Source: AIME (Artificial Intelligence in Medical Epidemiology)

Title: The use of AI in Dynamic Dengue Outbreak Surveillance & Forecasting

Purpose: Discussion

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Abstract: This PPT summarizes the content of G-024-A01 with a use-case demonstration of AI utilization in Dynamic Dengue Outbreak Surveillance & Forecasting, for presentation and discussion during the meeting.
Artificial Intelligence in Medical Epidemiology

In affiliation with:

AI4Good
WHAT WE DO

PUBLIC HEALTH LIKE NEVER BEFORE
WE BELIEVE IN TACKLING DISEASES BEFORE THEY HAPPEN.
WE BUILD PREDICTIVE & ANALYTICS PLATFORMS
FOR DECISION MAKERS IN CITIES, COUNTRIES
AND THE WORLD.

Know more
Dr Dhesi Baha Raja
- United Nations Exceptional Scientist Award
- MIT Innovator Under 35
- Harvard Most Impact Innovator
- Google Scholar to NASA Ames Research Park
- Public Health Medicine Specialist

Mr Rainier Mallol
- United Nations Young Leader
- MIT Innovator Under 35
- Harvard Most Impact Innovator
- Microsoft Certified Professional
- Forbes Top 40
- Technology Consultant to governments, NGOs and the private sector
- Telematics Specialist

Dr Helmi Zakariah
- Global Health Policy
- Malaysian rep to World Health Organization
- Speaker: Chatham House, CWDH, WEF
- Trade & public health (WTO)
- INGO: International Red Cross, Doctors Without Borders
- MPH (International Health)
Centers -
Business & Operations  
(KL, Malaysia)  
Research & Development  
(Dominican Republic)

Group Strength & Domain Expertise:

Over 35 years of combine expertise & practice

Public Health  
Telematics  
Agriculture  
Data Science
UNCERTAINTY
MALARIA
DENGUE
MEASLES
FLU
HIV/AIDS
CHIKUNGUNYA
EBOLA
MERS
TB
GONORRHEA
ZIKA
POLIO
CHOLERA
4 Million Cases

HIV/AIDS
40M Infected

DENGUE
2.5B at RISK

TB
1.5 Million Deaths

FLU
100 Million Deaths

TB
90% fatality

MALARIA
219 Million

CHOLERA
4 Million Cases

MERS

GONORRHEA
498M Cases

ZIKA
400M Dengue cases annually

2.5 BILLION AT RISK

1.3M Zika cases so far

Image Source: HealthMap
DENGUE & ZIKA ECONOMIC IMPACT

$1.3 B
DENGUE

$>3.5 B
ZIKA
CURRENT RESPONSE

PASSIVE 76.90%

ACTIVE 3.90%

SENTINEL 19.20%

SOURCE: ASIA-PACIFIC DENGUE PREVENTION BOARD AND THE AMERICAS DENGUE PREVENTION BOARD
The human costs of epidemics are going down but the economic costs are going up. Here's why
ISSUES IN DENGUE OUTBREAK MANAGEMENT

MISCLASSIFICATION
OUTBREAK AREAS

RESOURCE MANAGEMENT & DEPLOYMENT

FOGGING, LARVICIDING?
Theatrical Security

NON-HEALTH PLAYERS?

MAN-HOURS

The text suggests discussing issues in dengue outbreak management, including misclassification of outbreak areas, resource management and deployment, fogging and larviciding, and the involvement of non-health players. The mention of theatrical security and man-hours indicates a broader perspective on managing outbreaks.
AN AI-BACKED SURVEILLANCE

IDENTIFY EVENT in REAL-TIME

PRECISION PREDICTION of EVENT in the future

PRESCRIPTION of mitigation action

INTEGRATION of various and large data points
# How Do We Do It?

## Artificial Intelligence

Codename: REDINT

<table>
<thead>
<tr>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidemiology</td>
</tr>
<tr>
<td>Additional Data 2 (Socioeconomic)</td>
</tr>
<tr>
<td>Additional Data 3 (Landmarks)</td>
</tr>
<tr>
<td>Sourcing: Weather Parameters</td>
</tr>
<tr>
<td>Sourcing: Population density</td>
</tr>
</tbody>
</table>

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Artificial Intelligence (AI) is a technology that simulates and augments human intelligence. It aims to perform tasks that humans would traditionally do, like decision-making and problem-solving. Here are some ways we implement AI:

1. **Epidemiology**: Analyzing disease patterns and predicting outbreaks.
2. **Additional Data 2 (Socioeconomic)**: Understanding the socio-economic factors influencing health outcomes.
3. **Additional Data 3 (Landmarks)**: Using geographic data for targeted interventions.
4. **Sourcing: Weather Parameters**: Incorporating weather data to forecast health impacts.
5. **Sourcing: Population Density**: Examining population density to optimize resource allocation.
5 DISEASE OUTBREAK FORECAST
For each Disease Case which is introduced into the system, the REDINT automatically searches through more than 90 different databases for different variables. These variables range from different categories, obtaining Weather data, Geographical data, Socioeconomic data and historic epidemiological data. The design of REDINT may be extended to obtain information about different types of diseases, particular events, segmented demographics, etc. The amount of databases which it requests is also expandable, meaning different datasets, for which to extract data from. Below an example of how REDINT is used by our government CONSOLE.
WEATHER
- UN World Meteorological Organization
- Weather.com
- National Climatic Data Center - NOAA
- Environment and Climate Change API
- Global Forecast System
- Integrated Surface Database
- Meteorological Assimilation Data Ingest System
- Others

