DATA MINING B(2)

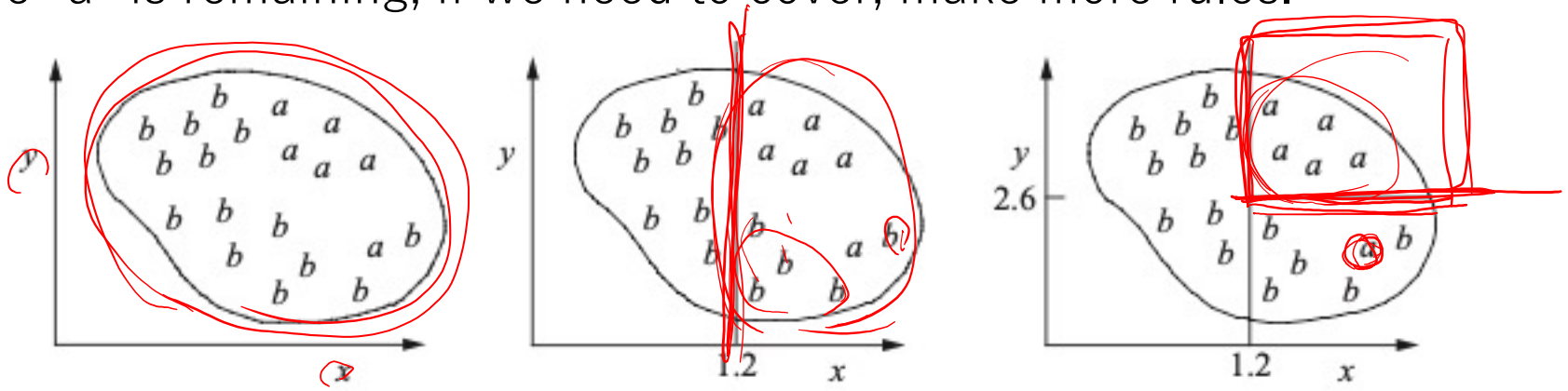
10-1. Covering Algorithm: Rule Construction

Rule Construction

- Rule can be constructed…
  - 1R-rule
    - Too simple
  - Decision Tree
    - Become complex.
  - Other way…
    - Covering Approach

Covering Approach

- Classification Rule
- Rough procedure
  - Consider rules to pick up target class's instances and exclude other instances. That covers target class.
  - Repeat until all target instance is covered.
  - Let's see the figure below.
    - Target is "a". Exclude "b" by x=1.2 and then y=2.6. Almost of "a" is covered.
    - One "a" is remaining, if we need to cover, make more rules.



Rules and Trees

- Covering approach is similar to decision tree.
- However there are many difference.
  - Tree considers all class in same time.
  - Covering approach targets 1 class in same time.
  - Rule from tree is redundant. “Replaced subtree problem”

Simple Covering Algorithm (0)

- The concept is
  - Add the test to improve accuracy of the rule.
  - Select more accurate test.
    - <-> entropy in decision tree
- Example on Contact Lens Data (right table)
  - We want to recommend hard lens, soft lens or none.
  - Who will be recommended “hard” lens?
  - Rule is “If ? then recommendation=hard”.

AGE	spectacle-prescrip	astigmatism	tear-prod-rate	contact-lenses
young	myope	no	reduced	none
young	myope	no	normal	soft
young	myope	yes	reduced	none
young	myope	yes	normal	hard
young	hypermetrope	no	reduced	none
young	hypermetrope	no	normal	soft
young	hypermetrope	yes	reduced	none
young	hypermetrope	yes	normal	hard
pre-presbyopic	myope	no	reduced	none
pre-presbyopic	myope	no	normal	soft
pre-presbyopic	myope	yes	reduced	none
pre-presbyopic	myope	yes	normal	hard
pre-presbyopic	hypermetrope	no	reduced	none
pre-presbyopic	hypermetrope	no	normal	soft
pre-presbyopic	hypermetrope	yes	reduced	none
pre-presbyopic	hypermetrope	yes	normal	none
presbyopic	myope	no	reduced	none
presbyopic	myope	no	normal	none
presbyopic	myope	yes	reduced	none
presbyopic	myope	yes	normal	hard
presbyopic	hypermetrope	no	reduced	none
presbyopic	hypermetrope	no	normal	soft
presbyopic	hypermetrope	yes	reduced	none
presbyopic	hypermetrope	yes	normal	none

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Simple Covering Algorithm (1)

- First candidate
  - age = young 2/8
  - age = pre-presbyopic 1/8
  - age = presbyopic 1/8
  - spectacle prescription = myope 3/12
  - spectacle prescription = hypermetrope 1/12
  - astigmatism = no 0/12
  - astigmatism = yes 4/12 ← **choose**
  - tear production rate = reduced 0/12
  - tear production rate = normal 4/12

