.

| Analyse the articles | Relevance evaluation | Key words improvement |
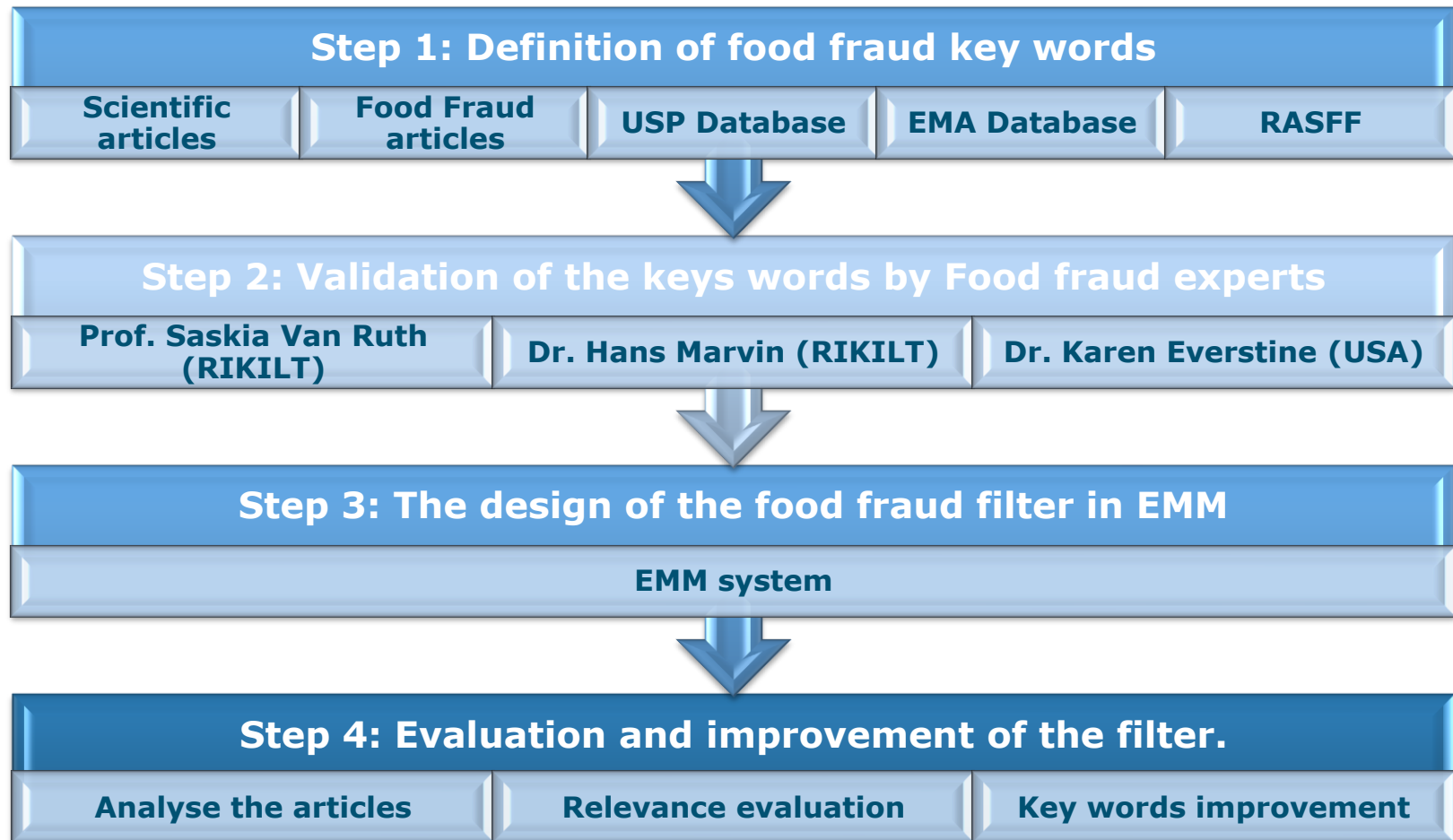
Figure.1: Design steps

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Food Fraud keywords

Generic Key words	Specific key words	Excluded key word
• Food Fraud • Mislabelled • Counterfeit • Tampering • Misleading • False • Intentional substitution • Smuggling • Dilution • Substitution • ..etc	• food+fraud • fake+food • mislabeled+food • economic+adulteration+food • food+adultration • counterfeit+food • olive+oil+dilution • olive+oil+fraud • counterfeit+olive+oil • mislabeled+olive+oil • honey+mislabling • honey+fraud	• Fraud • Artificial Food • Counterfeit Medicine • Goods fraud • Wine • How to make fake alcohol? • How to make fake milk? • How to make fake Oil?
Total of included key words	**64 x 8 = 512**	

