

# **The Consumer Complaint Monitoring System**

## **Enhancing Discovery and Mitigation of Foodborne Threats to Health through Pattern Surveillance, and Multiple-Attribute Algorithms**

CDR Kimberly Elenberg, Office of Food Defense and Emergency Response,  
Food Safety Inspection Service, United States Department of Agriculture

Dr. Artur Dubrawski, Auton Lab, The Robotics Institute,  
Carnegie Mellon University

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# Protecting the Food Supply

- Various Challenges
  - Agroterrorism Threat - malicious contamination of food
    - Biological, chemical, toxic, nuclear, radiological
    - Could have a global effect – economic losses, undermining sector stability
    - Anti-Livestock Disease Communicable to Humans – Anthrax, Newcastle, AI, Aspergillosis
  - Naturally Occurring Outbreaks
- Reasonable Precautions
  - Powerful Surveillance Capabilities
  - Rapid Responsive Capacity
- Future Actions
  - Strengthen current systems, consider new processes to fill gaps



**Tools for  
Surveillance  
Capabilities**

# Food Surveillance Today

## State Efforts

### **Pulse Net Isolates in Food**

- Detect Foodborne Disease Case Clusters in Humans
- Facilitates ID of Common Source Outbreaks (DNA fingerprinting)
- Assists Epidemiologists Investigating Outbreaks

**CDC**

## Other and International Activities

### **CCMS**

#### **Threat Spectrum**

- Collects passive information on adverse food event reports (Illness, Contamination)
- Not pathogen Specific
- Does not require lab confirmation
- Connected to FNS, NSLP
- Multiple-Attribute Surveillance Algorithms
- Provides Real-Time Communication to Field Investigators

**FSIS**

### **Food Net**

#### **Lab confirmed clusters in humans**

- Produces National Estimates of the Burden, Trends, and Sources Specific Foodborne Diseases In the US
- Active Surveillance and Epidemiologic Studies
- Represents 14% of US Population from 9 States
- Laboratory Confirmed Cases

**CDC, FDA,  
USDA**

# “The true incidence of food contamination is unknown...”

## GENERAL LIMITATIONS of TODAY'S SURVEILLANCE

- Active surveillance focuses on known Pathogens; not representative of entire population
- Surveillance that can view spectrum of threats is passive, data is sparse, and noisy
- Inability to view farm to table continuum
- Timeliness of data collection, detection, and communication to support rapid response and recovery

# The Consumer Complaint Monitoring System (CCMS)

- An electronic database used by FSIS to record, triage, analyze, and track all consumer complaints reported to the agency [FSIS Directive 5610.1, Reference 6500.1]
- Office of Public Health Science, Human Health Sciences Division
  - Manages the program
- Office of Food Defense and Emergency Response
  - Responsible for identifying non-routine incident patterns imbedded in FSIS data
    - The Human mind has limitations in dealing with complex problems that involve ambiguous information
    - CMU is working with FSIS to develop tools needed to assist OFDER with multi faceted estimative challenges



