

# ASSIGNMENT 1: HOUSE PRICES

Projects form an important part of the education of software engineers. They form an active method of teaching, as defined by Piaget, leading to a "training in self-discipline and voluntary effort", which is important to software engineering professionals. Two purposes served by these projects are: education in professional practice, and outcome-based assessment.

Data cleaning or data scrubbing is one of the most important steps previous to any data decision-making or modelling process. Data cleaning is the process of fixing or removing incorrect, corrupted, incorrectly formatted, duplicate, or incomplete data within a dataset.

**Data cleaning** is the process that **removes data** that does not belong to the dataset or it is not useful for modelling purposes. **Data transformation** is the process of **converting data** from one format or structure into another format. Transformation processes **can also be referred to as data wrangling**, or **data munging**, transforming and mapping data from one "raw" data form into another format. **Essentially, real-world data is messy data and for model building: garbage data in means garbage out.**

wrangle =  
discutir

munge =  
manipular  
(només per  
data)

This practical assignment belongs to Data Science Master at the UPC, any dataset for modelling purposes should include a first methodological step on **data preparation** about:

- **Removing** duplicate or irrelevant **observations**
- **Fix structural errors** (usually coding errors, trailing blanks in labels, lower/upper case consistency, etc.).
- **Check data types**. Dates should be coded as such and factors should have level names (if possible, levels have to be set and clarify the variable they belong to). This point is sometimes included under data transformation process. New derived variables are to be produced sometimes scaling and/or normalization (range/shape changes to numeric variables) or category regrouping for factors (nominal/ordinal).
- Filter unwanted **outliers**. Univariate and multivariate outliers have to be highlighted. Remove register/**erase values and set NA for univariate outliers**.
- **Handle missing data**: figure out why the data is missing. Data imputation is to be considered when the aim is modelling (imputation has to be validated).
- **Data validation** is mixed of '**common sense and sector knowledge**': Does the data make sense? Does the data follow the appropriate rules for its field? Does it prove or disprove the working theory, or bring any insight to light? Can you find trends in the data to help you form a new theory? If not, is that because of a data quality issue?

1

## Dataset Context and Contents

City in Iowa, USA

The **Ames Housing dataset** was compiled by Dean De Cock for use in data science education. It can be found in the Kaggle website (<https://www.kaggle.com/competitions/house-prices-advanced-regression-techniques/overview>), there are **1460 observations in the train dataset** and **1459 in the test dataset**. **Target variable is SalePrice**.

Student team consists of **2/3 students**. Contribution of each team member has to be included in the report.

Hint: You have to **retain all available numeric variables**. You are allowed to **select** a subset of about **10 available factors**.

More hints:

### Variables

- Use a profiling tool such as Condes and choose the 10 most representative
- First target against only numeric variables (transformations). Second, add factors (main effects)
- Third, add interactions (2nd order)  $Y \sim A \times B + C \times X_2$ . Finally, validation

**MSSubClass**: Identifies the type of dwelling involved in the sale.

20	1-STORY 1946 & NEWER ALL STYLES	This variable contains info already found in other variables and PUD classification
30	1-STORY 1945 & OLDER	
40	1-STORY W/FINISHED ATTIC ALL AGES	
45	1-1/2 STORY - UNFINISHED ALL AGES	
50	1-1/2 STORY FINISHED ALL AGES	
60	2-STORY 1946 & NEWER	
70	2-STORY 1945 & OLDER	
75	2-1/2 STORY ALL AGES	
80	SPLIT OR MULTI-LEVEL 2+basement or 3	
85	SPLIT FOYER foyer = vestíbul	
90	DUPLEX - ALL STYLES AND AGES 2 families	
120	1-STORY PUD (Planned Unit Development) - 1946 & NEWER	It belongs to a community with shared amenities
150	1-1/2 STORY PUD - ALL AGES	
160	2-STORY PUD - 1946 & NEWER lev=level	
180	PUD - MULTILEVEL - INCL SPLIT LEV/FOYER	
190	2 FAMILY CONVERSION - ALL STYLES AND AGES	Has been converted to fit 2 families instead of 1

