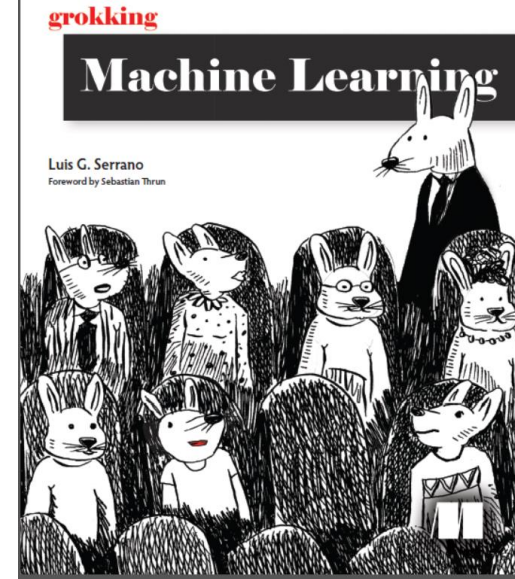


Machine Learning

| Error Functions - Healthcare Application

Prof. Dr. Mostafa Elhosseini

<https://youtube.com/@ProfElhosseiniTechVerse>



| Agenda

- Error functions
 - Absolute Error
 - Square Error
 - Mean absolute – Root Mean Square Errors
- Healthcare Application of Linear Regression
 - Predicting the length of a hospital stay

| Error Functions

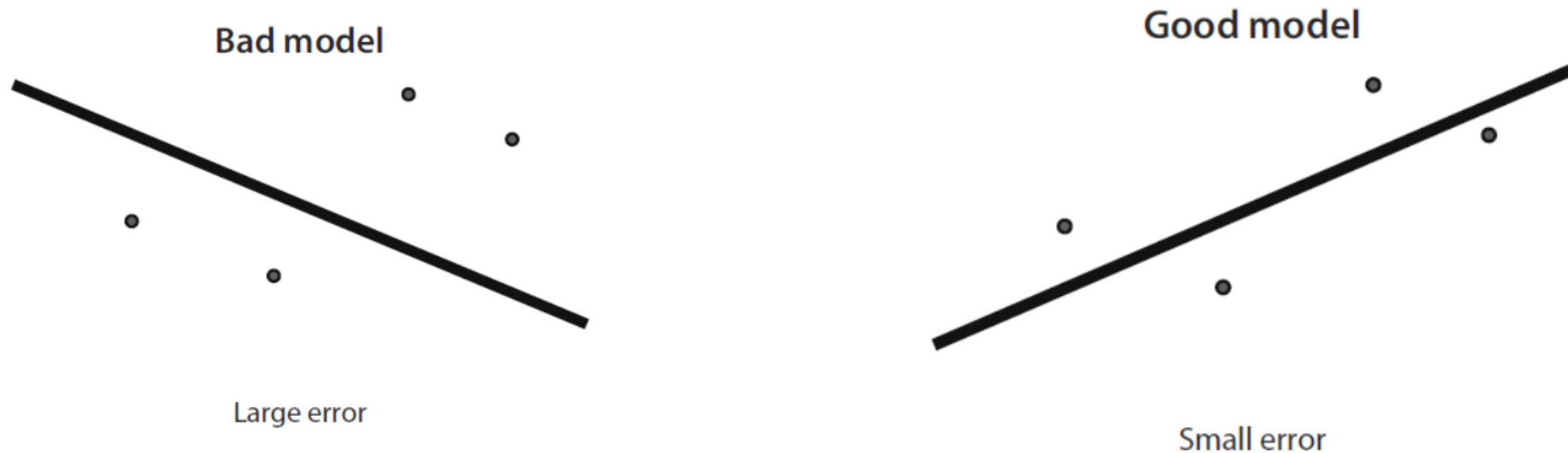
- **Error function**(also known as a **cost function** or **Loss function**) is a mathematical function that **measures the difference** between the predicted values generated by a model and the actual values from the data
- The **goal during training** is to **minimize** this loss function, guiding the model to improve its predictions.

| Error Functions

- Typically **designed to be smooth and differentiable** to facilitate optimization using gradient-based methods.
- **Different loss functions** are used depending on the type of problem (e.g., **Mean Squared Error** for regression, **Cross-Entropy Loss (Log Loss)** for classification).