AGE	spectacle-prescrip	astigmatism	tear-prod-rate	contact-lenses
young	myope	no	reduced	**none**
young	myope	no	normal	**soft**
young	myope	yes	reduced	**none**
young	myope	yes	normal	**hard**
young	hypermetrope	no	reduced	**none**
young	hypermetrope	no	normal	**soft**
young	hypermetrope	yes	reduced	**none**
young	hypermetrope	yes	normal	**hard**
pre-presbyopic	myope	no	reduced	**none**
pre-presbyopic	myope	no	normal	**soft**
pre-presbyopic	myope	yes	reduced	**none**
pre-presbyopic	myope	yes	normal	**hard**
pre-presbyopic	hypermetrope	no	reduced	**none**
pre-presbyopic	hypermetrope	no	normal	**soft**
pre-presbyopic	hypermetrope	yes	reduced	**none**
pre-presbyopic	hypermetrope	yes	normal	**none**
presbyopic	myope	no	reduced	**none**
presbyopic	myope	no	normal	**none**
presbyopic	myope	yes	reduced	**none**
presbyopic	myope	yes	normal	**hard**
presbyopic	hypermetrope	no	reduced	**none**
presbyopic	hypermetrope	no	normal	**soft**
presbyopic	hypermetrope	yes	reduced	**none**
presbyopic	hypermetrope	yes	normal	**none**

Simple Covering Algorithm (2)

- Rule
  - If astigmatism=yes and ? Then
    recommend="hard" 4/12
- Second candidate
  - age = young 2/4
  - age = pre-presbyopic 1/4
  - age = presbyopic 1/4
  - spectacle prescription = myope 3/6
  - spectacle prescription = hypermetrope 1/6
  - tear production rate = reduced 0/6
  - tear production rate = normal 4/6 ← **choose**

AGE	spectacle-prescrip	astigmatism	tear-prod-rate	contact-lenses
young	myope	yes	reduced	**none**
young	myope	yes	normal	**hard**
young	hypermetrope	yes	reduced	**none**
young	hypermetrope	yes	normal	**hard**
pre-presbyopic	myope	yes	reduced	**none**
pre-presbyopic	myope	yes	normal	**hard**
pre-presbyopic	hypermetrope	yes	reduced	**none**
pre-presbyopic	hypermetrope	yes	normal	**none**
presbyopic	myope	yes	reduced	**none**
presbyopic	myope	yes	normal	**hard**
presbyopic	hypermetrope	yes	reduced	**none**
presbyopic	hypermetrope	yes	normal	**none**

Simple Covering Algorithm (3)

AGE	spectacle-prescrip	astigmatism	tear-prod-rate	contact-lenses
young	myope	yes	normal	**hard**
young	hypermetrope	yes	normal	**hard**
pre-presbyopic	myope	yes	normal	**hard**
pre-presbyopic	hypermetrope	yes	normal	**none**
presbyopic	myope	yes	normal	**hard**
presbyopic	hypermetrope	yes	normal	**none**

- Rule
  - If astigmatism=yes and tear production rate = normal
    Then recommend="hard" 4/6
- Third candidate
  - age = young 2/2
  - age = pre-presbyopic 1/2
  - age = presbyopic 1/2
  - spectacle prescription = myope 3/3 ← **choose**
  - spectacle prescription = hypermetrope 1/3

Simple Covering Algorithm (4)

AGE	spectacle-prescrip	astigmatism	tear-prod-rate	contact-lenses
young	myope	yes	normal	**hard**
pre-presbyopic	myope	yes	normal	**hard**
presbyopic	myope	yes	normal	**hard**

- Rule
  - If astigmatism=yes and tear production rate = normal and spectacle prescription = myope
    Then recommend=“hard” 3/3
- We obtain the first rule. But many “hard” are remain.
- We need to make another rule after deleting instances covered by the first rule.

Algorithm

- The Simple Covering Algorithm "PRISM"

- For each class C
  - Initialize E to the instance set
  - While E contains instances in class C
    - Create a rule R with an empty left-hand side that predicts class C
    - Until R is perfect (or there are no more attributes to use) do
      - For each attribute A not mentioned in R, and each value v,
        - Consider adding the condition $A = v$ to the LHS of R
        - Select A and v to maximize the accuracy p/t
          (p/t is a fraction same meaning as in the example before)
          (break ties by choosing the condition with the largest p)
      - Add $A = v$ to R
    - Remove the instances covered by R from E

Rule and Decision List

- Rule by PRISM is order independent.
  - Each rule has same priority.
  - In some cases, two or more rules matches in same time. (in general)
    - Inconsistent may occur.

- Decision List
  - Stop matching if any one rule is matched.

- No rule matched…Use “Default Rule”.

Summary

- Decision Tree
  - Divide and Conquer
- Covering Algorithm
  - Narrowing down the target instance space.
    - Exclude non target instances.
  - Separate and Conquer