2

**MSZoning**: Identifies the general zoning classification of the sale.

A	Agriculture	
C	Commercial	
FV	Floating Village Residential	Literally floating on water
I	Industrial	
RH	Residential High Density	
RL	Residential Low Density	
RP	Residential Low Density Park	
RM	Residential Medium Density	

Lot = solar, Frontage = façana

**LotFrontage**: Linear feet of street connected to property (**numeric**) #feet of the perimeter that have street on one side

**LotArea**: Lot size in square feet (**numeric**)

**Street**: Type of road access to property

Grvl	Gravel
Pave	Paved

**Alley**: Type of alley access to property

Grvl	Gravel
Pave	Paved
NA	No alley access

**LotShape:** General shape of property

Reg	Regular
IR1	Slightly irregular
IR2	Moderately Irregular
IR3	Irregular

**LandContour:** Flatness of the property

Lvl	Near Flat/Level	Level = a nivell
Bnk	Banked - Quick and significant rise from street grade to building	
HLS	Hillside - Significant slope from side to side	
Low	Depression	

**Utilities:** Type of utilities available

There should be a space inbetween

AllPub	All public Utilities (E,G,W,& S) S = Sewer
NoSewr	Electricity, Gas, and Water (Septic Tank)
NoSeWa	Electricity and Gas Only
ELO	Electricity only

**LotConfig:** Lot configuration

Inside	Inside lot	<a href="https://www.allbusiness.com/media-library/image.gif?id=32013783&amp;width=470&amp;quality=80">https://www.allbusiness.com/media-library/image.gif?id=32013783&amp;width=470&amp;quality=80</a>
Corner	Corner lot	
CulDSac	Cul-de-sac	<a href="https://www.designingbuildings.co.uk/wiki/File:Culdesac.jpg">https://www.designingbuildings.co.uk/wiki/File:Culdesac.jpg</a>
FR2	Frontage on 2 sides of property	
FR3	Frontage on 3 sides of property	

**LandSlope:** Slope of property

Gtl	Gentle slope
Mod	Moderate Slope
Sev	Severe Slope

3

**Neighborhood:** Physical locations within Ames city limits Remember Ames is the city we're studying

Blmngtn	Bloomington Heights
Blueste	Bluestem
BrDale	Briardale
BrkSide	Brookside
ClearCr	Clear Creek
CollgCr	College Creek
Crawfor	Crawford
Edwards	Edwards
Gilbert	Gilbert
IDOTRR	Iowa DOT and Rail Road
MeadowV	Meadow Village
Mitchel	Mitchell

wrong tabulation

Names	North Ames
NoRidge	Northridge
NPkVill	Northpark Villa
NridgHt	Northridge Heights
NWAmes	Northwest Ames
OldTown	Old Town
SWISU	South & West of Iowa State University
SawyerSawyer	
SawyerW	Sawyer West
Somerst	Somerset
StoneBr	Stone Brook
Timber	Timberland
Veenker	Veenker

**Condition1:** Proximity to various conditions

Artery	Adjacent to arterial street
Feedr	Adjacent to feeder street

Norm Normal  
RRNn Within 200' of North-South Railroad  
RRAn Adjacent to North-South Railroad  
PosN Near positive off-site feature--park, greenbelt, etc.  
PosA Adjacent to positive off-site feature  
RRNe Within 200' of East-West Railroad  
RR Ae Adjacent to East-West Railroad

**Condition2:** Proximity to various conditions (if more than one is present)

ArteryAdjacent to arterial street  
Feedr Adjacent to feeder street  
Norm Normal  
RRNn Within 200' of North-South Railroad  
RRAn Adjacent to North-South Railroad  
PosN Near positive off-site feature--park, greenbelt, etc.  
PosA Adjacent to positive off-site feature  
RRNe Within 200' of East-West Railroad  
RR Ae Adjacent to East-West Railroad

Building Type

**BldgType:** Type of dwelling

1Fam Single-family Detached  
2FmConTwo-family Conversion; originally built as one-family dwelling  
Duplx Duplex Two-family  
TwnhsETownhouse End Unit  
TwnhsITownhouse Inside Unit In a row of homes (so they can be inside or at one end of the row)

