Multi-View Stacking for Dementia Classification

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What is Dementia?

Loss of mental functions...

Causes of dementia:
• Alzheimer (AD, main cause)
• Parkinson’s disease
• ...

Alzheimer: disease, symptom
Dementia $\neq$ AD, but ...

MCI: mild cognitive impairment

Early diagnosis of dementia $\rightarrow$ classification

AD vs. MCI
Data Acquisition

- Positron Emission Tomography (PET)
- Demographic variables (age, gender: 2)
- Neuropsychological Tests
  - Mini Mental Status Test (MMST: 1)
  - Consortium to Establish a Registry for Alzheimer's Disease (CERAD: 11)
  - Clock Drawing Test (CDT: 1)

57 AD, 70 MCI

PET Processing

original → normalization → smoothing
20 NC

Automated Anatomical Labeling

mean image

voxel mean

116 brain region

DBSCAN voxel value

many finer clusters (connected or disconnected)

DBSCAN (X, Y, Z)

10 Informative features

feature selection

1894 features (AD, MCI)

mean value each cluster AD, MCI

1894 finer clusters (connected)

left hippocampus

example
Multi-View Data

“View”

<table>
<thead>
<tr>
<th>PET</th>
<th>MMST</th>
<th>CERAD</th>
<th>Demo</th>
</tr>
</thead>
<tbody>
<tr>
<td>70.9</td>
<td>78.1</td>
<td>80.1</td>
<td>61.6</td>
</tr>
</tbody>
</table>

accuracy: %

K-Nearest Neighbor (KNN) classifier/learner

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</table>

75.8
Multi-View Stacking [Wolpert, 92]

KNN learner

Multi-response Linear Regression (MLR) [Ting & Witten, 99]

83.6% accuracy
## Contribution of Individual View w.r.t. MLR

<table>
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<tr>
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<th>PET</th>
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<th>CERAD</th>
<th>Demo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MCI (1)</strong></td>
<td>$\alpha$</td>
<td>-0.1366</td>
<td>-0.3098</td>
<td>-0.2668</td>
</tr>
<tr>
<td>p-value</td>
<td>0.0001</td>
<td>0.0314</td>
<td>0.0157</td>
<td>0.1791</td>
</tr>
<tr>
<td><strong>AD (2)</strong></td>
<td>$\beta$</td>
<td>0.4441</td>
<td>0.0837</td>
<td>0.1973</td>
</tr>
<tr>
<td>p-value</td>
<td>0.0006</td>
<td>0.0493</td>
<td>0.0108</td>
<td>0.1832</td>
</tr>
</tbody>
</table>

\[ Y = \alpha \cdot \text{PET(MCI)} + \beta \cdot \text{PET(AD)} + \cdots + \gamma \cdot \text{Demo(AD)} + \text{const.} \]
Contributing Factors of Good Performance

<table>
<thead>
<tr>
<th></th>
<th>Base Correlation</th>
<th>Meta Correlation</th>
<th>Std. of Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Views</td>
<td>0.62</td>
<td>0.28</td>
<td>14.5</td>
</tr>
<tr>
<td>Created Views 1</td>
<td>0.60</td>
<td>0.28</td>
<td>13.8</td>
</tr>
<tr>
<td>Created Views 2</td>
<td>0.88</td>
<td>0.27</td>
<td>12.6</td>
</tr>
</tbody>
</table>
\[ Y = \beta \cdot X + \text{const.} \]

- Slope = 12.4, p-value < 10^{-6}
- Slope = 20.6, p-value < 10^{-10}
- Slope = -0.34, p-value = 0.01

Legend:
- ○ hepatitis
- □ musk
- ○ ionosphere
- ○ sonar
- ○ ozone
- ○ spectf
- ○ parkinsons
- × promoters
- × german
- × breast
- × chess
- × spambase
- × heart
- × australian
Summary

• Dementia classification can benefit from various views

• Multi-view stacking can improve the overall system performance, if views are optimally correlated

• It should also be beneficial for biological data.
Thanks for your attention!
Questions?
References
