Real Estate Profitability

An Analysis of the Residential Building Dataset with the Support Vector Machine Method

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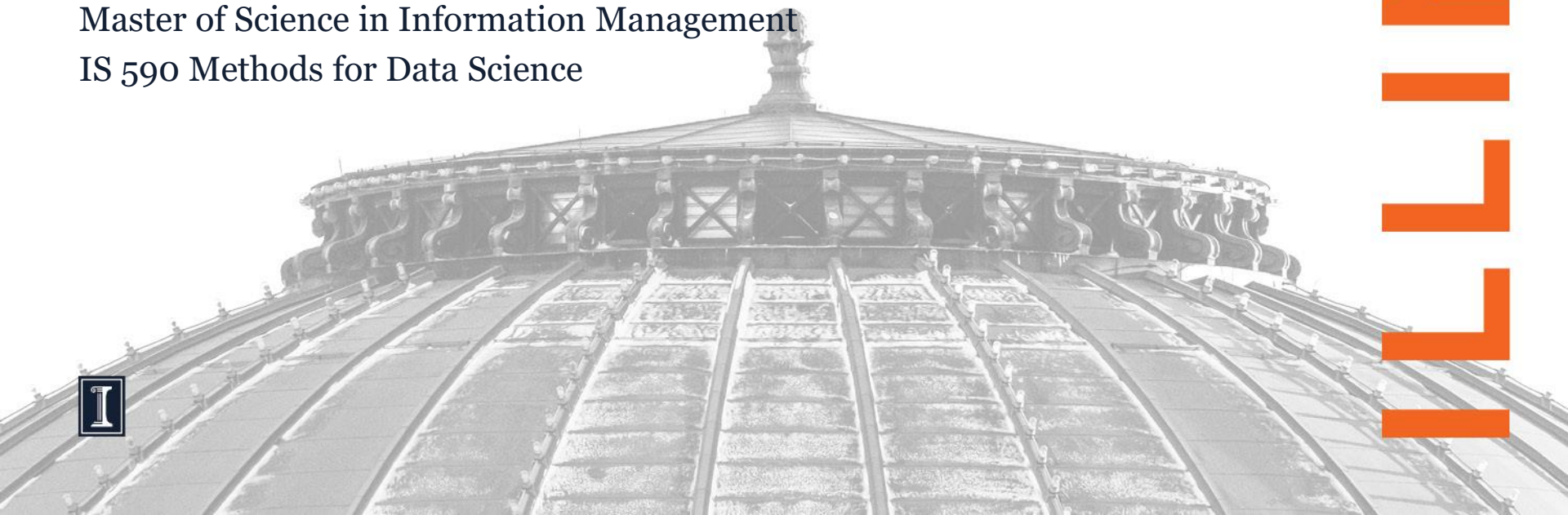
Master of Science in Information Management
IS 590 Methods for Data Science



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Agenda

- Background
- Dataset Overview
- Goal
- Support Vector Machine
  - Radial Kernel
  - Polynomial Kernel
- Diagnostics

Background

- What?
  - Residential buildings
- Where?
  - Tehran, Iran
- When?
  - From 1972 to 1990
- Source
  - Machine Learning Repository hosted by University of California, Irvine

