Eye Classification Using Hierarchical Logistical Regression Model

St 825 Final Project

Yan Xu
Xueliang Pan

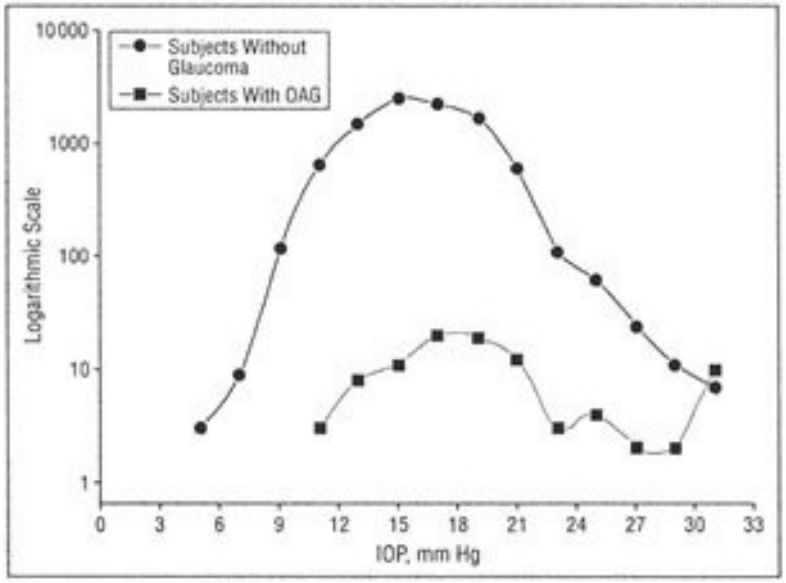
June 8th 2005

Introduction

- 65 million people worldwide have glaucoma. About 70% (three million) of the diagnosed cases of glaucoma are Primary open-angle glaucoma (POAG) in USA

- measurement of the Intraocular Pressure (IOP, or say inner eye pressure) was served as a tool to diagnose

Problem: Not all the people with higher IOP has glaucoma



The number of persons with each level of intraocular pressure (IOP) in the eye with a higher pressure among those without glaucoma and those with open-angle glaucoma (OAG), on a logarithmic scale. While the mean IOP is higher among those with OAG, the distributions are not dramatically different. Those with an IOP of 31 mm Hg or higher are grouped together, and only in this group do subjects with OAG predominate.

To help improve the diagnosis accuracy, IOP data is recommended to be integrated with data from other ophthalmological procedures to formulate a diagnosis

Clinical Measures

Age (year)	Age of patients
Sex	Male / Female
IOP_G (mmHg)	Intraocular Pressure (IOP) measured by Goldman meter
IOPave (mmHg)	IOP measured by Ocular Response Analyzer(ORA)
Hysteresis (mmHg)	Hysteresis measured by the ORA
EOP (mmHg)	Excess ocular pressure measured by ORA
CTM (um)	Corneal Thickness Measure by ultrasonic pachymeter
R (mm)	Eye Radius by ultrasonic pachymeter
Hypertension	Yes/no
Suspect	Glaucoma suspect or not
diseases	Glaucoma or not