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Key Words Languages

Spanish

Italian

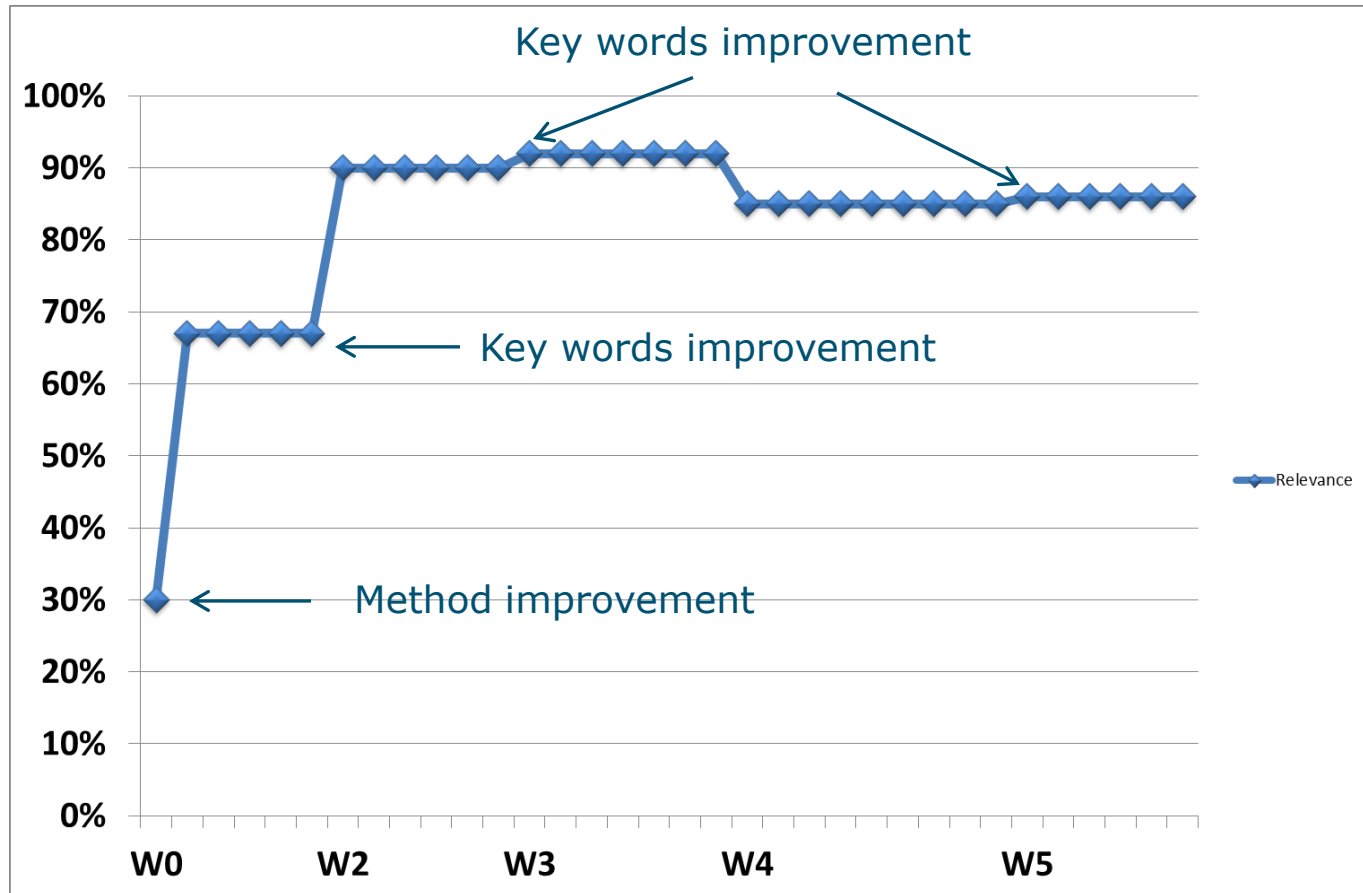English

German

French

Chinese

Dutch

Arabic

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Food fraud filter efficiency

Food Fraud filter efficiency:
More than 95 Food Fraud articles in last 2 months.
Relevance index = 86%.

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MedISys adapted to detect food fraud

Wine fraud in the UK is 'massive', says expert

By Nicholas Robinson+, 03-Dec-2014

Related topics: Food Safety, Beverages

Fraud in the UK's wine industry is rampant because the sector has failed to implement the controls necessary to stamp it out, a food safety expert has claimed.

Wine fraud in the UK has been grossly underestimated because of the way the sector is structured, claimed the food safety expert, who did not want to be named.

Big wine companies were not placing enough emphasis on preventing fraud and, as a result, crooks were cashing in on the opportunity, he said.

Food fraud costs UK firms £11bn a year

By Laurence Gibbons+
28-Nov-2014
Last updated on 28-Nov-2014 at 13:02 GMT

Fraud is costing the food industry £11.2bn a year

ALIMENTATION -

Fraude à la viande: la commune de Mol « pas au courant » des activités de Willy Selten

Accueil > Belgique - jeudi 29 janvier 2015 14h37 - Belga

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EMM Food Fraud Filter Design steps
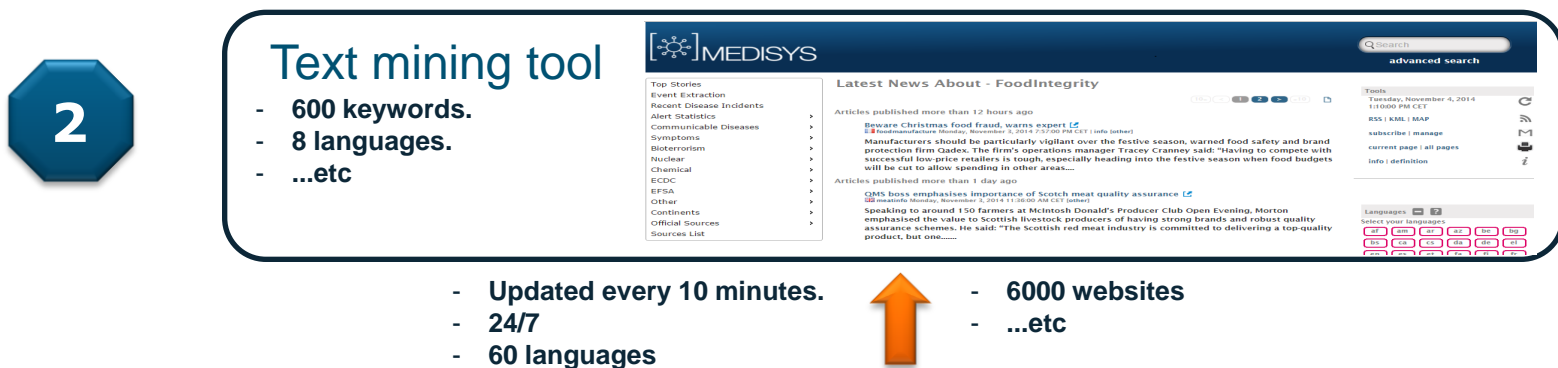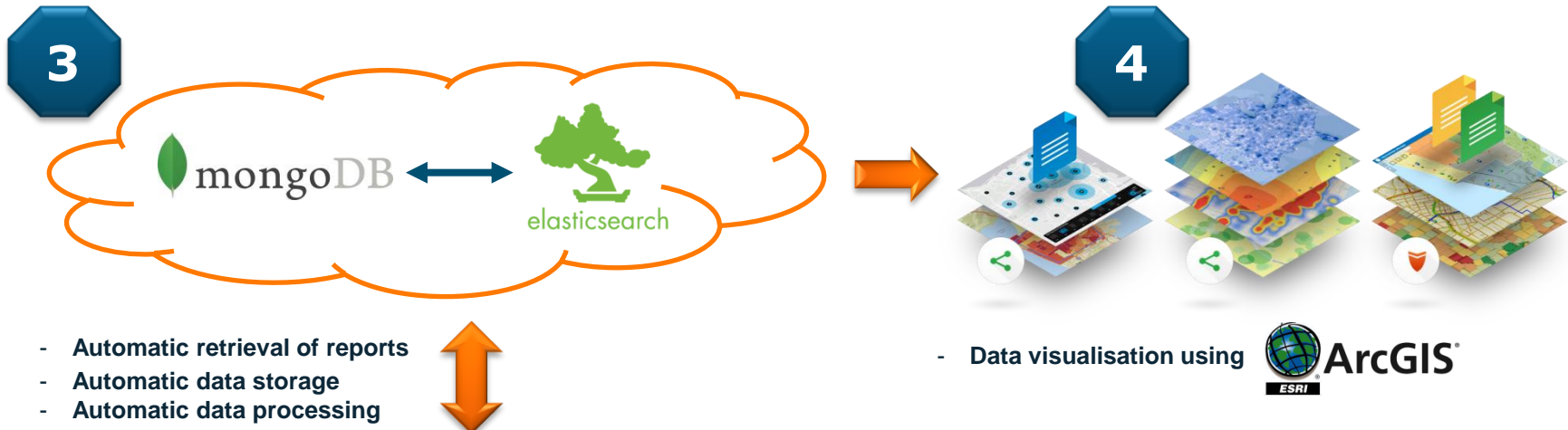
4 Data visualisation using ArcGIS