Photograph via loki010 on Reddit

Dataset Overview

Variable Group	Variable ID	Descriptions	Unit	Time Lag Number [p]
PROJECT PHYSICAL AND FINANCIAL VARIABLES	V-1	Project locality defined in terms of zip codes	N/A	N/A
	V-2	Total floor area of the building	m^2	N/A
	V-3	Lot area	m^2	N/A
	V-4	Total preliminary estimated construction cost based on the prices at the beginning of the project	10000000 IRR^m	N/A
	V-5	Preliminary estimated construction cost based on the prices at the beginning of the project	10000 IRR^m	N/A
	V-6	Equivalent preliminary estimated construction cost based on the prices at the beginning of the project in a selected base year [a]	10000 IRR^m	N/A
	V-7	Duration of construction	As a number of time resolution [e]	N/A
	V-8	Price of the unit at the beginning of the project per m^2	10000 IRR^m	N/A
	V-9	Actual sales prices (output)	10000 IRR^m	N/A
	V-10	Actual construction costs (output)	10000 IRR^m	N/A
ECONOMIC VARIABLES AND INDICES [n]	V-11	The number of building permits issued	N/A	1 to 5
	V-12	Building services index (BSI) [b] for a preselected base year [a]	N/A	1 to 5
	V-13	Wholesale price index (WPI) [c] of building materials for the base year	N/A	1 to 5
	V-14	Total floor areas of building permits issued by the city/municipality	m^2	1 to 5
	V-15	Cumulative liquidity [d]	10000000 IRR^m	1 to 5
	V-16	Private sector investment in new buildings	10000000 IRR^m	1 to 5
	V-17	Land price index for the base year [a]	10000000 IRR^m	1 to 5
	V-18	The number of loans extended by banks in a time resolution [e]	N/A	1 to 5
	V-19	The amount of loans extended by banks in a time resolution [e]	10000000 IRR^m	1 to 5
	V-20	The interest rate for loan in a time resolution [e]	%	1 to 5
	V-21	The average construction cost of buildings by private sector at the time of completion of construction	10000 IRR^m /m^2	1 to 5
	V-22	The average of construction cost of buildings by private sector at the beginning of the construction	10000 IRR^m /m^2	1 to 5
	V-23	Official exchange rate with respect to dollars	IRR^m	1 to 5
	V-24	Nonofficial (street market) exchange rate with respect to dollars [h]	IRR^m	1 to 5
	V-25	Consumer price index (CPI) [i] in the base year [a]	N/A	1 to 5
	V-26	CPI of housing, water, fuel & power in the base year [a]	N/A	1 to 5
	V-27	Stock market index [j]	N/A	1 to 5
	V-28	Population of the city	N/A	1 to 5
	V-29	Gold price per ounce	IRR^m	1 to 5

Dataset Overview

- Response (1):
  - Profitability (binary)
  - Ratio = Actual sales prices/Actual construction costs
  - Levels:
    - “Y” if ratio > 5
    - “N” if ratio < 5

- Predictors (27):
  - 8 project physicals and financial variables (V-1 to V- 8)
  - 19 economic variables and indices (V-11 to V-29)

Goal

- Build a SVM with either a polynomial kernel or a radial kernel
- Ys on a side of a kernel, while Ns on the other side of a kernel.
- Make inference if the profitability of a residential building is larger than a particular threshold given physical, financial and economic variables.

Why Support Vector Machine

- Dataset
  - Categorical response and continuous predictors
- Robust
  - Only support vectors would affect kernels
  - Resistant to outliers
- Options
  - Combines support vector classifier with a non-linear kernel
  - Radial or polynomial

SVM – Radial Kernel

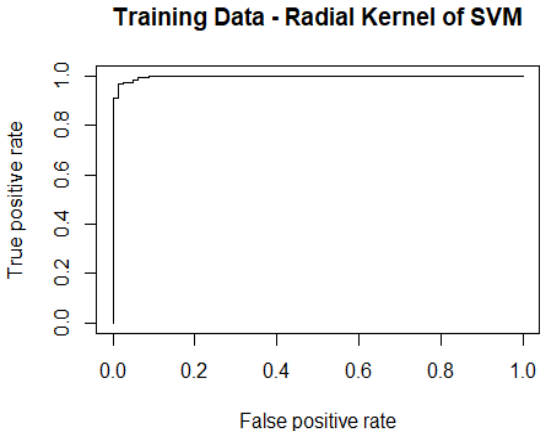
- Select the best choice of gamma and cost for an SVM with radial kernel

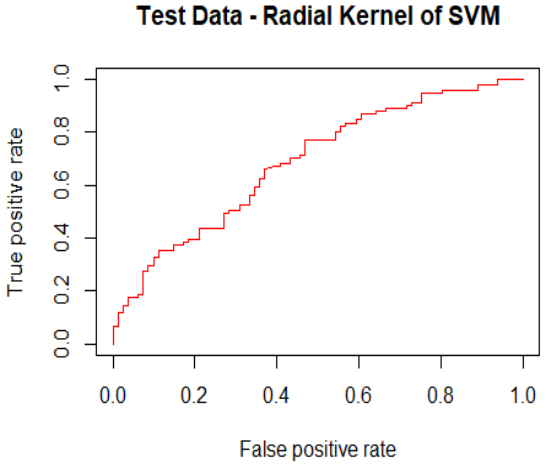
```
tune.out = tune(svm, prof~., data = mydata[train, ], kernel ='radial',
                ranges =
                  list(cost = c(0.1, 1, 10, 100, 1000),
                       gamma = c(0.5, 1, 2, 3, 4)),
                decision.values = TRUE)
summary(tune.out)
## Parameter tuning of 'svm':
## - sampling method: 10-fold cross validation
##
## - best parameters:
##  cost gamma
##     1   0.5
## - best performance: 0.295
```

