

REGRESSION ANALYSIS



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Agenda

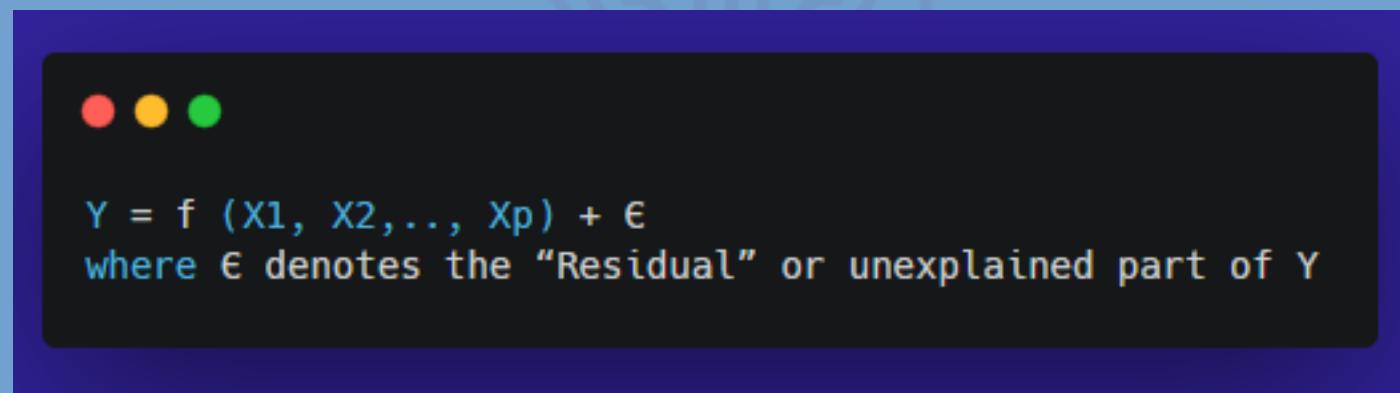
- Introduction to Regression Analysis
 - What is Regression Analysis
 - Why do we need Regression Analysis in Business – Introduction to Modeling
- Introduction to OLS Regression
- Introduction to Modeling Process



What is Regression Analysis?

Regression Analysis captures the relationship between one or more response variables (dependent/predicted variable –denoted by Y) and the its predictor variables (independent/explanatory variables –denoted by X) using historical observations of both.

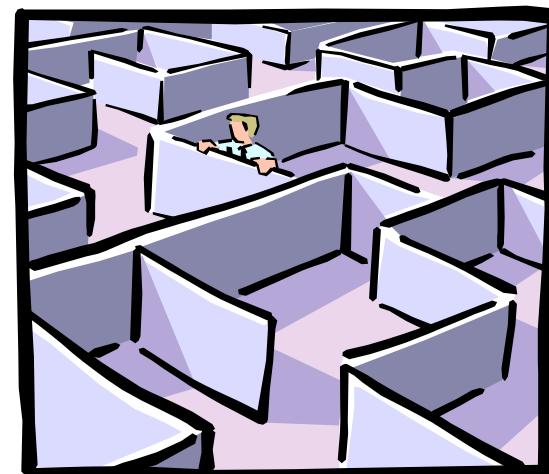
Hence its estimates the functional relationship between a set of independent variables X_1, X_2, \dots, X_p with the response variable Y which estimate of the functional form best fits the historical data.



Historical Data



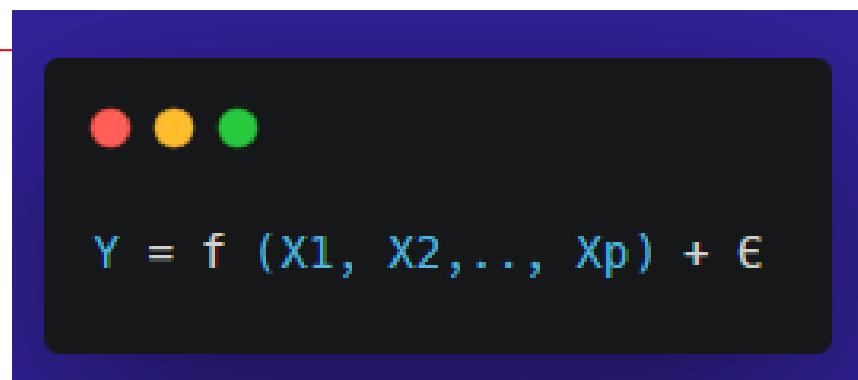
Statistical Analyses



Predict Future Events



Types of Regression Analysis



There are various kinds of Regressions based on the nature of :-

- the functional form of the relationship
- the residual
- the dependent variable
- the independent variables