Food fraud reports (overall) in MedISys (period September 2014 to December 2015; N = 1114)

Data visualisation using ArcGIS

4

Food fraud reports (milk) in MedISys (period September 2014 to December 2015)
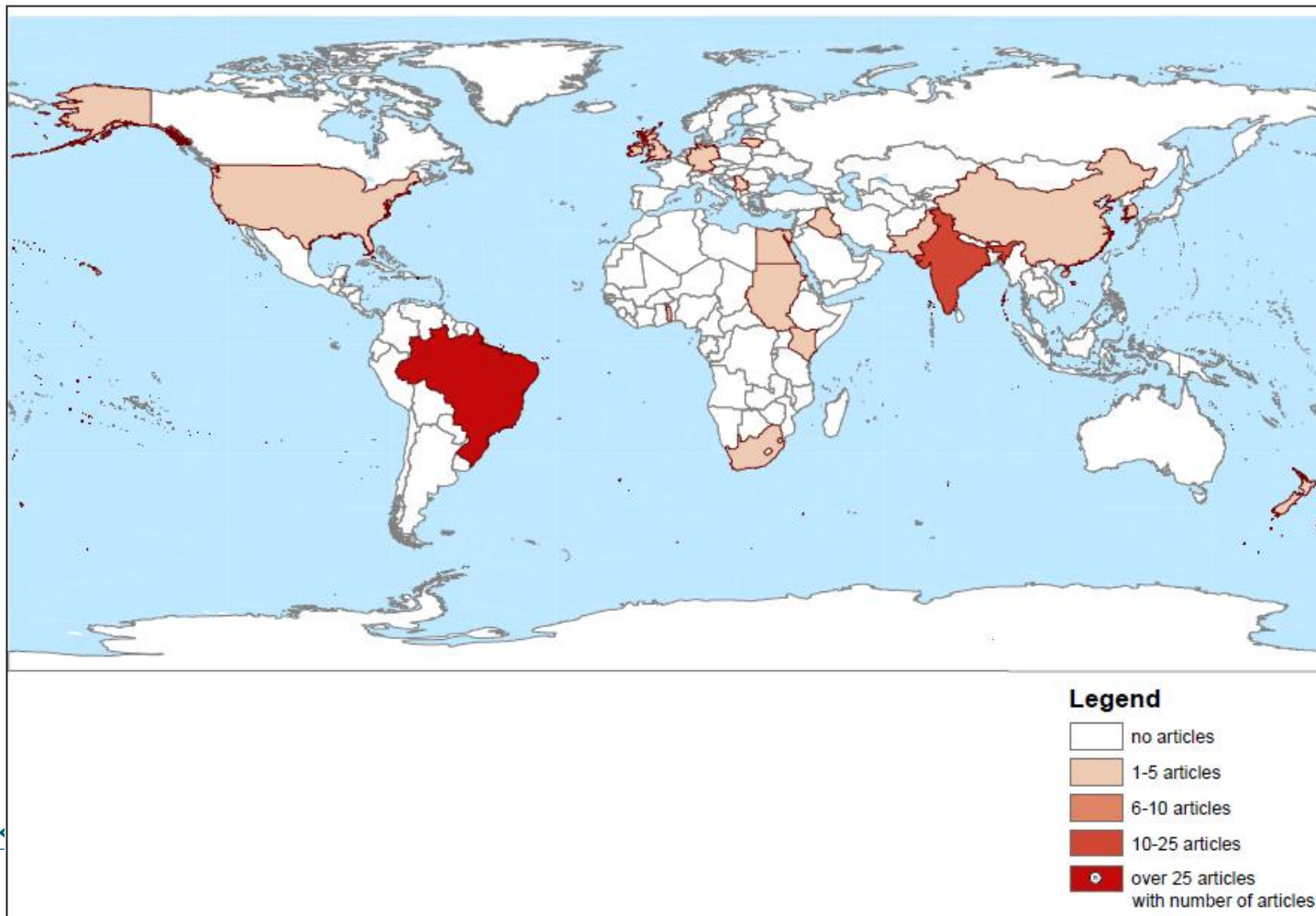
Legend
- no articles
- 1-5 articles
- 6-10 articles
- 10-25 articles
- over 25 articles with number of articles

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Identification of fraud: research at RIKILT

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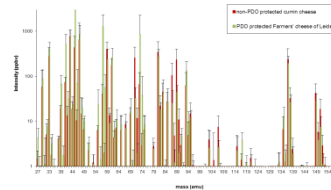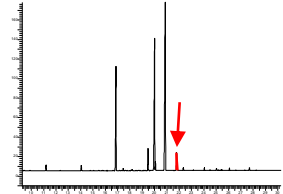
- Text mining approach (MedISys)