# The Consumer Complaint Monitoring System (CCMS)

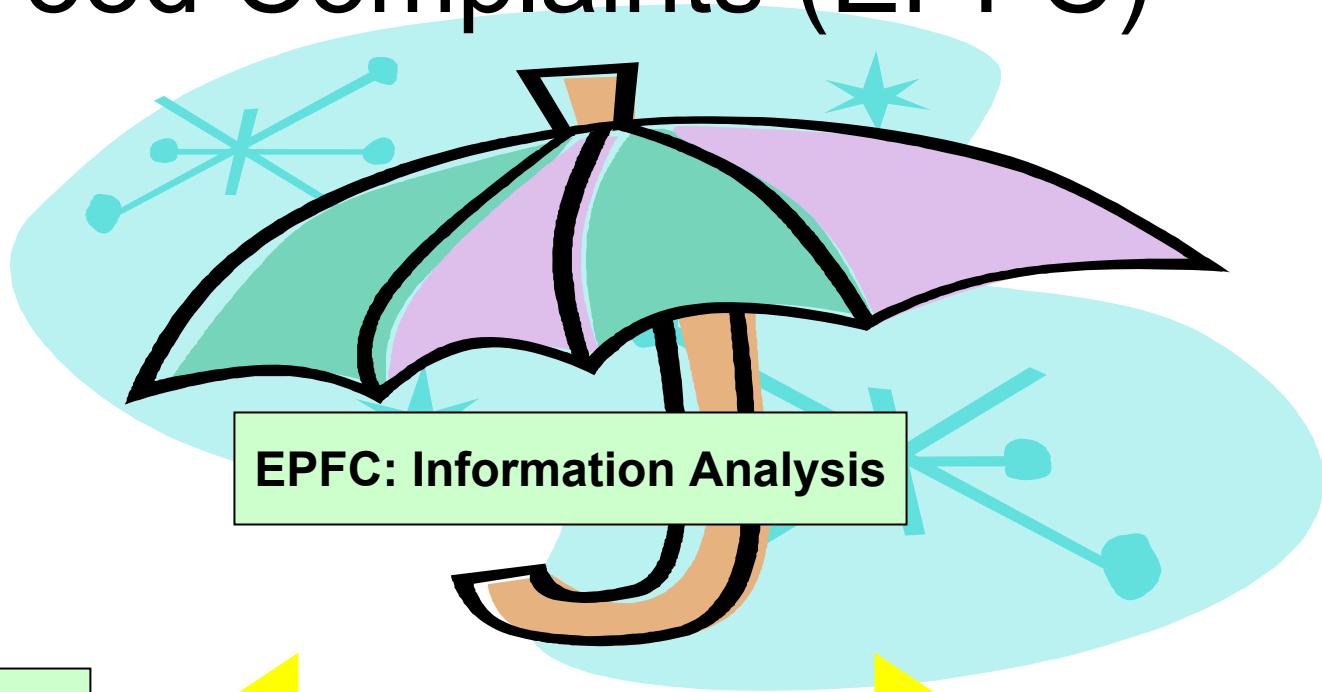
- An electronic database to track all consumer complaints [5610.1, Reference 6500.1]
- Office of Public Health
  - Manages the program
- Office of Food Defense
  - Responsible for identifying FSIS data
    - The Human mind involve ambiguous
    - CMU is working with multi faceted estimation

**A Goal of CCMS is to provide indications and warnings of large scale natural outbreaks and intentional attacks on food by analyzing:**

- adverse food event reports
- reported syndromic symptoms
- epidemiological data
- temporal resolution
- spatial resolution
- causal models



# CCMS Tool: Emerging Patterns in Food Complaints (EPFC)



**EPFC: Information Analysis**

**Management  
Decisions, Food  
Safety  
and Food Security**

**Reduce Vulnerability, Minimize Damage**

**Recover**

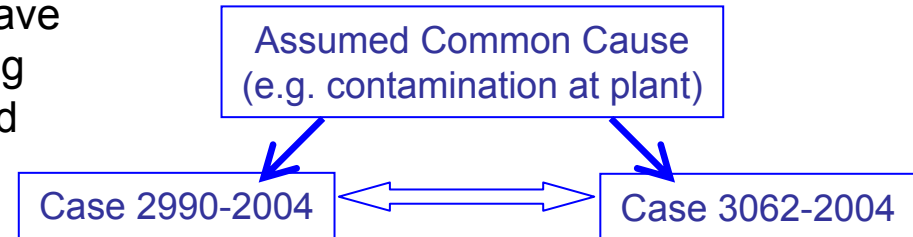
**Emergency Response**



# EPFC: Emerging Patterns in Food Complaints

## Approach:

- Hypothesize that the two complaints have been generated by the same underlying process (select from a list of predefined possible causes)
- Compute prob. of such an event (Bayesian way)