**HouseStyle:** Style of dwelling Except for the finished/unfinished label, this info is already in MSSubClass

1StoryOne story  
1.5FinOne and one-half story: 2nd level finished  
1.5UnfOne and one-half story: 2nd level unfinished  
2StoryTwo story  
2.5FinTwo and one-half story: 2nd level finished  
2.5UnfTwo and one-half story: 2nd level unfinished  
SFoyerSplit Foyer  
SLvl Split Level

**OverallQual:** Rates the overall material and finish of the house

10 Very Excellent  
9 Excellent  
8 Very Good  
7 Good  
6 Above Average  
5 Average  
4 Below Average  
3 Fair  
2 Poor  
1 Very Poor

**OverallCond:** Rates the overall condition of the house

10 Very Excellent  
9 Excellent  
8 Very Good  
7 Good  
6 Above Average  
5 Average  
4 Below Average  
3 Fair  
2 Poor  
1 Very Poor

**YearBuilt:** Original construction date (numeric/date)

**YearRemodAdd:** Remodel date (same as construction date if no remodeling or additions)  
(numeric/date)

**RoofStyle:** Type of roof

Flat	Flat
Gable	Gable
Gambrel	Gabrel (Barn)
Hip	Hip
Mansard	Mansard
Shed	Shed

**RoofMatl:** Roof material

ClyTile	Clay or Tile
CompShg	Standard (Composite) Shingle
Membran	Membrane
Metal	Metal
Roll	Roll
Tar&Grv	Gravel & Tar
WdShake	Wood Shakes
WdShngl	Wood Shingles

**CAREFUL!** **Exterior1st:** Exterior covering on house

It's Exterior1st, not  
Exteriorist  
(because it's the  
1st covering)

AsbShng	Asbestos Shingles
AsphShn	Asphalt Shingles
BrkComm	Brick Common
BrkFace	Brick Face
CBlock	Cinder Block
CemntBd	Cement Board
HdBoard	Hard Board
ImStucc	Imitation Stucco
MetalSd	Metal Siding
Other	Other
Plywood	Plywood
PreCast	PreCast
Stone	Stone
Stucco	Stucco
VinylSd	Vinyl Siding
Wd Sdng	Wood Siding
WdShing	Wood Shingles

**Exterior2nd:** Exterior covering on house (if more than one material)

AsbShng	Asbestos Shingles
AsphShn	Asphalt Shingles
BrkComm	Brick Common
BrkFace	Brick Face
CBlock	Cinder Block
CemntBd	Cement Board
HdBoard	Hard Board
ImStucc	Imitation Stucco
MetalSd	Metal Siding
Other	Other
Plywood	Plywood
PreCast	PreCast
Stone	Stone
Stucco	Stucco
VinylSd	Vinyl Siding
Wd Sdng	Wood Siding
WdShing	Wood Shingles

**MasVnrType:** Masonry veneer type Tipus de revestiment de les totxanes (parets)

BrkCmn	Brick Common
BrkFace	Brick Face
CBlock	Cinder Block
None	None
Stone	Stone

**MasVnrArea:** Masonry veneer area in square feet (numeric)

**ExterQual:** Evaluates the quality of the material on the exterior

Ex	Excellent
Gd	Good
TA	Average/Typical
Fa	Fair
Po	Poor

**ExterCond:** Evaluates the present condition of the material on the exterior

Ex	Excellent
Gd	Good
TA	Average/Typical
Fa	Fair
Po	Poor

**Foundation:** Type of foundation

BrkTil	Brick & Tile
CBlock	Cinder Block
PConc	Poured Contrete
Slab	Slab
Stone	Stone
Wood	Wood

**BsmtQual:** Evaluates the height of the basement

Ex	Excellent (100+ inches)
Gd	Good (90-99 inches)
TA	Typical (80-89 inches)
Fa	Fair (70-79 inches)
Po	Poor (<70 inches)
NA	No Basement

**BsmtCond:** Evaluates the general condition of the basement

Ex	Excellent
Gd	Good
TA	Typical - slight dampness allowed
Fa	Fair - dampness or some cracking or settling
Po	Poor - Severe cracking, settling, or wetness
NA	No Basement

**BsmtExposure:** Refers to walkout or garden level walls Quant dona el subterrani a l'exterior (hi ha subterrànies que tenen una sortida al nivell del jardí)

Gd	Good Exposure
Av	Average Exposure (split levels or foyers typically score average or above)
Mn	Minimum Exposure
No	No Exposure
NA	No Basement