| Error Function

- An error function is a metric that tells us how our model is doing

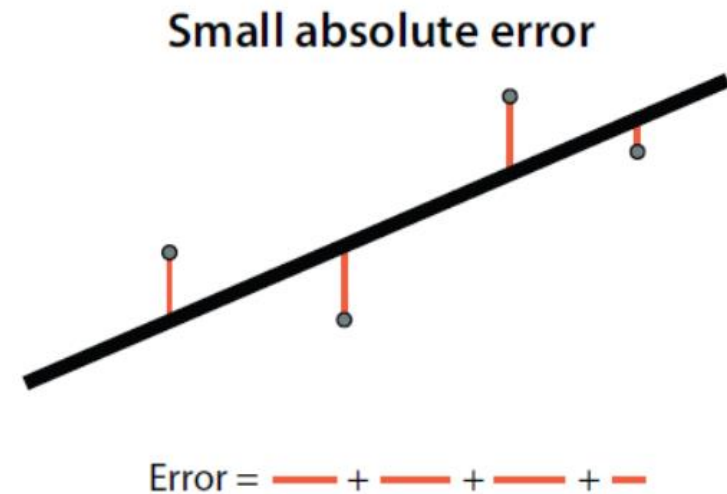
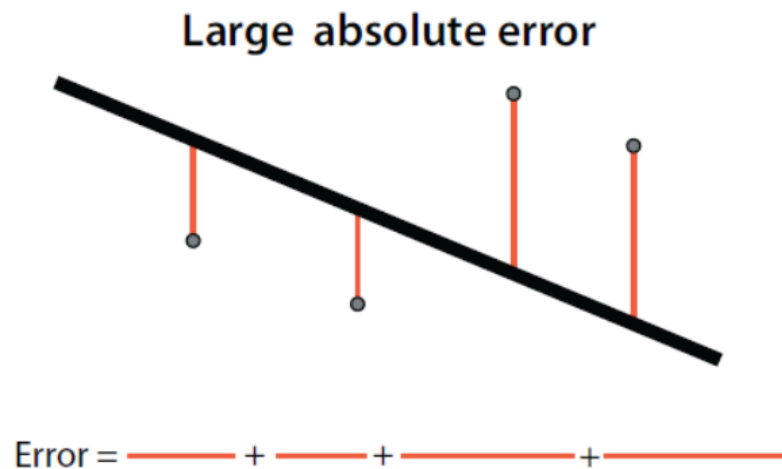


| How do we define a good error function

- Two common ways are the **absolute error** and the **square error**
 - The **absolute error** is the sum of vertical distances from the line to the points in the dataset
 - The **Square error** is the sum of the squares of these distances.

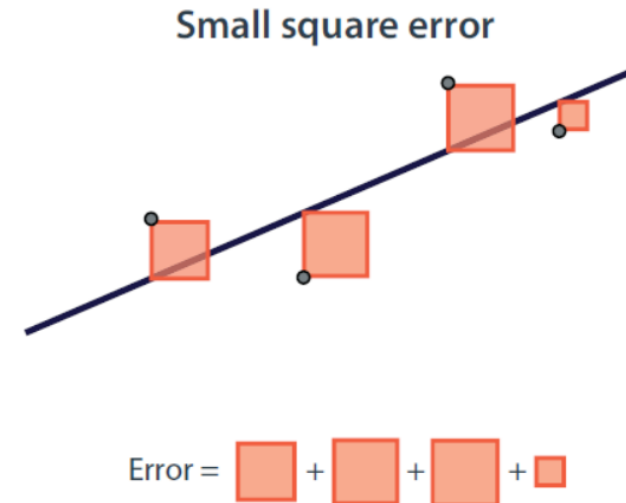
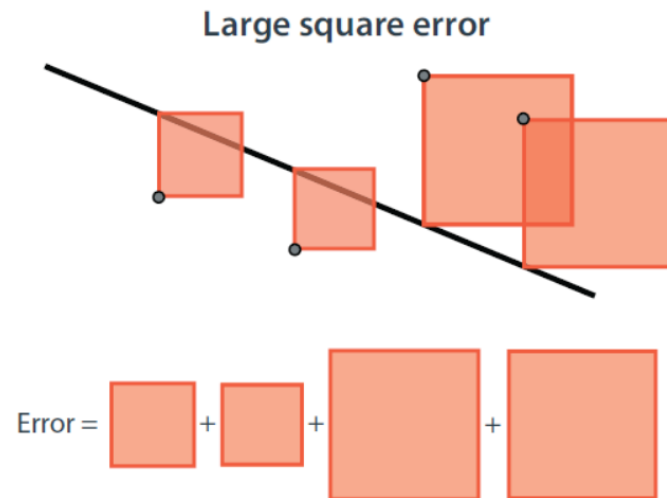
| Absolute Error