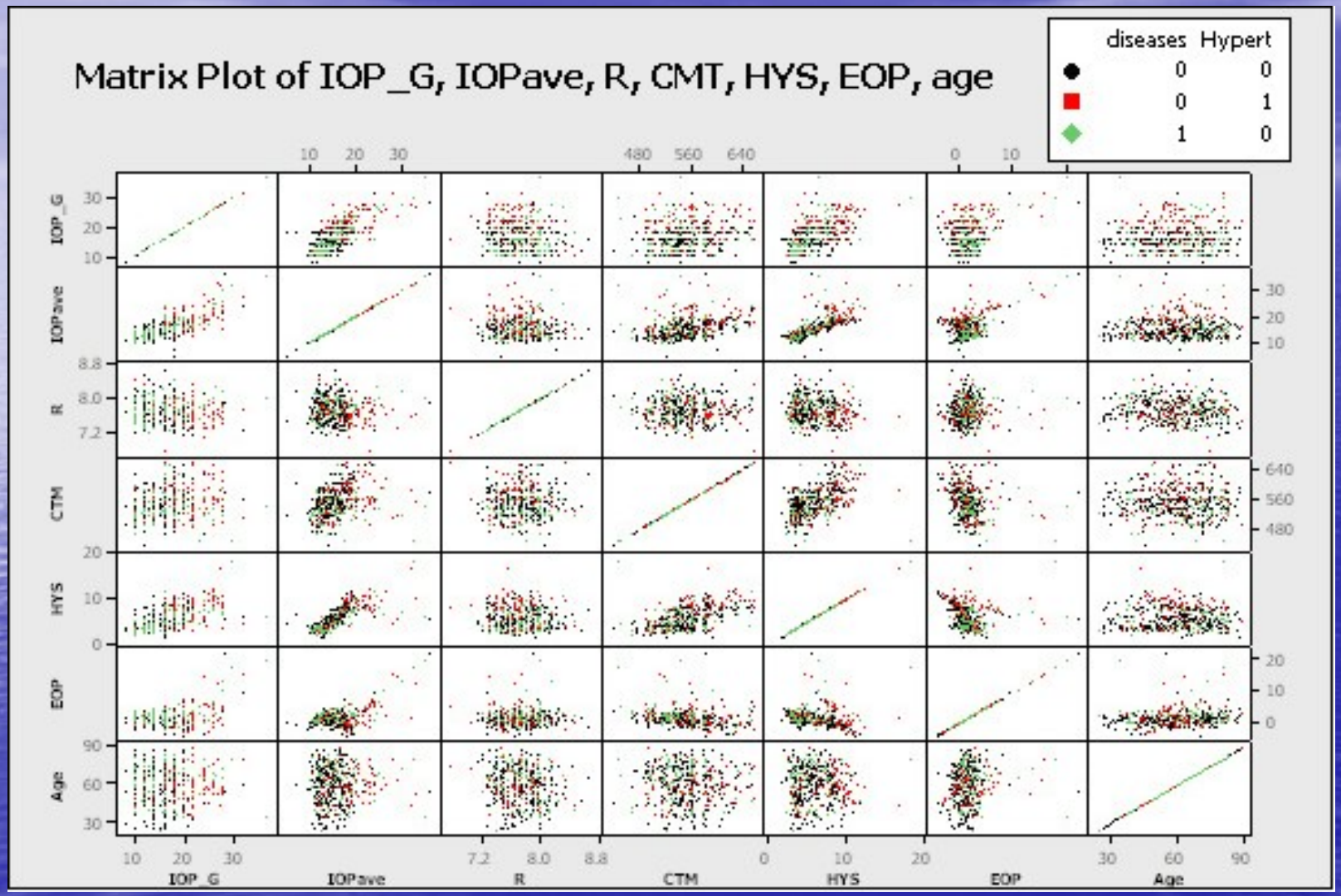
Preliminary Data Analysis

Variable	N	N*	Mean	SE	Min	Q1	M	Q3	Max
IOP_G	401	0	16.798	0.239	8	14	16	20	37
CTM	401	0	552.03	2.01	437	524	550	579.5	659
R	397	4	7.7249	0.0137	6.75	7.545	7.7	7.9	8.65
IOPave	401	0	15.866	0.206	4.8	12.9	15.2	17.65	36.6
HYS	401	0	5.997	0.121	1.8	4	5.5	7.85	18.2
EOP	401	0	1.558	0.143	-4.3	0.2	1.2	2.35	22.5
Age	397	4	59.738	0.718	24	49.5	61	71	89

Hypertension: 1-> no glaucoma, just hypertension, 0 ->else

Suspect: 1-> no glaucoma but may have it, 0 -> elsu

Disease: 1 -> Glaucoma, 0 -> else


Matrix Plot of IOP_G, IOPave, R, CMT, HYS, EOP, age
diseases Hypert
0 0
0 1
1 0
IOP_G
IOPave
R
CTM
HYS
EOP
Age