**BsmtFinType1:** Rating of basement finished area

GLQ	Good Living Quarters
ALQ	Average Living Quarters
BLQ	Below Average Living Quarters
Rec	Average Rec Room <span style="color: blue;">Rec = Recreation</span>
LwQ	Low Quality
Unf	Unfinished
NA	No Basement

**BsmtFinSF1:** Type 1 finished square feet (numeric)

**BsmtFinType2:** Rating of basement finished area (if multiple types)

GLQ Good Living Quarters  
ALQ Average Living Quarters  
BLQ Below Average Living Quarters  
Rec Average Rec Room  
LwQ Low Quality  
Unf Unfinished  
NA No Basement

**BsmtFinSF2**: Type 2 finished square feet (numeric)

**BsmtUnfSF**: Unfinished square feet of basement area (numeric)

**TotalBsmtSF**: Total square feet of basement area (numeric)

**Heating**: Type of heating

Floor Floor Furnace  
GasA Gas forced warm air furnace  
GasW Gas hot water or steam heat  
Grav Gravity furnace  
OthW Hot water or steam heat other than gas  
Wall Wall furnace

**HeatingQC**: Heating quality and condition

Ex Excellent  
Gd Good  
TA Average/Typical  
Fa Fair  
Po Poor

**CentralAir**: Central air conditioning

N No  
Y Yes

**Electrical**: Electrical system

SBrkr Standard Circuit Breakers & Romex  
FuseA Fuse Box over 60 AMP and all Romex wiring (Average)  
FuseF 60 AMP Fuse Box and mostly Romex wiring (Fair)  
FuseP 60 AMP Fuse Box and mostly knob & tube wiring (poor)  
Mix Mixed

**1stFlrSF**: First Floor square feet (numeric)

**2ndFlrSF**: Second floor square feet (numeric)

**LowQualFinSF**: Low quality finished square feet (all floors) (numeric)  
Above grade = above ground level

**GrLivArea**: Above grade (ground) living area square feet (numeric)

**BsmtFullBath**: Basement full bathrooms (numeric)

**BsmtHalfBath**: Basement half bathrooms (numeric)

**FullBath**: Full bathrooms above grade (numeric)

**HalfBath**: Half baths above grade (numeric)

**Bedroom**: Bedrooms above grade (does NOT include basement bedrooms) (numeric)

**Kitchen**: Kitchens above grade (numeric)

**KitchenQual**: Kitchen quality

Ex Excellent

Gd	Good
TA	Typical/Average
Fa	Fair
Po	Poor

**TotRmsAbvGrd:** Total rooms above grade (does not include bathrooms) (numeric)

**Functional:** Home functionality (Assume typical unless deductions are warranted)

Typ	Typical Functionality
Min1	Minor Deductions 1
Min2	Minor Deductions 2
Mod	Moderate Deductions
Maj1	Major Deductions 1
Maj2	Major Deductions 2
Sev	Severely Damaged
Sal	Salvage only

**Fireplaces:** Number of fireplaces (numeric)

**FireplaceQu:** Fireplace quality

Ex	Excellent - Exceptional Masonry Fireplace
Gd	Good - Masonry Fireplace in main level
TA	Average - Prefabricated Fireplace in main living area or Masonry Fireplace in basement
Fa	Fair - Prefabricated Fireplace in basement
Po	Poor - Ben Franklin Stove
NA	No Fireplace

**GarageType:** Garage location

2Types	More than one type of garage
Attchd	Attached to home
Basment	Basement Garage
BuiltIn	Built-In (Garage part of house - typically has room above garage)
CarPort	Car Port <a href="#">Cobert pel cotxe</a>
Detchd	Detached from home
NA	No Garage

