Computer Aided Diagnosis

Medical Informatics Workshop
9 May 2008
DePaul University
Diagnosis (Dx)

- The recognition of a disease or condition by its outward signs and symptoms
- The analysis of the underlying physiological/biochemical cause(s) of a disease or condition
- Refers to both the process and the conclusion drawn
Cornerstones of Diagnosis

Physiology

Pathology

Anatomy

Departure from Normality
Historical Tools

- Compound Microscope – could see bacteria and protozoa
- Thermometer – accurately evaluate temperature
- Stethoscope – hear the chest and heart
- X-rays – “see” inside the human body
- These tools allow a more complete collection of symptoms
Using Computers

- Diagnosis can be viewed as a pattern analysis task
- Given a set of symptoms, what is the correct label (diagnosis) to apply to that set?
Machine Learning

- Ideally suited to the task of medical diagnosis (at least the first definition)
- Known diagnoses {symptoms|diagnosis} are used to train the machine learning algorithm
- Unknown diagnoses {symptoms|?} are submitted to the algorithm for classification
Online Diagnosis

- [http://www.medical-library.org/mddx_index.htm](http://www.medical-library.org/mddx_index.htm)
- [http://www.yourdiagnosis.com/yourdiagnosis/start_diagnosis.htm](http://www.yourdiagnosis.com/yourdiagnosis/start_diagnosis.htm)
- [http://easydiagnosis.com/](http://easydiagnosis.com/)
Online Diagnosis

- “DiagnosisPro is not intended to make the final diagnosis for a medical practitioner; nothing can replace a physician's expertise and experience.”
Medical Imaging

- Since the advent of X-ray technology, one of the most powerful ways to investigate patient illness
- Like the mechanical tools that predate imaging, imaging allows a physician to collect a more complete set of symptoms
- A problem with imaging is understanding the symptoms
Understanding the Symptoms

Based upon the symptoms, does this patient have lung cancer?
Issues

- What exactly are the symptoms?
- The image contains only pixel values – typically complex detection and measurement algorithms required to determine “symptoms”
- Computer Aided Detection (CAD) is used to find structures, which are then measured to determine diagnosis
Image Checker

- ImageChecker by R2 Technology
- First CAD system approved by the FDA (1998) for screening mammography
- Used as a “second pair of eyes”

Effectiveness

- Most CAD systems will use sensitivity and specificity to evaluate their effectiveness.

<table>
<thead>
<tr>
<th>Condition (as determined by &quot;Gold standard&quot;)</th>
<th>True</th>
<th>False</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test outcome</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>True Positive</td>
<td>False Positive (Type I error, P-value)</td>
</tr>
<tr>
<td>Negative</td>
<td>False Negative (Type II error)</td>
<td>True Negative</td>
</tr>
</tbody>
</table>

→ Positive predictive value

→ Negative predictive value

↓ Sensitivity

↓ Specificity
Sensitivity vs. Specificity

- High sensitivity shows us that most malignancies are being diagnosed
- High specificity shows us that there are few false alarms
- Sensitivity is critical; specificity requires extra work
- Improve specificity but not at the expense of sensitivity
Conference

- [http://www.cars-int.org/index.htm](http://www.cars-int.org/index.htm)