Hierarchical Logistic Regression

$$p(y=1|\beta, x) = \psi(\beta^T x)$$

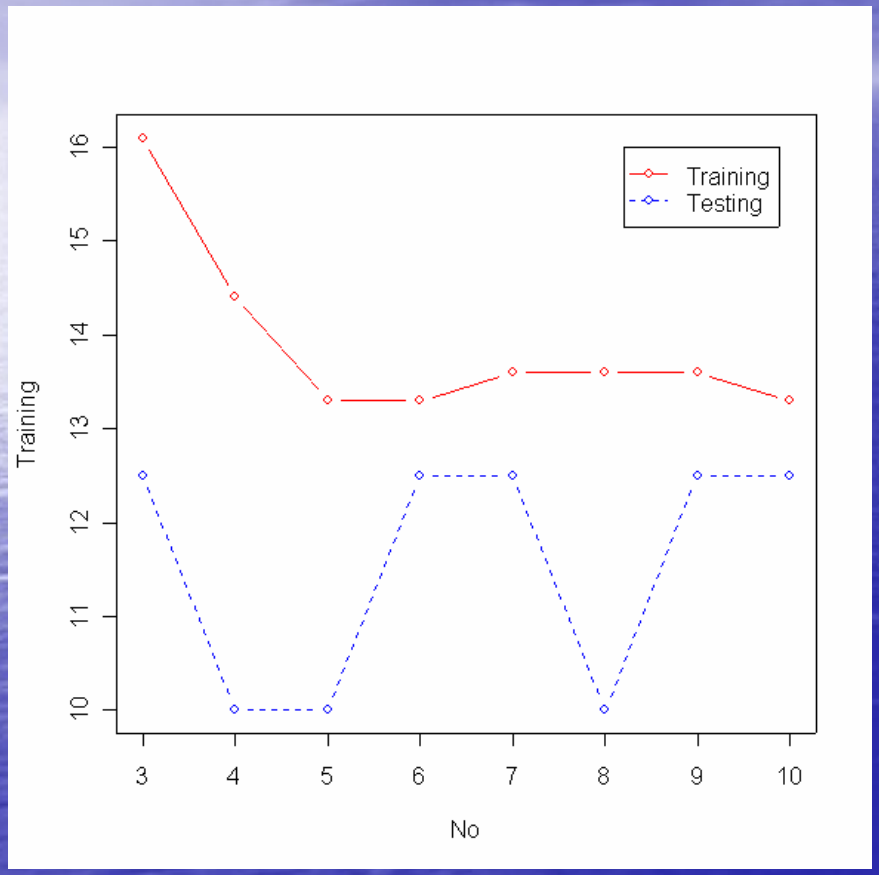
$$\psi(z) = \exp(z)/(1+\exp(z))$$

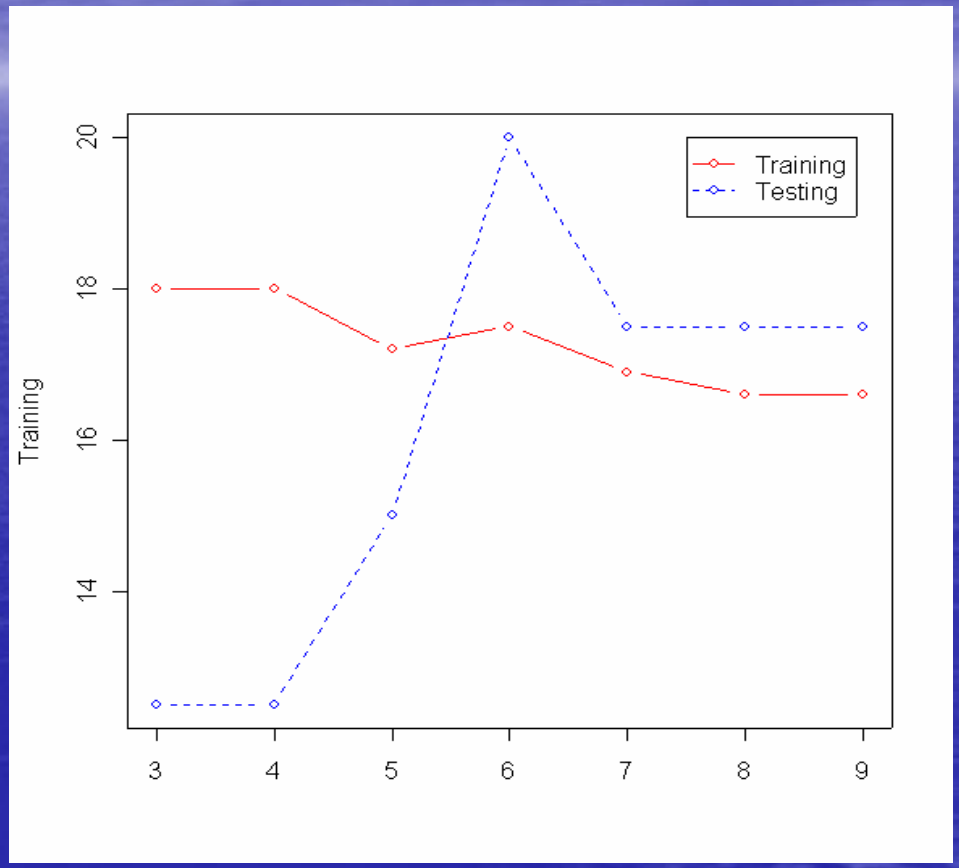
$$p(\beta_j \mid \tau_j) = N(0, \tau_j) = \frac{1}{\sqrt{2\pi\tau_j}} \exp(\frac{-\beta_j^2}{2\tau_j})$$