- **Trend analysis** (**databases (RASFF, EMA**, UPS etc) & **prediction modelling** (agent modelling, **Bayesians network)**

Food fraud is reported in Rapid Alert System for Food and Feed (RASFF)

Food fraud notifications in RASFF (2000 to 2013).
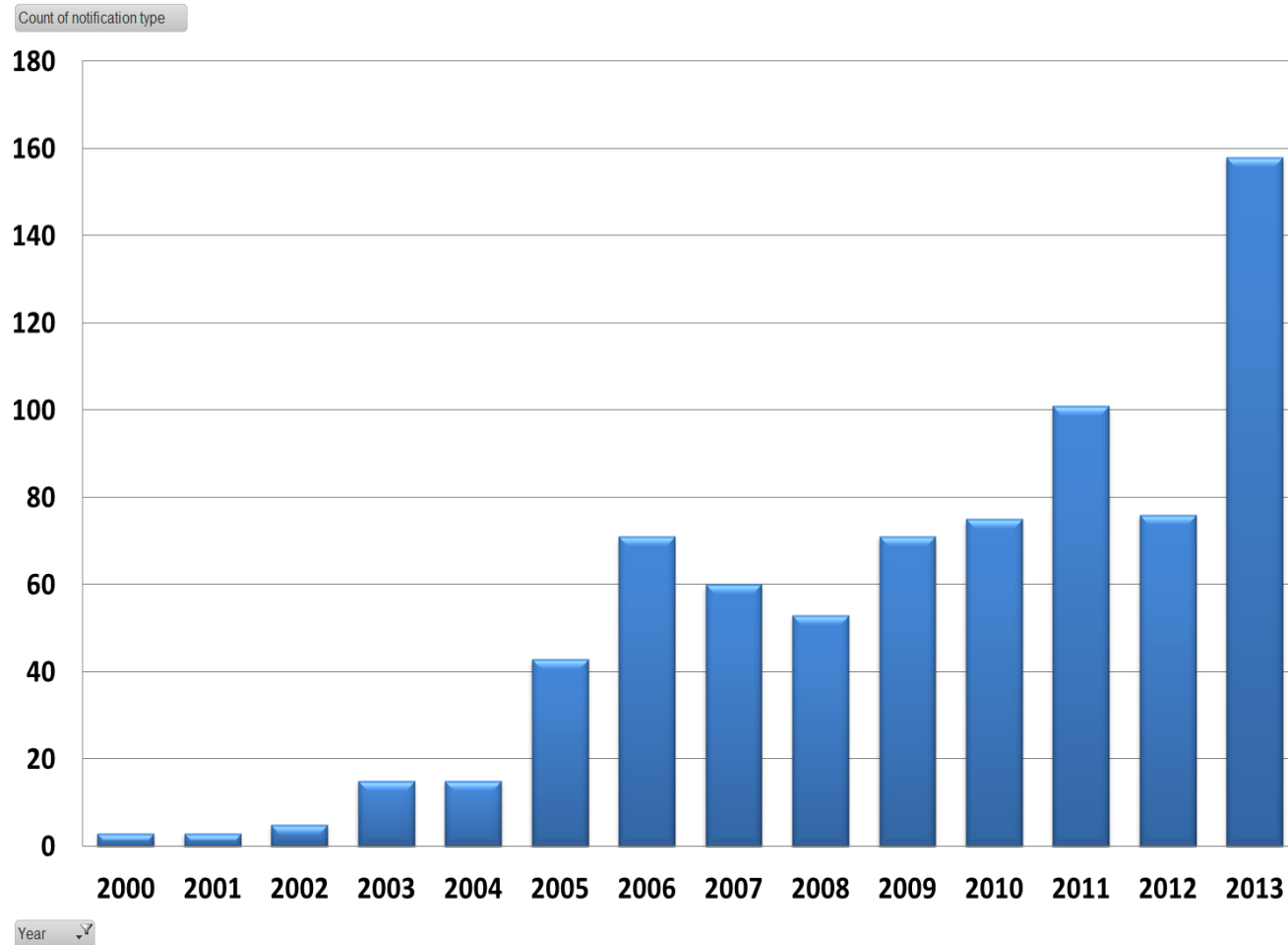
Products related to food fraud in RASFF
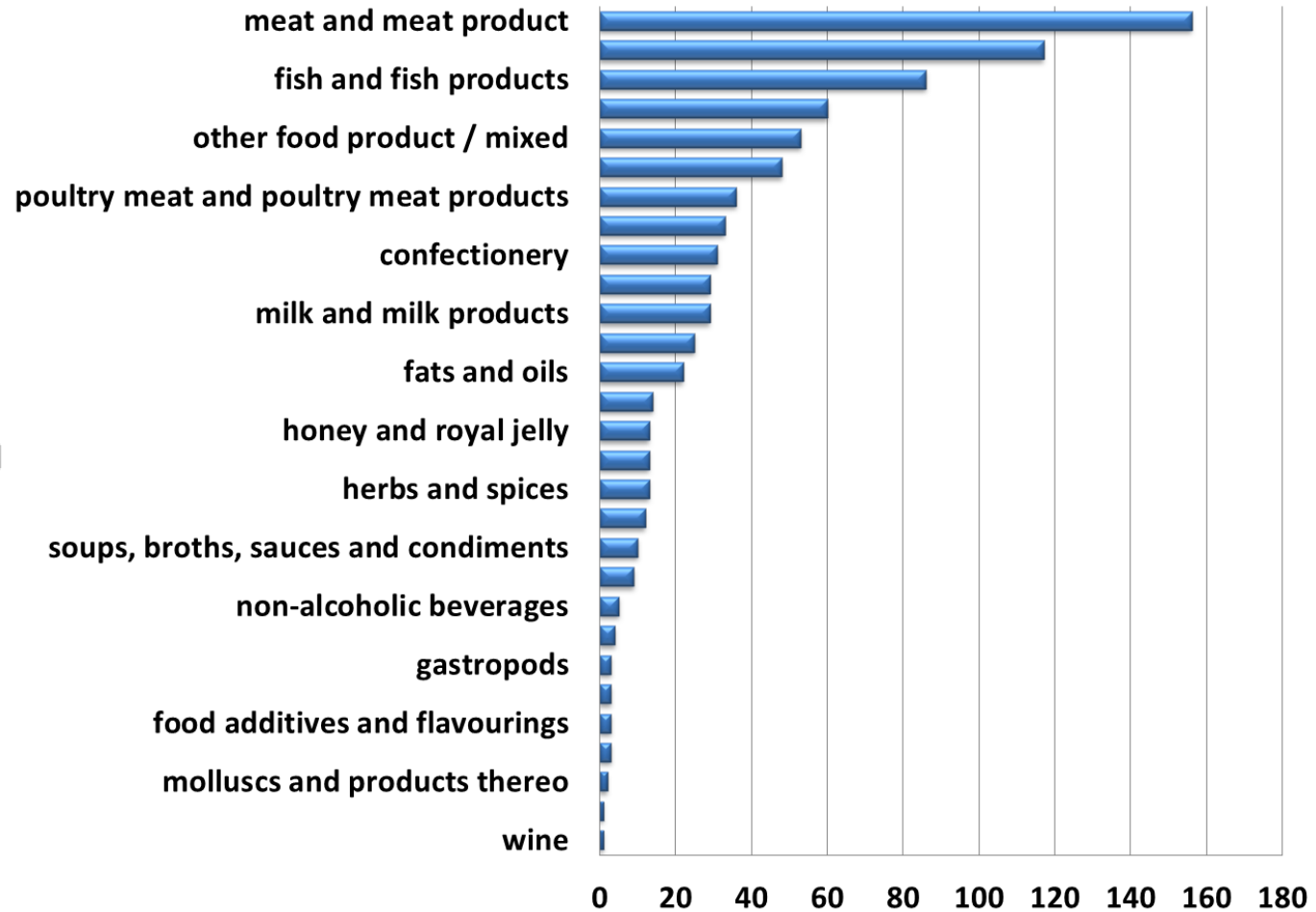
Modelling of Fraud in RASFF using Bayesians network