Functional Form	Residual	Dependent Var	Independent Var
<ul style="list-style-type: none">▪ Linear▪ Non-Linear —Out of scope for this presentation	<ul style="list-style-type: none">▪ Based on the distribution of the residual —normal, binomial, poisson, exponential	<ul style="list-style-type: none">▪ Single<ul style="list-style-type: none">▪ Continuous▪ Discrete▪ Binary▪ Multiple —Out of scope for this presentation	<ul style="list-style-type: none">▪ Numerical▪ Discrete<ul style="list-style-type: none">▪ Continuous▪ Categorical<ul style="list-style-type: none">▪ Ordinal▪ Nominal



Types of Linear Regression

Dependent Variable Type	Residual Distribution	Types of Regression
Continuous	Normal (with constant variance)	Ordinary Least Squares (OLS)
Continuous	Normal (without constant variance)	Generalized Least Square
Binary	Binomial	Logistic Regression
Discrete	Poisson	Poisson Regression
Rational	Exponential Family of Distributions	Generalized Least Squares

DATA SCIENCE



Other Types of Regression Related Techniques

- **Simultaneous Equation Models**
 - When both X & Y are dependent on each other
- **Structural Equation Modeling / Pathways**
 - Captures the inter-relations between Xs i.e. captures how Xs affect each other before affecting Y
- **Survival Analysis**
 - Predicts a decay curve for a probability of an event
- **Hierarchal Bayesian**
 - Estimates a non-linear equation



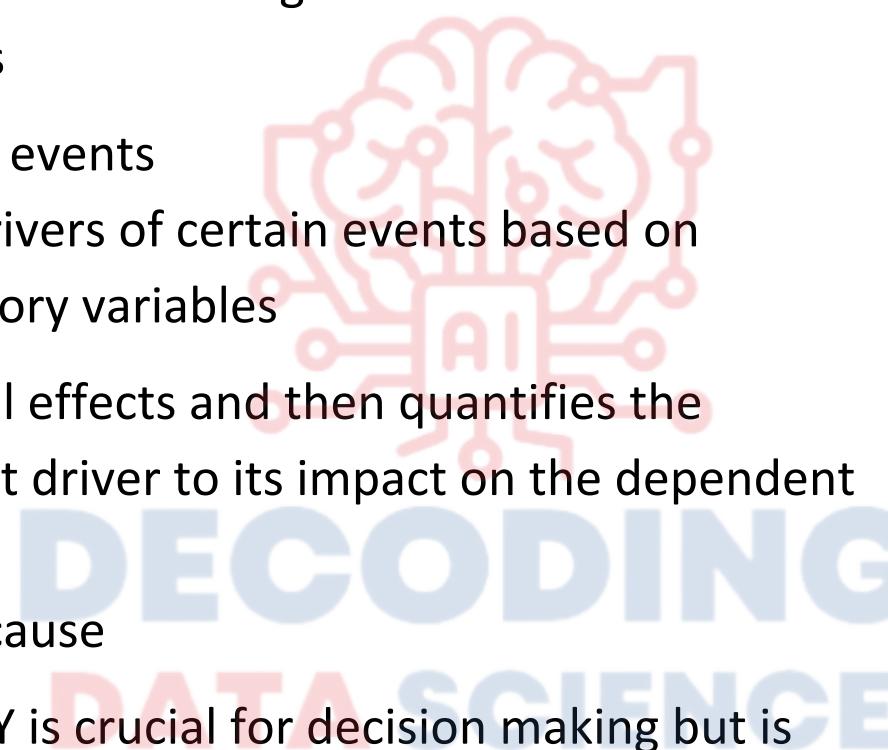
Agenda

- **Introduction to Regression Analysis**
 - What is Regression Analysis
 - Why do we need Regression Analysis in Business –
 - Introduction to Modeling
- **Introduction to OLS Regression**
- **Introduction to Modeling Process**



What is Modeling?