**GarageYrBlt:** Year garage was built (numeric/date)

**GarageFinish:** Interior finish of the garage

Fin	Finished
Rfn	Rough Finished
Unf	Unfinished
NA	No Garage

**GarageCars:** Size of garage in car capacity (numeric)

**GarageArea:** Size of garage in square feet (numeric)

**GarageQual:** Garage quality

Ex	Excellent
Gd	Good
TA	Typical/Average
Fa	Fair
Po	Poor
NA	No Garage

**GarageCond:** Garage condition

Ex	Excellent
Gd	Good
TA	Typical/Average
Fa	Fair



Po	Poor	
NA	No Garage	
<b>PavedDrive:</b> Paved driveway    driveway = entrada del carrer a la casa pel cotxe		
Y	Paved	
P	Partial Pavement	
N	Dirt/Gravel	
	deck = plataforma	
<b>WoodDeckSF:</b> Wood deck area in square feet (numeric)		
<b>OpenPorchSF:</b> Open porch area in square feet (numeric)		
<b>EnclosedPorch:</b> Enclosed porch area in square feet (numeric)		
<b>3SsnPorch:</b> Three season porch area in square feet (numeric)		
<b>ScreenPorch:</b> Screen porch area in square feet (numeric)		
<b>PoolArea:</b> Pool area in square feet (numeric)		
<b>PoolQC:</b> Pool quality		
Ex	Excellent	
Gd	Good	
TA	Average/Typical	
Fa	Fair	
NA	No Pool	
<b>Fence:</b> Fence quality		
GdPrv	Good Privacy	
MnPrv	Minimum Privacy	
GdWo	Good Wood	
MnWw	Minimum Wood/Wire	
NA	No Fence	
<b>MiscFeature:</b> Miscellaneous feature not covered in other categories		
Elev	Elevator	
Gar2	2nd Garage (if not described in garage section)	(by 2Types category, from GarageType)
Othr	Other	
Shed	Shed (over 100 SF)	
TenC	Tennis Court	
NA	None	
<b>MiscVal:</b> \$Value of miscellaneous feature (numeric, \$)		
<b>MoSold:</b> Month Sold (MM)		
<b>YrSold:</b> Year Sold (YYYY)		
<b>SaleType:</b> Type of sale		
	Deed = escriptura	
WD	Warranty Deed - Conventional	
CWD	Warranty Deed - Cash	
VWD	Warranty Deed - VA Loan	Per veterans de guerra i similars
New	Home just constructed and sold	
COD	Court Officer Deed/Estate	Court Officer = persona que treballa al sistema judicial
Con	Contract 15% Down payment regular terms	Down payment = acompte (1a part del pagament que és realitza al moment de la compra)
ConLw	Contract Low Down payment and low interest	
ConLI	Contract Low Interest	
ConLD	Contract Low Down	
Oth	Other	
<b>SaleCondition:</b> Condition of sale		
Normal	Normal Sale	

foreclosure = prendre la vivenda al comprador perquè no paga a temps

Abnorml	Abnormal Sale - trade, foreclosure, short sale
AdjLand	Adjoining Land Purchase <i>També es compra un terreny adjacent</i>
Alloca	Allocation - two linked properties with separate deeds, typically condo with a garage unit
Family	Sale between family members
Partial	Home was not completed when last assessed (associated with New Homes)

**SalePrice**: Target variable (numeric)

The file contains some numeric variables (retain all of them) and many factors (restrict to 10 to reduce the effort).

- Exploratory Data Analysis and Model Fitting should take train sample only.
- Create factors for retained qualitative variables. Train and Test samples.
- Determine if the response variable (*SalePrice* charges) has an acceptably normal distribution.
- Address tests to discard serial correlation. *Serial correlation???*
- Detect univariant and multivariant outliers, errors and missing values (if any) and apply an imputation technique if needed.
- Preliminary exploratory analysis to describe observed relations has to be undertaken.
- If you can improve linear relations or limit the effect of influential data, you must consider suitable transformations for variables. *???*
- Apart from the retained factor variables, you can consider other categorical variables that can be defined from categorized numeric variables. Do not forget to implement new variable definitions in the test sample.
- You must take into account possible interactions between categorical and numerical variables.
- When building the model, you should study the presence of multicollinearity and try to reduce their impact on the model for easier interpretation.
- You should build the model using a technique for selecting variables (removing no significant predictors and/or stepwise selection of the best models). *Stepwise???*
- The validation of the model has to be done with graphs and / or suitable tests to verify model assumptions.
- You must include the study of unusual and / or influential data. *What data is unusual/influential?*
- The resulting model should be interpreted in terms of the relationships of selected predictors and its effect on the response variable.
- You have to apply your final model to the test sample and roughly assess forecasting capability.

10