inholland hogeschool

Evaluation

Data Mining Concepts and Techniques

Chapter 9.5

Partly based on slides prepared by Jiawei Han

Evaluation

- Why?
- What?
- How?
  - Measures
  - Training and test data
  - Significance

```
                 0.96        0.03
Weighted Avg.    0.96        0.02

=== Confusion Matrix ===

  a  b  c   <-- classified as
 49  1  0 |  a = Iris-setosa
  0 47  3 |  b = Iris-versicolor
  0  2 48 |  c = Iris-virginica
```

Two classes

- Two classes: T/F, Positive/Negative

	Predicted positive	Predicted negative
Actual positive		
Actual negative		

Two classes

- Two classes: T/F, Positive/Negative

	Predicted positive	Predicted negative
Actual positive	True positives	False negatives
Actual negative	False positives	True negatives

Two class measures

True positive / false positive / true negative / false negative

- Accuracy (TP+TN) /(P+N)
- Error rate (FP+FN) / (P+N)
- Sensitivity TP / P
- Specificity TN / N
- Precision TP / (TP + FP)
- Recall TP / P
- F-score (2 * precision * recall)/(precision + recall)

Multi-class measures?

True positive / false positive / true negative / false negative

- Accuracy (TP+TN) /(P+N)
- Error rate (FP+FN) / (P+N)
- Sensitivity TP / P
- Specificity TN / N
- Precision TP / (TP + FP)
- Recall TP / P
- F-score (2 * precision * recall)/(precision + recall)

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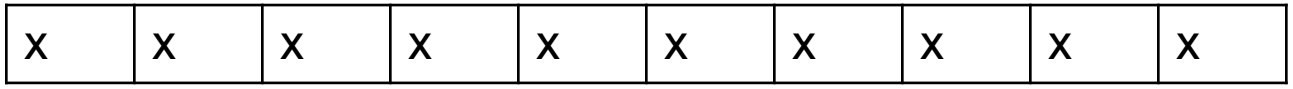
Training en test data 1: same data for training en testing

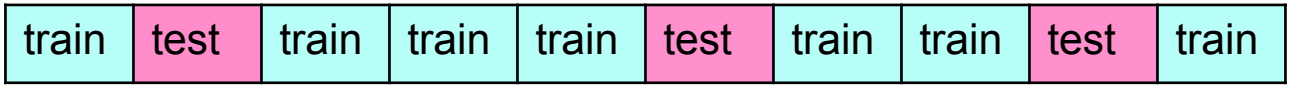
Bad idea => why?

Training en test data 2: holdout / percentage split

Complete data set



Randomly select x% as test data

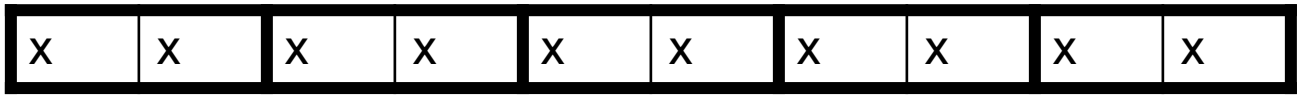


Risk?

Atypical test set

Training en test data 3: k-fold cross-validation

Complete data set



Fold 1: test test train train train train train train train train

Fold 2: train train test test train train train train train train

Fold 3: train train train train test test train train train train

Fold 4: train train train train train train test test train train

Fold 5: train train train train train train train train test test

Average results over folds

More cross-validation

- Leave-one-out
- Stratified cross-validation

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Method M1 *significantly* better than M2?

- 10-fold cross-validation => n=10
- Paired t-test
  - H0: performance M1 same as M2
  - H1: performance M1 differs from M2

$$t = \frac{\overline{err}(M_1) - \overline{err}(M_2)}{\sqrt{var(M_1 - M_2)/k}}$$

$$var(M_1 - M_2) = \frac{1}{k} \sum_{i=1}^{k} \left[err(M_1)_i - err(M_2)_i - (\overline{err}(M_1) - \overline{err}(M_2)) \right]^2$$

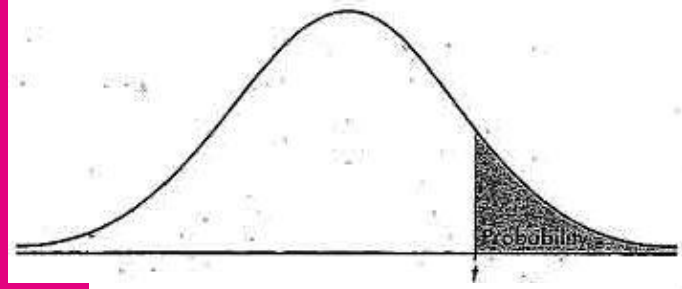

TABLE B: *t*-DISTRIBUTION CRITICAL VALUES

	Tail probability p											
	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.0005
	1.000	1.376	1.963	3.078	6.314	12.71	15.89	31.82	63.66	127.3	318.3	636.6
	.816	1.061	1.386	1.886	2.920	4.303	4.849	6.965	9.925	14.09	22.33	31.60
	.765	.978	1.250	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
	.741	.941	1.190	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.610
5	.727	.920	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	.718	.906	1.134	1.440	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	.711	.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	.706	.889	1.108	1.397	1.860	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	.703	.883	1.100	1.383	1.833	2.262	2.398	2.821	3.250	3.690	4.297	4.781
10	.700	.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	.697	.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	.695	.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.930	4.318
13	.694	.870	1.079	1.350	1.771	2.160	2.282	2.650	3.012	3.372	3.852	4.221
14	.692	.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.140
15	.691	.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	.690	.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	.689	.863	1.069	1.333	1.740	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	.688	.862	1.067	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	.688	.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	.687	.860	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.850
21	.686	.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	.686	.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	.685	.858	1.060	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	.685	.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	.684	.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	.684	.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	.684	.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.690
28	.683	.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	.683	.854	1.055	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	.683	.854	1.055	1.310	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.646
40	.681	.851	1.050	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551
50	.679	.849	1.047	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	3.496
60	.679	.848	1.045	1.296	1.671	2.000	2.099	2.390	2.660	2.915	3.232	3.460
80	.678	.846	1.043	1.292	1.664	1.990	2.088	2.374	2.639	2.887	3.195	3.416
100	.677	.845	1.042	1.290	1.660	1.984	2.081	2.364	2.626	2.871	3.174	3.390
1000	.675	.842	1.037	1.282	1.646	1.962	2.056	2.330	2.581	2.813	3.098	3.300
∞	.674	.841	1.036	1.282	1.645	1.960	2.054	2.326	2.576	2.807	3.091	3.291
	50%	60%	70%	80%	90%	95%	96%	98%	99%	99.5%	99.8%	99.9%
	Confidence level C											

Other aspects of performance

- Efficiency
- Scalability
- Robustness
- Interpretability

And now…

- Do exercise evaluation