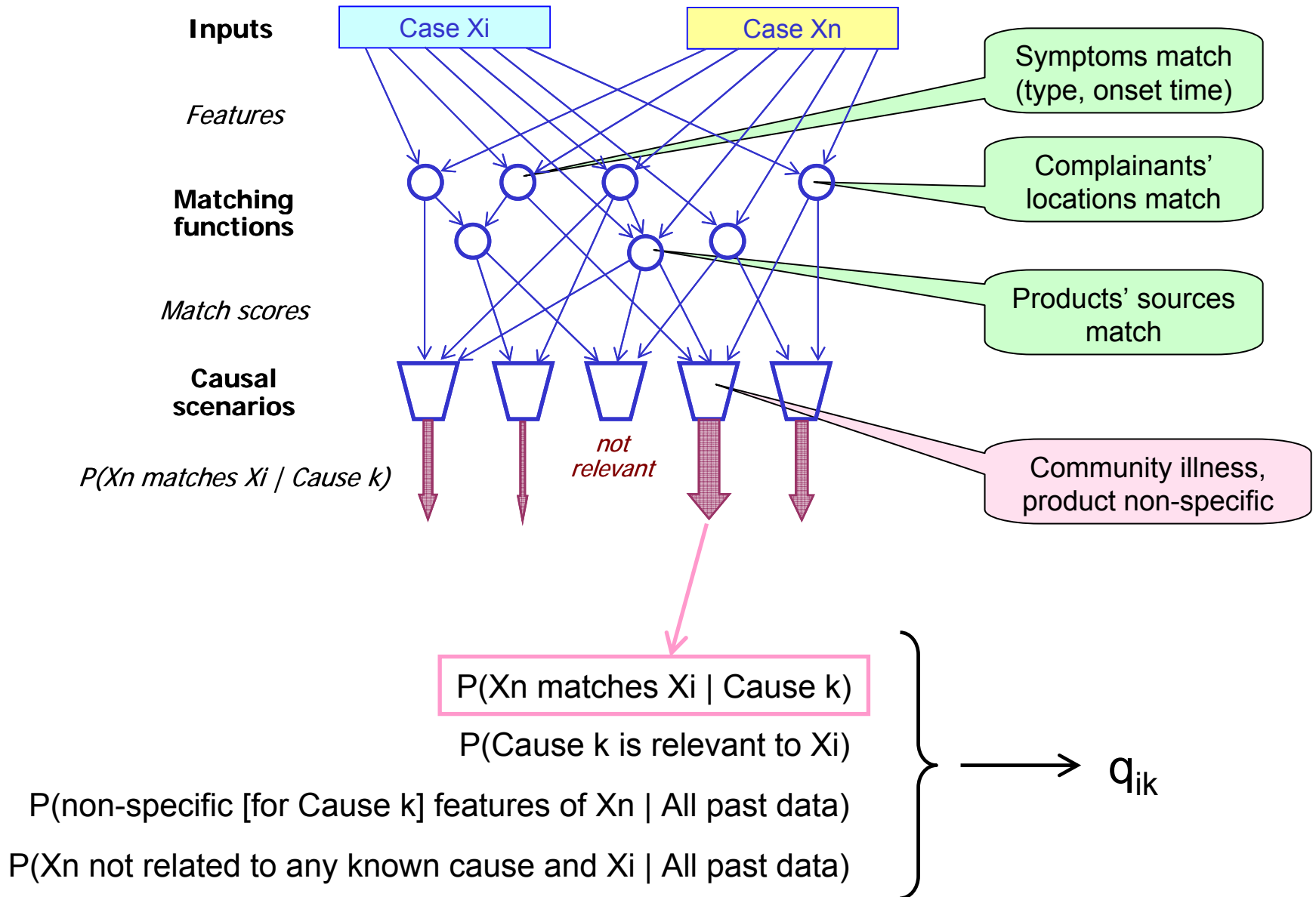


## Causal scenario models:

42 predefined scenarios for various assumed origins, classifications, product specificity

| Case Classification | Product specificity | Origin |     |           |       |       |              |
|---------------------|---------------------|--------|-----|-----------|-------|-------|--------------|
|                     |                     | Plant  | POP | Community | Chain | Brand | Plant Co-loc |
| Illness             | Yes                 | √      | √   | √         | √     | √     |              |
|                     | No                  | √      | √   | √         | √     | √     |              |
|                     | N/A                 |        |     |           |       |       | √            |
| Foreign Object      | Yes                 | √      | √   |           | √     | √     |              |
|                     | No                  | √      | √   |           | √     | √     |              |
|                     | N/A                 |        |     |           |       |       |              |
| Injury              | Yes                 | √      |     |           |       |       |              |
|                     | No                  | √      |     |           |       |       |              |
|                     | N/A                 |        | √   | √         |       |       |              |
| OT/OO/OC            | Yes                 | √      | √   |           | √     | √     |              |
|                     | No                  | √      | √   |           | √     | √     |              |
|                     | N/A                 |        |     |           |       |       |              |
| Allergy             | Yes                 |        | √   |           | √     | √     |              |
|                     | No                  |        | √   |           | √     | √     |              |
|                     | N/A                 | √      |     | √         |       |       | √            |

# EPFC: Structure of Causal Models



# EPFC: Emerging Patterns in Food Complaints

## Presentation of results:

Only a few entries from the result table are presented to the analyst (to avoid information overflow and to focus attention on the most likely matches of adverse events)

The selection combines:

- The highest scoring past cases ( $q_i$ ), irrespective of a particular causal assumption

- The highest scoring causal scenarios ( $q_k$ )

- The highest values of  $q_{ik}$  (intersections of particular past case and particular causal scenario)