Model developed with RASFF data up to 2013

Model validated with RASFF data of 2014

Model performance:
- 82% correct prediction of fraud type
- 51% prediction of new fraud combinations
- static

Higher performance with dynamic model approach

fraud
- 1.74 Labelling
- 4.54 CED
- 31.11 Illegal-importation
- 44.19 HC
- 15.22 Tampering
- 3.20 Expired-Date

notification
- 46.06 information
- 47.93 border-rejection
- 6.01 alert

Product
- 0.40 alcoholic
- 4.14 molluscs
- 1.20 cephalopods
- 3.07 cereals
- 1.34 Coffe
- 3.87 confectionery
- 3.20 crustaceans
- 1.47 dietetic
- 1.87 eggs
- 2.67 fats
- 11.21 fish
- 0.40 food additives and flavourings
- 4.41 fruits
- 0.40 gastropods
- 1.74 spices
- 1.74 honey
- 0.13 ices
- 20.69 meat
- 3.87 milk
- 0.40 water
- 0.67 non-alcoholic
- 12.82 nuts
- 6.01 mixed
- 4.54 poultry
- 6.28 snacks
- 0.93 soups
- 0.53 wild

Year μ=2009.44, σ2=9.03
- 0.40 2000
- 0.40 2001
- 0.67 2002
- 2.00 2003
- 2.00 2004
- 5.74 2005
- 9.48 2006
- 8.01 2007
- 7.08 2008
- 9.48 2009
- 10.01 2010
- 13.48 2011
- 10.15 2012
- 21.09 2013

notified
- 16.15 United Kingdom
- 0.53 Portugal
- 6.54 Spain
- 16.02 Italy
- 2.14 Denmark
- 3.74 Netherlands
- 8.54 Germany
- 3.34 Lithuania
- 3.07 Norway
- 1.47 Sweden
- 5.21 Greece
- 2.67 Cyprus
- 0.40 Luxembourg
- 1.07 Latvia
- 6.41 France
- 4.67 Belgium
- 1.34 Malta
- 0.53 Slovakia
- 5.21 Poland
- 0.53 Estonia
- 2.54 Romania
- 1.87 Hungary
- 2.67 Slovenia
- 1.20 Bulgaria
- 0.80 Czech Republic
- 0.13 Finland
- 0.53 Ireland
- 0.67 Austria