SVM – Radial Kernel

```
summary(bestmod.radial)
## Call:
## best.tune(method = svm, train.x = prof ~ ., data = mydata[train,
##     ], ranges = list(cost = c(0.1, 1, 10, 100, 1000), gamma = c(0.5,
##     1, 2, 3, 4)), kernel = "radial", decision.values = TRUE)
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  1
##       gamma:  0.5
##
## Number of Support Vectors:  193
##
##  ( 115 78 )
##
## Number of Classes:  2
## Levels:
##  N Y
```

		Truth	
Predict		N	Y
	N	27	10
	Y	54	81
	Error Rate: 0.372		





SVM – Polynomial Kernel

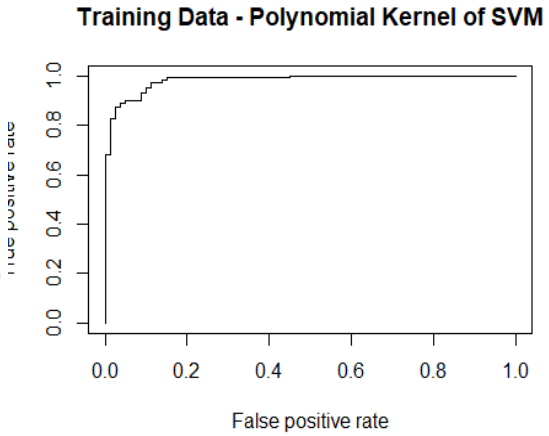
- Select the best choice of degree and cost for an SVM w ith polynomial kernel

```
tune.out = tune(svm, prof~., data = mydata[train,], kernel = 'polynomial',
                ranges =
                  list(degree =c(1, 2, 3, 4, 5),
                       cost = c(0.1, 1, 10, 100, 1000)),
                decision.values = TRUE)
summary(tune.out)
## Parameter tuning of 'svm':
## - sampling method: 10-fold cross validation
## - best parameters:
##  degree cost
##       1  100
## - best performance: 0.115
```

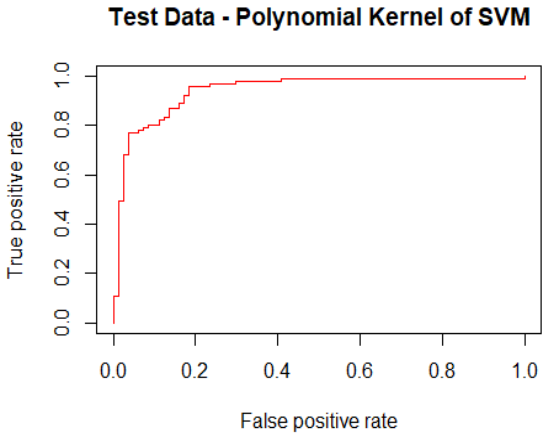
Support vector classifier with a linear decision boundary

SVM – Polynomial Kernel

```
summary(bestmod.poly)
##
## Call:
## best.tune(method = svm, train.x = prof ~ ., data = mydata[train,
##     ], ranges = list(degree = c(1, 2, 3, 4, 5), cost = c(0.1,
##     1, 10, 100, 1000)), kernel = "polynomial", decision.values = TRUE)
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  polynomial
##        cost:  100
##      degree:  1
##       gamma:  0.03703704
##      coef.0:  0
## Number of Support Vectors:  63
##  ( 30 33 )
##
## Number of Classes:  2
##
## Levels:
##  N Y
```



		Truth	
Predict		N	Y
	N	66	7
	Y	15	84
	Error Rate: 0.128		



Diagnostics

- Bias-variance tradeoff

Cost	Margin	Bias	Variance
decreases	wide	low	high
increases	narrow	high	low

- A more flexible method will often produce a lower training error rate, but does not necessarily lead to improved performance on test data
- The choice of tuning parameter determine the extent to which the model underfits or overfits the data

Reference

- Rafiei, M.H. and Adeli, H. (2015). A Novel Machine Learning Model for Estimation of Sale Prices of Real Estate Units. ASCE, Journal of Construction Engineering & Management, 142(2), 04015066.