$$l(\boldsymbol{\beta}) = \ln p(\boldsymbol{\beta}|D) = -(\sum_{i=1}^{n} \ln(1 + \exp(-\boldsymbol{\beta}^T \boldsymbol{x_i} y_i)) + \ln p(\boldsymbol{\beta})$$

Results

		Sex	IOP	CTM	R	IOPave	HYS	EOP	Age	Hyp	Susp	Train MCR	Test MCR
10	10	x	x	x	x	x	x	x	x	x	x	13.30%	12.50%
	9	x		x	x	x	x	x	x	x	x	13.60%	12.50%
	8	x		x	x	x		x	x	x	x	13.60%	10%
	7	x		x	x			x	x	x	x	13.60%	12.50%
	6	x		x	x			x		x	x	13.30%	12.50%
	5	x		x				x		x	x	13.30%	10%
	4	x						x		x	x	14.40%	10%
	3							x		x	x	16.10%	12.50%
9	9	x	x	x	x	x	x	x	x	x		16.60%	17.50%
	8	x		x	x	x	x	x	x	x		16.60%	17.50%
	7	x		x	x	x		x	x	x		16.90%	17.50%
	6	x		x	x			x	x	x		17.50%	20%
	5	x		x	x				x	x		17.20%	15%
	4	x		x					x	x		18%	12.50%
	3	x							x	x		18%	12.50%


Training
Testing
Training
No
10
11
12
13
14
15
16
3
4
5
6
7
8
9
10

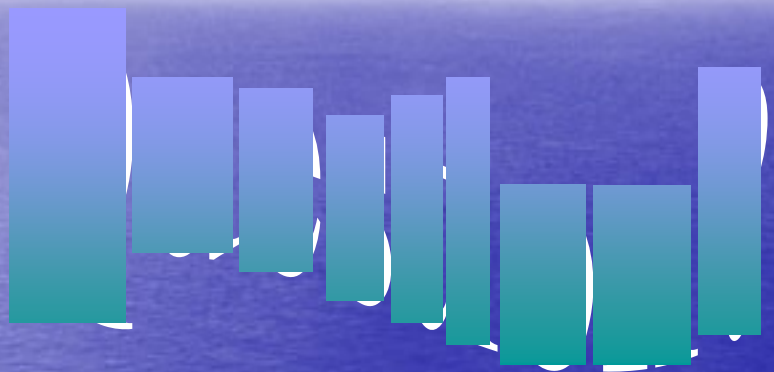

Training
Testing
Training
14
16
18
20
3
4
5
6
7
8
9

Conclusion

- Considering misclassification rate (MCR), the models have MCR about 10% to 20%
- The more variables selected, the less training MCR
- The test MCR is hard to predict
- With IOP along, it is hard to separate the people with glaucoma from others

Future Work

- Use different priors to improve the classification accuracy
- Try SVM classification
- Use big data set as test data to measure the test MCR



Thanks !!