origin
- 1.07 unknown origi
- 4.41 United States
- 3.61 Japan
- 0.53 Uruguay
- 23.77 China
- 1.34 South Korea
- 1.07 Tunisia
- 0.40 Croatia
- 0.40 New Zealand
- 1.74 Vietnam
- 9.61 Turkey
- 1.07 Morocco
- 0.13 Indonesia
- 1.34 Argentina
- 0.80 Senegal
- 0.40 Taiwan
- 0.13 Mauritania
- 1.47 United Kingdor
- 1.01 Belgium
- 0.13 Kazakhstan
- 0.80 Hong Kong
- 0.80 Netherlands
- 0.80 Iran
- 0.40 Colombia
- 4.14 Philippines
- 0.13 Cuba
- 0.27 Malaysia
- 3.07 India
- 0.27 Guinea
- 0.13 Gabon
- 0.40 Canada
- 0.53 Bangladesh
- 2.14 Ecuador
- 0.13 Mozambique
- 0.67 Russia
- 0.27 Czech Republi
- 0.13 Peru
- 3.21 Poland
- 2.27 Ukraine
- 0.94 Latvia
- 1.87 France
- 1.60 Italy
- 1.47 Ghana
- 0.13 Democratic Re
- 0.80 Thailand
- 0.53 Nigeria
- 0.13 Falkland Island
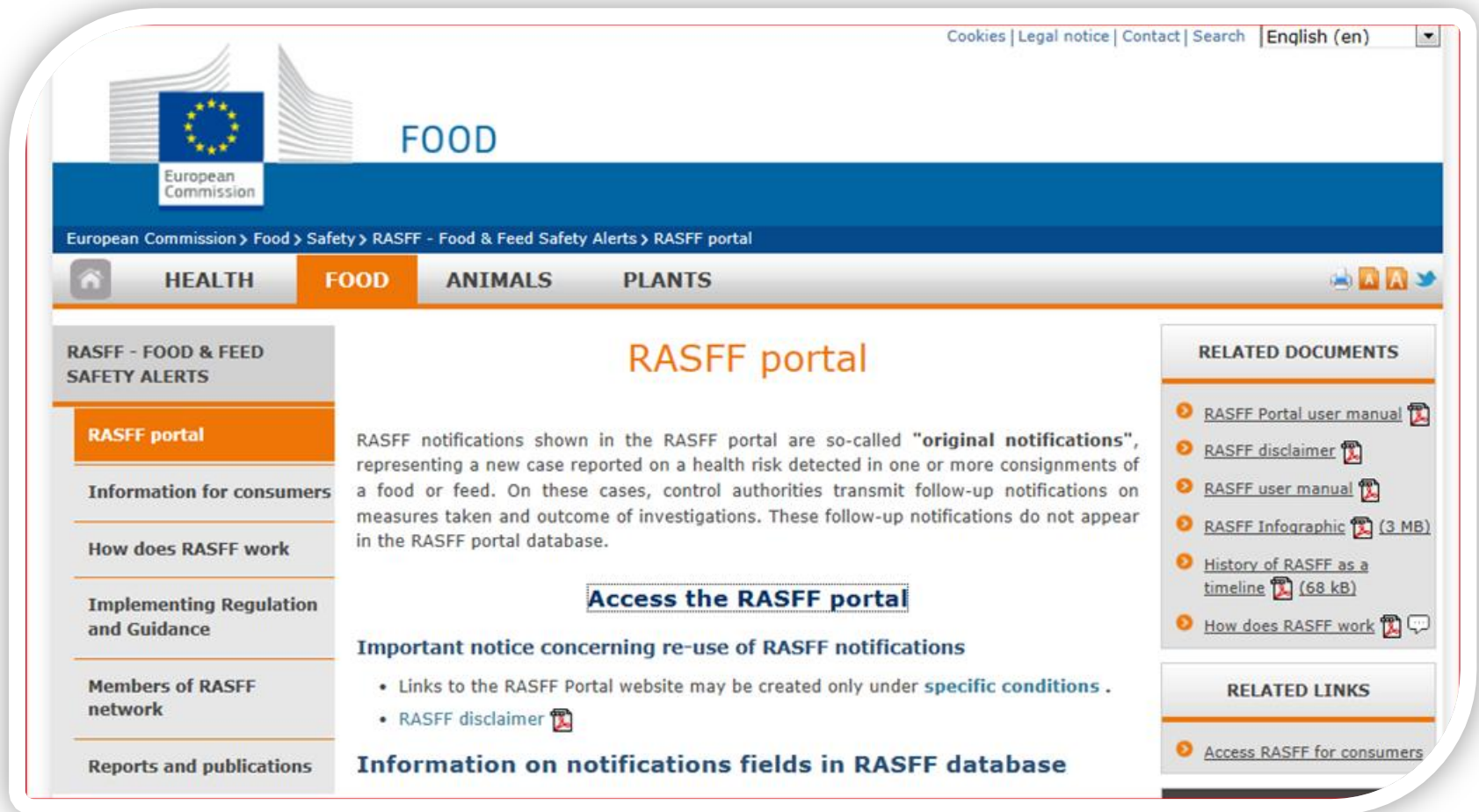- 0.13 Sri Lanka
- 0.67 Gambia
- 0.13 Oman
- 0.53 Sweden
- 2.54 Germany
- 0.13 former Yugosl
- 0.27 Lithuania
- 0.13 Jamaica
- 4.27 Brazil
- 1.07 Egypt
- 0.80 Spain
- 0.13 Moldova
- 0.40 Portugal
- 0.53 Ireland
- 0.13 Slovakia
- 0.80 Greece
- 0.27 Lebanon
- 0.40 Pakistan

Application of BNs to predict food fraud

- (Bouzembrak and *Marvin,* 2016) used BNs prediction model to aid the border inspector to detect the type of food fraud.

Contents lists available at ScienceDirect

Food Control

journal homepage: www.elsevier.com/locate/foodcont

ELSEVIER

Prediction of food fraud type using data from Rapid Alert System for Food and Feed (RASFF) and Bayesian network modelling

CrossMark

Yamine Bouzembrak, Hans J.P. Marvin[*]

RIKILT Wageningen UR, Akkermaalsbos 2, 6708 WB Wageningen, The Netherlands

ARTICLE INFO

ABSTRACT

Because food fraud can harm human health and erode consumer trust, it is imperative that it is detected at an early stage. Therefore the aim of this study was to predict the expected food fraud type for imported products for which the product category and country of origin are known in order to target enforcement activities. For this purpose we used a Bayesian Network (BN) model that was developed based on adulteration/fraud notifications as reported in the Rapid Alert System for Food and Feed (RASFF) in the period 2000–2013. In this period 749 food fraud notifications were reported and were categorised in 6 different fraud types (i) improper, fraudulent, missing or absent health certificates, (ii) illegal importation, (iii) tampering, (iv) improper, expired, fraudulent or missing common entry documents or import declarations, (v) expiration date, (vi) mislabelling. The data were then used to develop a BN model. The constructed BN model was validated using 88 food fraud notifications reported in RASFF in 2014. The proposed model predicted 80% of food fraud types correctly when food fraud type, country and food

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Bayesian Networks (BNs) modelling in Big Data research