## Result table:

|                  |     | Causes |     |     |                       |     |     |                      |
|------------------|-----|--------|-----|-----|-----------------------|-----|-----|----------------------|
|                  |     | R_1    | R_2 | ... | R_k                   | ... | R_K | $\Sigma$             |
| Historical Cases | C_1 |        |     |     |                       |     |     |                      |
|                  | ... |        |     |     |                       |     |     |                      |
|                  | ... |        |     |     |                       |     |     |                      |
|                  | ... |        |     |     |                       |     |     |                      |
|                  | C_i |        |     |     | <b>q<sub>ik</sub></b> |     |     | <b>q<sub>i</sub></b> |
|                  | ... |        |     |     |                       |     |     |                      |
|                  | ... |        |     |     |                       |     |     |                      |
|                  | ... |        |     |     |                       |     |     |                      |
|                  | C_2 |        |     |     |                       |     |     |                      |
|                  | C_1 |        |     |     |                       |     |     |                      |
| $\Sigma$         |     |        |     |     | <b>q<sub>k</sub></b>  |     |     | <b>q</b>             |

# EPFC: Example results

Search Case 2990-2004 ---- Vigilance Score 0.98066100

Do you want to be alerted for cases similar to this ?  Yes  No

| <a href="#">Old Case</a>          | <a href="#">Qik Score</a> | <a href="#">Qi Score</a> | <a href="#">Qk Score</a> | <a href="#">Possible Cause</a>         | <a href="#">Feedback</a> | <a href="#">Analyze</a>                | <a href="#">T/F</a> | <a href="#">S/S</a> | <a href="#">Comp Loc</a> | <a href="#">POP Loc</a> | <a href="#">Est</a> | <a href="#">Species</a> | <a href="#">Proc Type</a> | <a href="#">Prod spec</a> | <a href="#">Prod n-spec</a> | <a href="#">For Obj</a> |
|-----------------------------------|---------------------------|--------------------------|--------------------------|--|--------------------------|--|---------------------|---------------------|--------------------------|-------------------------|---------------------|-------------------------|---------------------------|---------------------------|-----------------------------|-------------------------|
| <b>Candidate Positive Matches</b> |                           |                          |                          |  |                          |  |                     |                     |                          |                         |                     |                         |                           |                           |                             |                         |
| 1863-2003                         | <a href="#">0.0268</a>    | 0.06883                  | 0.0268                   | plant_product_non_specific_illness     | --                       | <input type="button" value="Analyze"/> | 0.06301             | 0                   | 0                        | 0                       | 0.95                | 0.5                     | 1                         | 0.04112                   | 0.6664                      | 0                       |
| 2583-2004                         | <a href="#">0.02263</a>   | 0.06554                  | 0.1627                   | pop_chain_product_non_specific_illness | --                       | <input type="button" value="Analyze"/> | 0.6577              | 0                   | 0                        | 0.07143                 | 0                   | 0                       | 1                         | 0                         | 1                           | 0                       |
| 2953-2004                         | 0.02247                   | 0.04075                  | <a href="#">0.3572</a>   | brand_product_non_specific_illness     | --                       | <input type="button" value="Analyze"/> | 0.9747              | 0                   | 0                        | 0                       | 0                   | 1                       | 0                         | 0.151                     | 0.3403                      | 0                       |
| 1452-2002                         | <a href="#">0.02145</a>   | 0.07969                  | 0.1627                   | pop_chain_product_non_specific_illness | --                       | <input type="button" value="Analyze"/> | 0.01151             | 0                   | 0                        | 0.06667                 | 0                   | 1                       | 0                         | 0                         | 1                           | 0                       |
| 1863-2003                         | <a href="#">0.02132</a>   | 0.06883                  | 0.3572                   | brand_product_non_specific_illness     | --                       | <input type="button" value="Analyze"/> | 0.06301             | 0                   | 0                        | 0                       | 0.95                | 0.5                     | 1                         | 0.04112                   | 0.6664                      | 0                       |
| 1492-2002                         | <a href="#">0.02091</a>   | 0.02093                  | 0.3572                   | brand_product_non_specific_illness     | --                       | <input type="button" value="Analyze"/> | 0.01699             | 0                   | 0                        | 0                       | 0                   | 0                       | 0                         | 0.002199                  | 0.4757                      | 0                       |
| 1646-2002                         | <a href="#">0.02091</a>   | 0.02093                  | 0.3572                   | brand_product_non_specific_illness     | --                       | <input type="button" value="Analyze"/> | 0.03616             | 0                   | 0                        | 0                       | 0                   | 0                       | 0                         | 0.002007                  | 0.5292                      | 0                       |
| 1513-2002                         | 0.0209                    | <a href="#">0.08145</a>  | 0.3572                   | brand_product_non_specific_illness     | --                       | <input type="button" value="Analyze"/> | 0.02082             | 0                   | 0                        | 0.1                     | 0                   | 0                       | 0                         | 0.0006931                 | 0.6872                      | 0                       |
| 1542-2002                         | 0.02089                   | <a href="#">0.08077</a>  | 0.3572                   | brand_product_non_specific_illness     | --                       | <input type="button" value="Analyze"/> | 0.02384             | 0                   | 0                        | 0.07143                 | 0                   | 0                       | 0                         | 0.0003573                 | 0.7125                      | 0                       |
| 2583-2004                         | 0.02                      | 0.06554                  | <a href="#">0.1939</a>   | pop_product_non_specific_illness       | --                       | <input type="button" value="Analyze"/> | 0.6577              | 0                   | 0                        | 0.07143                 | 0                   | 0                       | 1                         | 0                         | 1                           | 0                       |
| <b>Candidate Negative Matches</b> |                           |                          |                          |  |                          |  |                     |                     |                          |                         |                     |                         |                           |                           |                             |                         |
| 1292-2002                         | <a href="#">0</a>         | 0                        | 0.02027                  | plant_product_specific_illness         | --                       | <input type="button" value="Analyze"/> | 0                   | 0                   | 0                        | 0.04167                 | 0                   | 0                       | 1                         | 0                         | 1                           | 0                       |
| 1292-2002                         | <a href="#">0</a>         | 0                        | 0.0268                   | plant_product_non_specific_illness     | --                       | <input type="button" value="Analyze"/> | 0                   | 0                   | 0                        | 0.04167                 | 0                   | 0                       | 1                         | 0                         | 1                           | 0                       |
| 1292-2002                         | <a href="#">0</a>         | 0                        | 0.1072                   | pop_product_specific_illness           | --                       | <input type="button" value="Analyze"/> | 0                   | 0                   | 0                        | 0.04167                 | 0                   | 0                       | 1                         | 0                         | 1                           | 0                       |

