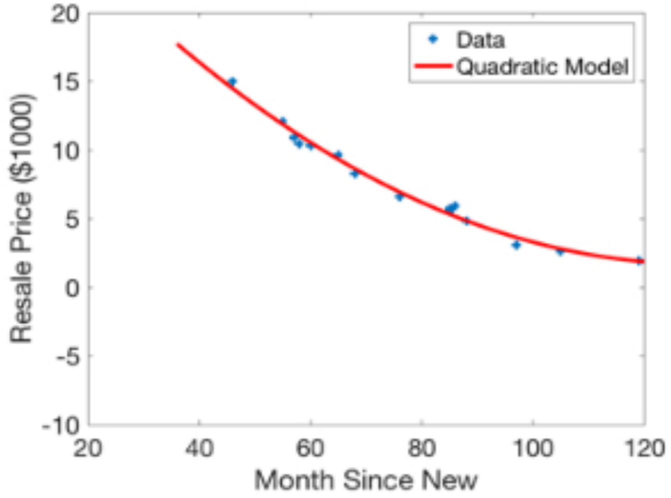
# CS/ECE/ME 532
# Activity 4

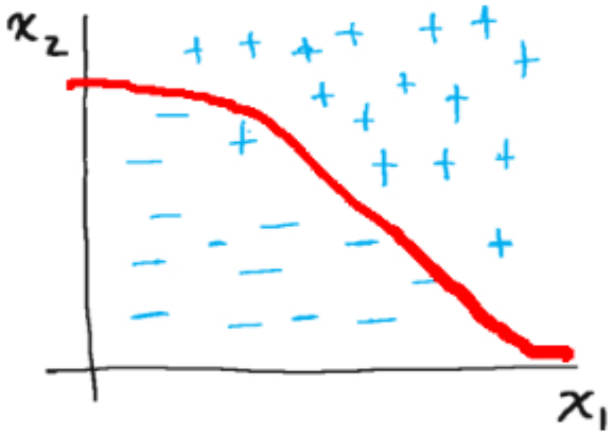
- Unit 1 Quiz Tuesday
  - 25 minutes, at start of class
  - Sit at your table, **video must be on**
  - Open notes
  - No interaction with anyone besides instructors
  - Additional practice problems (end of Week 2 module)

- Unit 2: Linear systems of equations in ML
  - Lessons 2.1, 2.2 for today, 2.3-2.7 for Thursday
  - Prediction and forecasting
  - Classifier design
  - Foundation for what's coming soon: the SVD

- Will be running Python/Jupyter next week
  - Option 1: CoE Jupyterhub Launcher
  - Option 2: Google Colab
  - Option 3: Local installation (recommended!)




$$\begin{bmatrix} 1 & t_1 & t_1^2 \\ 1 & t_2 & t_2^2 \\ & \vdots & \\ 1 & t_n & t_n^2 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ w_3 \end{bmatrix} = \begin{bmatrix} p_1 \\ p_2 \\ \vdots \\ p_n \end{bmatrix}$$




$$\operatorname{sign}(\boldsymbol{x}_1^T \boldsymbol{w}) = -1$$
$$\operatorname{sign}(\boldsymbol{x}_2^T \boldsymbol{w}) = +1$$
$$\vdots$$

$$\boldsymbol{X}\boldsymbol{w} \approx \boldsymbol{y}$$

## Definitions:

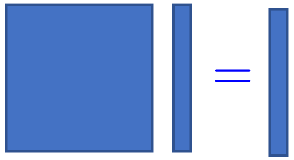
- $\text{span}(\boldsymbol{a}_1, \boldsymbol{a}_2, \ldots \boldsymbol{a}_n)$ = all the vectors we can write as a weighted sum of $\boldsymbol{a}_1, \boldsymbol{a}_2, \ldots \boldsymbol{a}_n$
- $\boldsymbol{a}_1, \ldots, \boldsymbol{a}_n$ are linearly dependent if we can write $\sum_i \alpha_i \boldsymbol{a}_i = \boldsymbol{0}$ for $\alpha_i$ that aren't all zero
- $\text{rank}(\boldsymbol{A})$ = number of linearly independent columns (or rows) in $\boldsymbol{A}$

$$\boldsymbol{A}\boldsymbol{w} = \boldsymbol{d}$$

Three options:

1. Unique solution
2. Infinite number of solutions
3. No solution

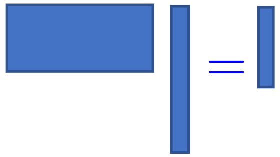
### Option 1: *A unique solution*



- usually doesn't happen with real data
- happens when:

*i)* $d$ is in the span of the columns of $A$ and
*ii)* columns of $A$ are linearly independent

### Option 2: *An infinite number of solutions*

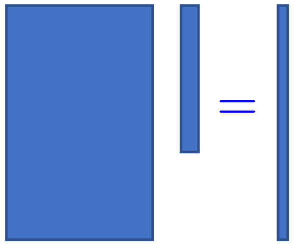


- happens when:

*i)* $d$ is in the span of the columns of $A$ and
*ii)* columns of $A$ are linearly dependent

### Option 3: *No solution*

- Usually what happens with real data
- We can find approximate solution



- happens when:

$d$ is not in the span of the columns of $A$