BN is able to combine data from different nature and location
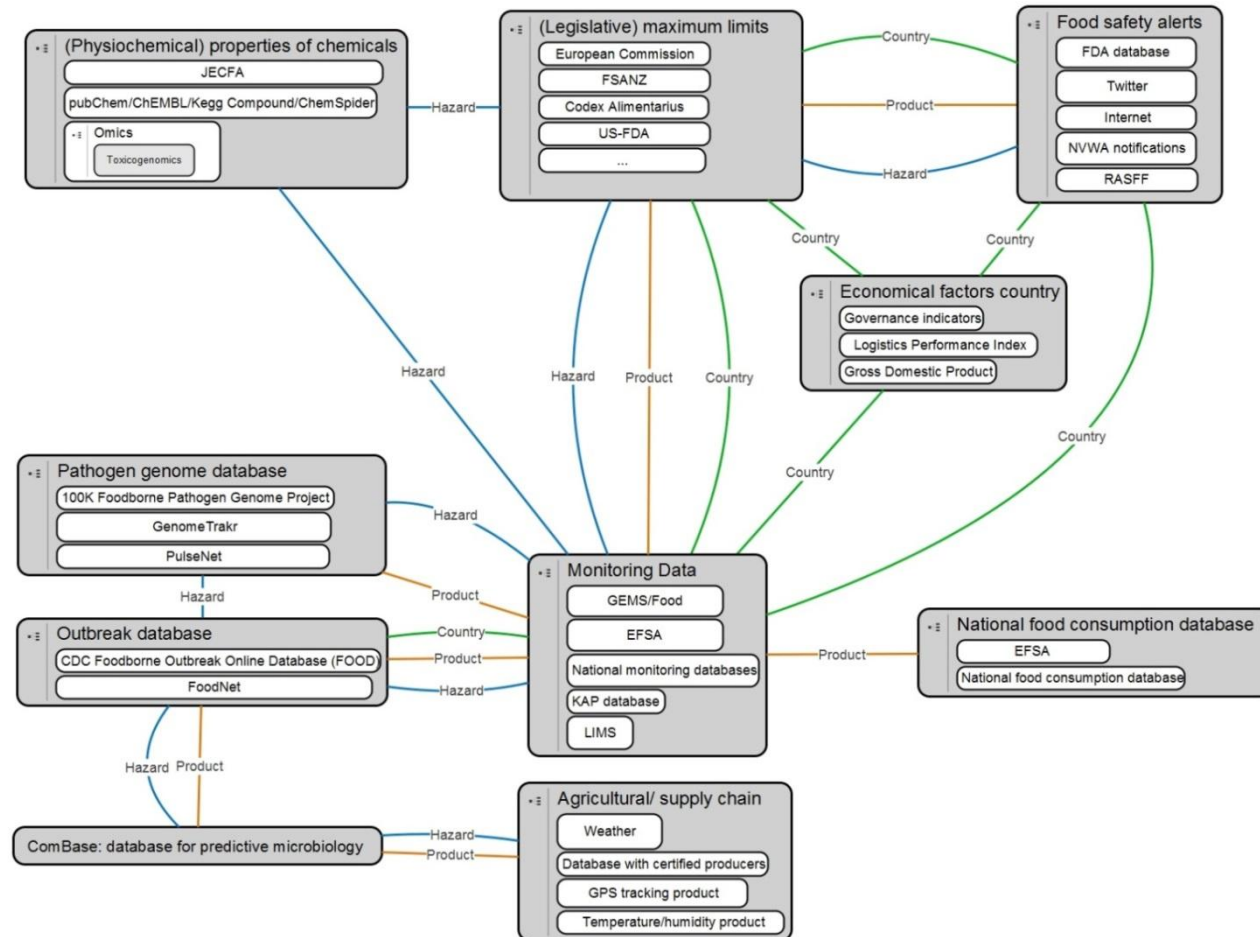
Application of BNs to predict food fraud

Prediction of food fraud using multiple data sources and expert knowledge

- Identify parameters relevant for food fraud (=> nodes in BN model)

- Determine the relationships between these parameters (expert knowledge, literature)

- Identify data sources of these parameters

- Develop the BN model

- Validate the BN model

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Application of BNs to predict food fraud

Parameters relevant for food fraud (some examples)

Economic parameters:
- Prices of the fraudulent product at the time of detection
- Price spike around the period of detection
- Trade volumes of the product between the country of detection and country of origin
- Complexity of the food chain

Parameters of the country of origin & detection
- Indices: corruption index, food safety index, governance index, legal system index, press index, human development index and technology index.

Detected food fraud cases
- RASFF and EMA

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BN model to predicting food fraud
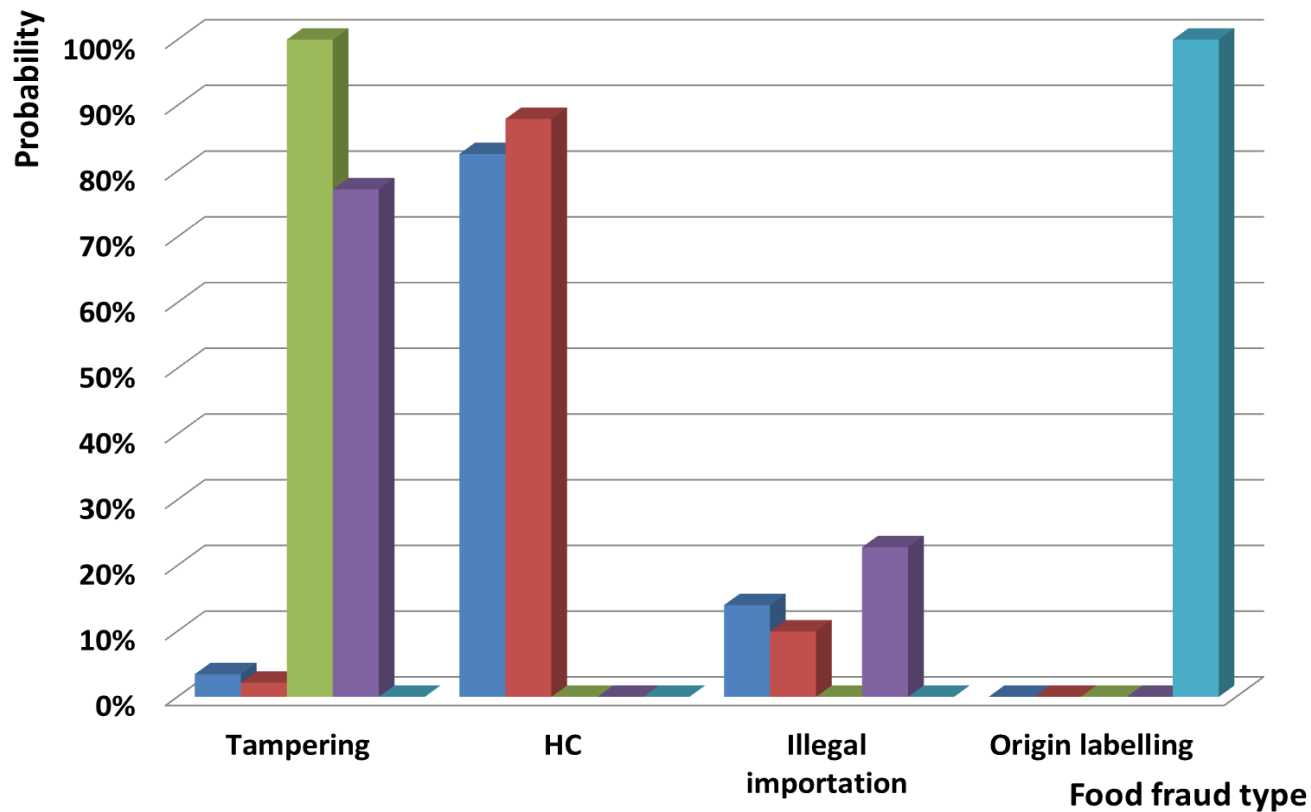## linking 36 data sources (18 databases and 8 expert judgements)

