Infermedica
Artificial Intelligence in Medicine
A System for Automated General Medical Diagnosis using Bayesian Networks

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Martwisz się o swoje zdrowie?
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Notify me
Purpose of the System

• A general medical diagnostic expert system intended to serve as an educational self-diagnostic tool
  – Openly available through the WWW for general public
  – Intended for self-diagnosis adults only
  – ... imagine a visit to your GP with a new concern
  – at the end of the process always refers to a doctor

• Implications
  – Virtually no medical history considered
  – Questions should be suitable for non-professionals
  – The response times should be short (less than 1 sec)
  – ... not all conditions can be diagnosed
An elicitation support tool 'Medibase' was developed with time:

- A collaborative tool
- Quality assurance (review processes)
- Multi-language support

The reasoning engine is based on an ensemble of SMILE engines – C++ library for BN modelling and inference developed

- The parallelization and aggregation for incoming queries is based on in-house solution
- The system is fully scalable

A team of practicing doctors is used to build the knowledge base

- Different specializations
- Special scholarships
- For each of 250+ conditions relevant symptoms and risk factors were elicited

Bayesian network models are generated automatically from the medical database

- Generating multiple BN models
- Ensuring models are computationally tractable (<1 sec)

www.symptomate.com

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... we offer a web-service, other tools:
DxMate.com
Patient

Please fill in some basic information about yourself to personalize the results of your online checkup.

Sex
- Female
- Male

Age
- 18-30
- 31-45
- 46-60
- 60+

Height
- 5.5 cm

Weight
- 165 kg
Symptomate - Online Checkup

Questions

Answer the question shown below.

Does your head ache on one side?

Back  Yes  No  Don't know
Symptomate

Results

Your checkup is complete. Take a look at the results below.

Migraines

Medium risk (60%)

I’d recommend seeing a neurologist.

Cluster headaches

Medium risk (50%)

Tension-type headaches

Low risk (28%)

Hypertension

Low risk (14%)

This list may not be complete. Only a licensed medical provider can diagnose and treat illnesses.
Modelling Approach

• A two-layer Bayesian Network with the noisy-OR nodes (BN2O) is the **backbone** of the system

• The next question is determined based on a criterion based on the value of information

• In order to make the model computationally efficient we needed to introduce several elements:
  – Divide model into several (overlapping) models
  – Incorporated risk factors (a novel approach)
  – Added some rule-based logic
Results

• An analysis of over 100,000 diagnostic cases is presented
  – Only Polish-language version
  – We should expect users to ‘test’ the system
  – A typical user profile: a young female
  – Most of the diagnosis are related to unhealthy lifestyle: stress, lack of sleep, etc.
  – Sexual health issues seem to be popular
User Profile

![Bar graph showing user profile by age group and gender.]

- **18-30**:
  - Male: ~35,000
  - Female: ~10,000

- **30-50**:
  - Male: ~15,000
  - Female: ~5,000

- **60-80**:
  - Male: ~2,000
  - Female: ~1,000

- **80+**:
  - Male: ~1,000
  - Female: ~500
<table>
<thead>
<tr>
<th>Condition</th>
<th>Age 18-30</th>
<th>Age 30-50</th>
<th>Age 50-70</th>
<th>Age above 70</th>
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<td>6.8</td>
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<td>4.2</td>
<td>5.8</td>
<td>4.6</td>
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<td>3.7</td>
<td>3.3</td>
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<tr>
<td>Irritable Bowel</td>
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<td>3.2</td>
</tr>
<tr>
<td>Supraven. E. B</td>
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<td>3.1</td>
<td>2.9</td>
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<tr>
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<tr>
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<td>9.3</td>
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Next steps...

• Evaluate performance of the system at GP practices
• Extended English-language version coming soon...

... but by the MEDINFO community can be accessed at:

http://alpha.symptomate.com

NOTE: translation is not complete
Next steps... DxMate

- A decision support system for differential diagnosis intended for doctors:
  - Extended set of questions
  - Included lab test results
  - Presenting several hypothesis at each step
  - Explanation of reasoning
  - Intended primarily for general practitioners
  - We are looking for practicing doctors for evaluation

If you are interested, we can provide access, please email me at adam.zagorecki@infermedica.com
Any Questions???