Enter any missed positive matches

Case No  Cause Name

# Significance and Action Items

## Significance and validation to date:

- EPFC Demonstrated ability to detect interesting low amplitude signals in sparse and noisy data which comes in a short supply;
- Useful alerts can be generated using more specific information and on fewer cases than typically attainable in syndromic surveillance;
- Success story (on historical data): immediate detection of an outbreak of a food borne E.coli infection which originally took two weeks of skilled analysts to identify.

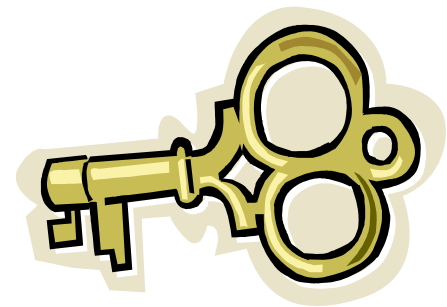
## Action Items:

- Increase volume and coverage of data collected on adverse food events
- Improve information analysis
  - Include capability to identify threats, and intention
- Be prepared for surge capacity
- Bring forth the vision of a concerted national effort for robust risk assessment and appropriate consequence management
  - Results notification
  - Response
  - Recovery

# A “Bigger Picture” Action Item for Consideration: The Department of Homeland Security’s National Bio-Surveillance Integration System (NBIS)

- Could effectively address many identified gaps and required actions
- Vision: to integrate multi-agency data and provide information fusion
  - Animal
  - Plant
  - Human
  - **USDA through FSIS and APHIS are developing the concept of operations needed for fusing data from the farm to table, this will feed NBIS**
    - *Effort includes agency specific analysts for agency specific data*
    - *Leveraging current analytical tools developed for CCMS, adding time series aggregation, etc.*
    - *Bring forth the vision of a system that can tell us “What is happening in FSIS/Agriculture Today and what does it mean?”*
    - *Support appropriate incident management*
- Provide more complete coverage of extended population
  - improves national situational awareness and global activity awareness
  - Could give an eagle eye view of the farm to table continuum

# Summary



- Many positive initiatives for food surveillance TODAY however NOT comprehensive enough:
  - Active surveillance
    - focuses on known pathogens; not representative of entire population
  - Surveillance that can view spectrum of threats
    - passive, data is sparse and noisy
  - View farm to table continuum
  - Timeliness of data collection, detection, and communication to support rapid response and recovery
- Early detection is the key to keeping consequences manageable
- It will take both tools as well as changes in the way we do business to improve early detection of adverse food events

# Questions?

## Contact Information

CDR Kimberly Elenberg

[Kimberly.Elenberg@fsis.usda.gov](mailto:Kimberly.Elenberg@fsis.usda.gov)

Dr. Artur Dubrawski

[awd@cs.cmu.edu](mailto:awd@cs.cmu.edu)