GEOGRAPHIC
- NASA Satellite Lookup
- Google Earth Lookup
- Local Mapping Institution
- Local Registries
- Others

SOCIOECONOMIC
- UN World Bank Data
- Data from local Statistics Offices
- CENSUS Data
- ESRI
- Others

LANDMARKS
- Telecom Malaysia
- MapIt
- Others

OUTBREAK CALCULATION

PREDICTIONS

REDINT
Remote Data Input Interface
CASE 1
COLLECTED 276 DATA POINTS
ALL OUTBREAKS CALCULATED
ALL OUTBREAKS UPDATED
PREDICTED OUTBREAKS

REDINT - RESULT
ALL IN < 21 SECONDS
1 CASE
276 COLLECTED DATA POINTS

ALL OUTBREAKS CALCULATED
ALL OUTBREAKS UPDATED
PREDICTED OUTBREAKS ALL IN < 21 SECONDS
Determining the exact distance & location for current outbreak (red circle):

**Geocoding : Multiple Cross-reference**

Superior than single source geocode.

**Dataset adjustments due to clinical onset**

Recalculate epicentre & demarcations of outbreak immediately after new cases are registered in the area.

**Use Case : Control Activity**

Fogging, repellent distribution
Common Statistical Analysis

Environmental Determinants

Real-time update

Segregated information by Outbreak area
2nd fx: Prediction of upcoming outbreak
Secondary functions
Forecasting Future Outbreak (Predicted Area – purple circles/ Priority list)
- 81% - 84% accuracy in “controlled environment”
- Field tested in multiple areas

- **Use Case for: Preventive & Protection**
  - Pemusnahan Tempat Pembiakan (PTP)
  - Larviciding
  - Gotong-royong
  - Awareness
VALIDATION OF A.I DISEASE CONSOLE IN PENANG, MALAYSIA - A CASE STUDY

INSTITUTE FOR MEDICAL RESEARCH (IMR)
MINISTRY OF HEALTH MALAYSIA
PREDICTION; 30 DAYS IN ADVANCE IN PENANG (37 OUTBREAKS)
REAL OUTBREAKS THAT OCCURRED IN PENANG WITHIN 30 DAYS (30 OUTBREAKS) – CROSS VALIDATED (JKN PENANG)

AIME’s Predicted and Actual Outbreaks with Predictive Accuracy from 11th May to 10th June 2017

<table>
<thead>
<tr>
<th>AIME’s PREDICTED OUTBREAKS</th>
<th>ACTUAL OUTBREAKS</th>
<th>FIELD PREDICTIVE ACCURACY</th>
</tr>
</thead>
<tbody>
<tr>
<td>37 OUTBREAKS</td>
<td>30 OUTBREAKS</td>
<td>81.08%</td>
</tr>
</tbody>
</table>
DISEASE PREDICTIVE ACCURACY

84.11%
84.87%
81.08%
Utilizing Artificial Intelligence as a Dengue Surveillance and Prediction Tool

Bala Muruli Sundram*, Dheesi Baha Raja*, Fazliah Mydin†, Ting Choo Yee, Kamesh Raj† and Padiathan Kamalam†

Abstract

Objectives: A major challenge in passive surveillance is that an outbreak has often occurred before it is recognized. The main purpose of this study is to determine how well an artificial intelligence mediated system can improve the quality of Malaysia’s dengue surveillance system. In particular, the focus of the study was to evaluate the effectiveness of a real-time surveillance system in dengue case detection and prediction of future outbreaks.

Methods: A feasibility study was conducted in the state of Penang by incorporating artificial intelligence and machine learning capabilities to geo-locate and determine future dengue outbreaks. This decision-making tool supports data entry, retrieval, storage and analysis for dengue vector management and promotes the execution of dengue control programs that are designed, evaluated and refined based on locally gathered evidence.

Results: The system predicted 37 outbreaks up to 30 days in advance, geo-locating them up to 400 metres radius. This prediction was then cross-validated with the Penang State Health Department dengue reports in which 30 outbreaks occurred within the predicted period. The prediction accuracy of this case was 81.08%.

Conclusions: The Bayesian network system has the potential to report & predict the next dengue outbreaks in real-time. It incorporates user-friendly functionalities for data entry or input, data storage, data query, case and disease outbreak mapping, reporting, advance outbreak predictions and even suggested vector control management. This network system is anticipated to improve the current dengue surveillance, intervention monitoring and evaluation of the overall dengue vector control program performance.

Keywords: Artificial Intelligence, Bayesian Network, Dengue Surveillance, Disease Prediction, Outbreaks

Introduction

1. Introduction

1.1 Dengue Virus

...those hospitalized being young children. Current dengue trends indicate that not only are the number of new cases increasing over the years, but also occurring in new locales which were previously dengue-free such as...
Figure 6: Bayesian Network with Tree-Augmented Naïve Bayes Structure.

Figure 8: AUC Observed Value of Bayesian Network with Augmented Naïve Bayes structure.
SOLUTIONS PORTFOLIO

AI.griculture
agricultura intelligente

JALA

LIME

tagshelf