- The absolute error is the sum of the distances between the data points and the line
- The **line we pick** is the one that minimizes the absolute error, that is, the one for which the sum of vertical distances from each of the points to the line is minimal.



| Square Error

- Except **instead of taking the absolute value** of the difference between the label and the predicted label, we **take the square**
- the square error is used **more commonly in practice** than the absolute error. Why? A square has a much **nicer derivative** than an absolute value, which comes in handy **during the training process**.



| Mean absolute – Root Mean Square Errors

- The Mean Absolute Error and the Mean Square Error are used much **more commonly**.
- The mean absolute error is the **average** of the vertical distances from the points to the line.
- The **mean** square error is the average of the squares of these same distances.
 - if we'd like to **compare the error** or a model using two datasets with different sizes

| Mean absolute – Root Mean Square Errors

- Another error commonly used is the **root mean square error**, or **RMSE** for short.
- Defined as the root of the mean square error.
- It is used to **match the units** in the problem and also to give us a **better idea** of how much error the model makes in a prediction.
 - Not only do we get the correct unit, but we also get a more accurate idea of roughly by how many dollars the model is off per house

| Health care

- Predicting the life span of a patient, based on their current health conditions
- Predicting the length of a hospital stay, based on current symptoms

| Predicting the length of a hospital stay

- Predicting the length of a hospital stay using linear regression, we will consider features related to the patient's condition and treatment
 - Age
 - Severity of Condition (on a scale of 1 to 10)
 - Number of Previous Hospitalizations
 - Comorbidities (الأمراض المصاحبة) (number of additional diseases or conditions)
 - Type of Admission (encoded as 0 for elective, 1 for emergency)
 - Days Since Last Visit

| Predicting the length of a hospital stay

- We aim to predict the length of hospital stay (in days) for a patient based on these features.

Patient ID	Age	Severity of Condition	Number of Previous Hospitalizations	Comorbidities	Type of Admission	Days Since Last Visit	Length of Hospital Stay (days)
1	70	8	3	2	1	30	10
2	50	5	1	1	0	180	5
3	65	9	4	3	1	60	15
4	40	4	0	0	0	365	2
5	55	6	2	1	1	90	7

| Predicting the length of a hospital stay

- Accurately predicting the length of a patient's hospital stay is crucial for several reasons, both from a **healthcare and business** perspective:

| Healthcare Perspective:

Resource Allocation

- Bed Management
- Staffing
- Equipment and Supplies

| Healthcare Perspective:

Patient Care and Outcomes

- Personalized Care Plans: Enables the development of individualized care plans tailored to the expected duration of the patient's stay.
- Reduced Readmissions (إعادة القبول بالمستشفى)
- Patient Satisfaction

| Healthcare Perspective:

Operational Efficiency

- Scheduling Procedures: Helps in scheduling surgeries and other procedures more effectively by predicting recovery times.
- Minimizing Bottlenecks: Reduces bottlenecks in emergency departments and other critical care units by ensuring smooth patient flow.

| Business Perspective:

Cost Management

- **Financial Planning:** Hospitals can better manage costs associated with prolonged stays and optimize their financial planning and budgeting.
- **Insurance Negotiations:** Accurate predictions help in negotiations with insurance companies regarding coverage and reimbursements.

| Business Perspective:

Revenue Optimization

- Maximizing Utilization: Ensures that hospital resources are used optimally, maximizing revenue from available facilities.
- Reducing Unnecessary Expenses: Helps in identifying and reducing unnecessary tests and procedures, thereby controlling costs.

| Business Perspective:

Regulatory Compliance

- Meeting Standards: Helps in complying with regulatory standards related to patient care, including **metrics** like average length of stay (ALOS).
- Quality Metrics: **Improves hospital ratings and quality metrics**, which are often tied to reimbursements and funding.

| Business Perspective:

Strategic Planning

- Expansion Decisions: Data on patient stays can inform decisions on **expanding facilities or services**.
- Market Positioning: Hospitals can position themselves better in the market by **showcasing their efficiency and quality of care**.

| Next Lecture

- Gradient Descent