Transfer of Predictive Models for Classification of Statutory Texts in Multi-jurisdictional Settings

Coding Scheme
- Citation
- Relevance
- Acting PHS agent (Who is acting?)
- Prescription
- Action (Which action is being taken?)
- Goal
- Purpose (For what purpose is action being taken?)
- Type of Emergency Disaster
- Receiving PHS agent
- Timeframe (In what timeframe can/must action be taken?)
- Condition

Example Code Assignment

Example Statutory Provision
The number of patients admitted to any area of the hospital shall not exceed the number for which the area is designed, equipped, and staffed except in cases of emergency, and then only in accordance with the emergency or disaster plan of the hospital.

Corresponding Code
28 Pa. Code § 101.172; Hospital (14); Must Do (2); Suspense (29); Rules/Regulations/Restrictions (4); For Emergency Response (2); Non-specific Disaster/Emergency (5); Public/Individuals (27); Silent (0); Silent (0)

Framework for Transfer of Predictive Models
At minimum, framework assumes existence of labeled dataset:

\[ D_{train} = \{x_{train}, y_{train}\} \in D_{target} \]

In addition, there may be an arbitrary number of labeled datasets:

\[ D_{aux} = \{x_{aux}, y_{aux}\} \in D_{aux} \sim D_{target} \]

Goal is to train \( f() \) which performs well on unseen \( y_{test} \) in \( D_{target} \).

Instead of actual prediction for \( y_{test} \), probability distribution over label space is used:

\[ f(y_{test}) = \{p(y_1), p(y_2), \ldots, p(y_n)\} \]

We train a predictive function \( f_{train}(\cdot) \) on \( D_{train} \).

In addition, we train \( f_{aux}(\cdot) \) for each available \( D_{aux}^{(i)} \).

We generate accuracy matrix:

\[ A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \]

where \( a_{ij} = \frac{1}{n} \sum_{k=1}^{n} f_k(y(k)) = f_j \)

Next, we generate a prediction matrix:

\[ p_{x(k)}^{(y)} = \left( p_{y_1}^{(x(k))}, p_{y_2}^{(x(k))}, \ldots, p_{y_n}^{(x(k))} \right) \]

We perform element-wise multiplication of \( A \) and \( p_{x(k)}^{(y)} \) to obtain confidence matrix for \( y(k) \):

\[ C(x(k)) = A \odot p_{x(k)}^{(y)} \]

Each \( a_{ij} \times p_{ij} \) represents a confidence that \( x(k) \) should be labeled with class \( j \) emulated by \( f(.) \).

Experiments
We generate following data sets:

\[ D_{train}^{(1)} = \{x_{train}^{(1)}, y_{train}^{(1)}\} \]

\[ D_{aux}^{(1)} = \{x_{aux}^{(1)}, y_{aux}^{(1)}\} \]

\[ D_{aux}^{(2)} = \{x_{aux}^{(2)}, y_{aux}^{(2)}\} \]

For each task we conduct 8 related experiments:

- (AK, MD, TX, KS, CA, ND, PA, AK, ND, CA, TK, MD)

In related experiments there are 100 runs for first and eighth experiments and 300 runs for other experiments.

Results

<table>
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<tr>
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<tr>
<td>task 1a</td>
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Example

COMAR 01.03.2003 (D)(2)

CODE OF MARYLAND REGULATIONS
TITLE 01. EXECUTIVE DEPARTMENT
SUBTITLE 01. EXECUTIVE ORDERS

Establishment of the Governor’s Office of Homeland Security

The Director shall be responsible for the following activities: Advise the Governor on policies, strategies, and measures to enhance and improve the ability to detect, prevent, prepare for, protect against, respond to, and recover from, main-made emergencies or disasters, including terrorist attacks;

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