BN model to predict food fraud
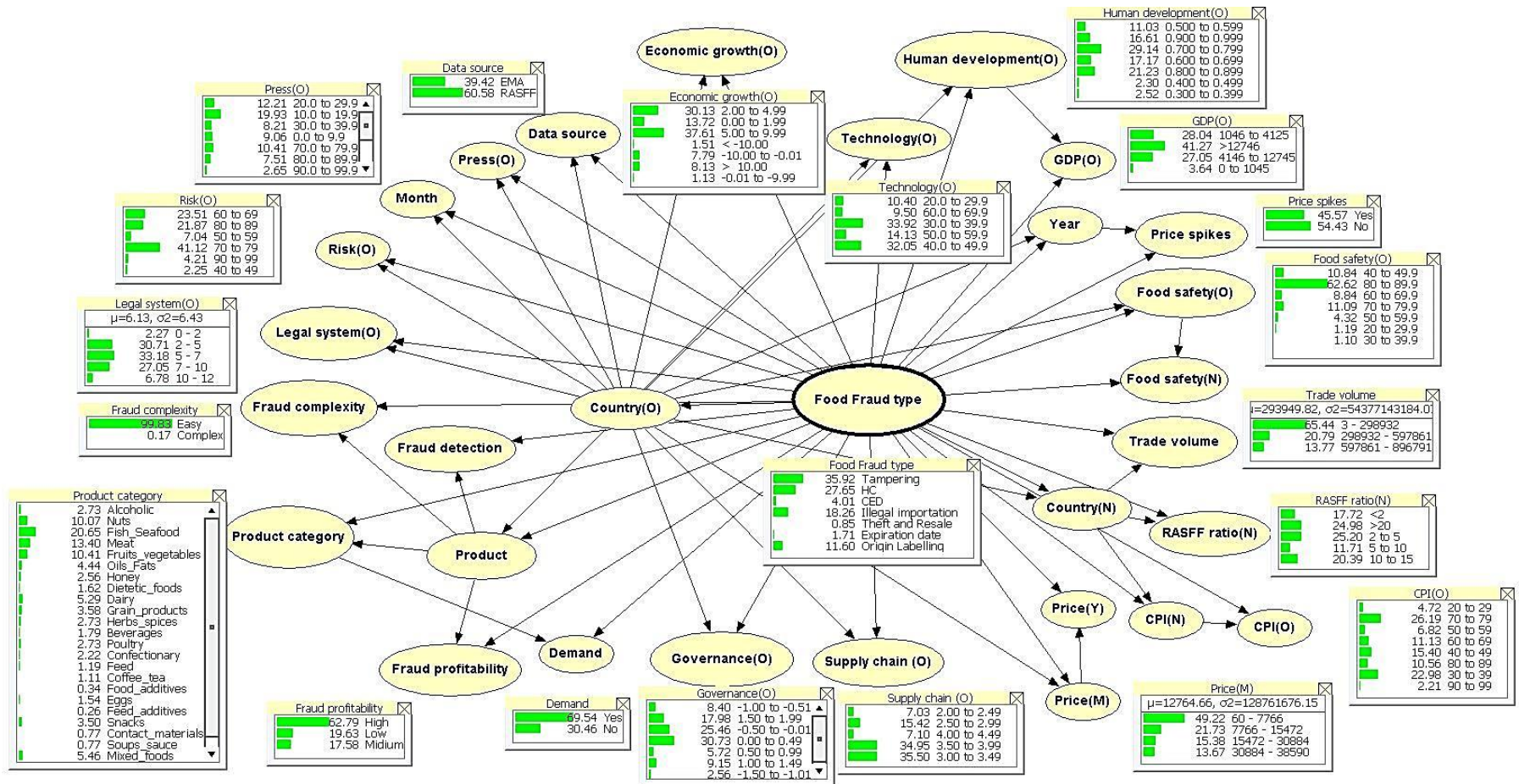
Results: 91.5 % correct prediction of food fraud type

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The effect of country of origin on the type of food fraud for meat in the low price category originating from Brazil (dark blue), Argentina (red), Poland (green), Canada (purple) and Belgium (light blue).

Application of BNs to predict food fraud

- (*Marvin et al,* 2016) A holistic approach to food safety risks: Food fraud as an example.

A holistic approach to food safety risks: Food fraud as an example

Hans J.P. Marvin *, Yamine Bouzembrak, Esmée M. Janssen, H.J. van der Fels- Klerx, Esther D. van Asselt, Gijs A. Kleter

RIKILT - Wageningen UR, Akkermaalsbos 2, 6708 PD Wageningen, The Netherlands

A B S T R A C T

Production of sufficient, safe and nutritious food is a global challenge faced by the actors operating in the food production chain. The performance of food-producing systems from farm to fork is directly and indirectly influenced by major changes in, for example, climate, demographics, and the economy. Many of these major trends will also drive the development of food safety risks and thus will have an effect on human health, local societies and economies. It is advocated that a holistic or system approach taking into account the influence of multiple "drivers" on food safety is followed to predict the increased likelihood of occurrence of safety incidents so as to be better prepared to prevent

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Conclusions

- The food fraud filter in MedISys, as developed by RIKILT, is useful to collect publications in the media on food fraud

- The food fraud coverage in the media differ greatly between countries

- There is an increasing trend in the number of fraud incidents, as reported in RASFF

- Meat & meat products and fish & fish products are the food categories with the highest number of reports

- BN models are suitable to predict the food fraud category

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Thank you

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