- Is based on Regression Analysis
- It can be used for the following two distinct but related purposes
 1. Predict certain events
 2. Identify the drivers of certain events based on some explanatory variables
- Isolates individual effects and then quantifies the magnitude of that driver to its impact on the dependent variable
- It is required because
 1. Knowledge of Y is crucial for decision making but is not deterministic
 2. X is available at the time of decision making and is related to Y



Volume = Base Sales + b2 (GRPs) + b3 (Dist) ... + bn (Price)



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Example of Modeling in Business

- Predict the sales that a customer would contribute, given a certain set of attributes like demographic information, credit history, prior purchase behavior, etc.
- Predict the probability of response from a direct mail thus saving cost and acquire potential customers.
- Identify high responsive and high profit segments and targeting only these segments for direct mail campaigns
- Identify the most effective marketing levers & quantify their impact
- To find out what differentiates between buyers and non buyers based on their past 3 months usage of the product and the age group



Agenda

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- **Introduction to OLS Regression**
- **Introduction to Modeling Process**



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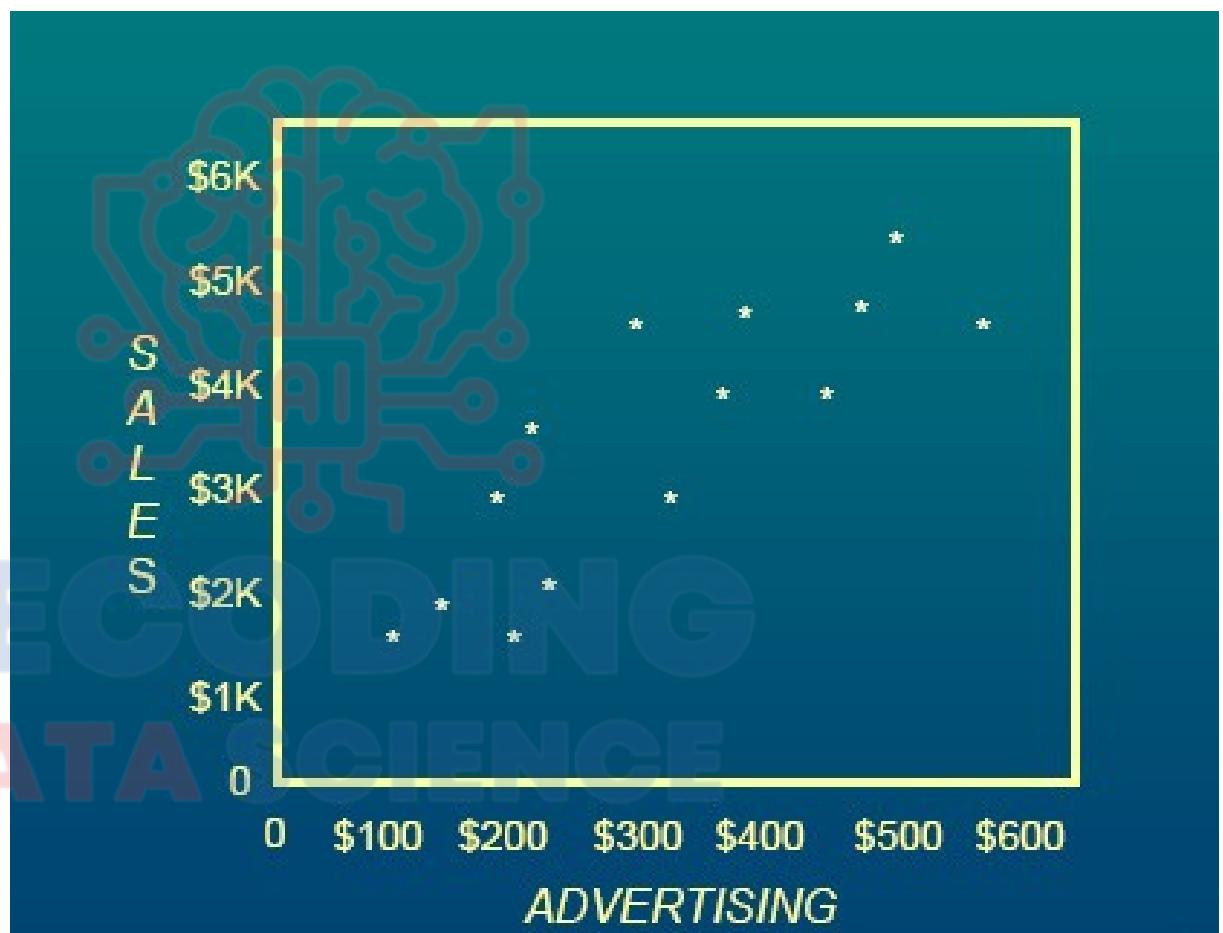
Introduction to Ordinary Least Squares

Dependent Variable Type	Residual Distribution	Types of Regression
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Introduction to Ordinary Least Squares – Simple Regression

Advertising	Sales
\$120	\$1,503
\$160	\$1,755
\$205	\$2,971
\$210	\$1,682
\$225	\$3,497
\$230	\$1,998
\$290	\$4,528
\$315	\$2,937
\$375	\$3,622
\$390	\$4,402
\$440	\$3,844
\$475	\$4,470
\$490	\$5,492
\$550	\$4,398



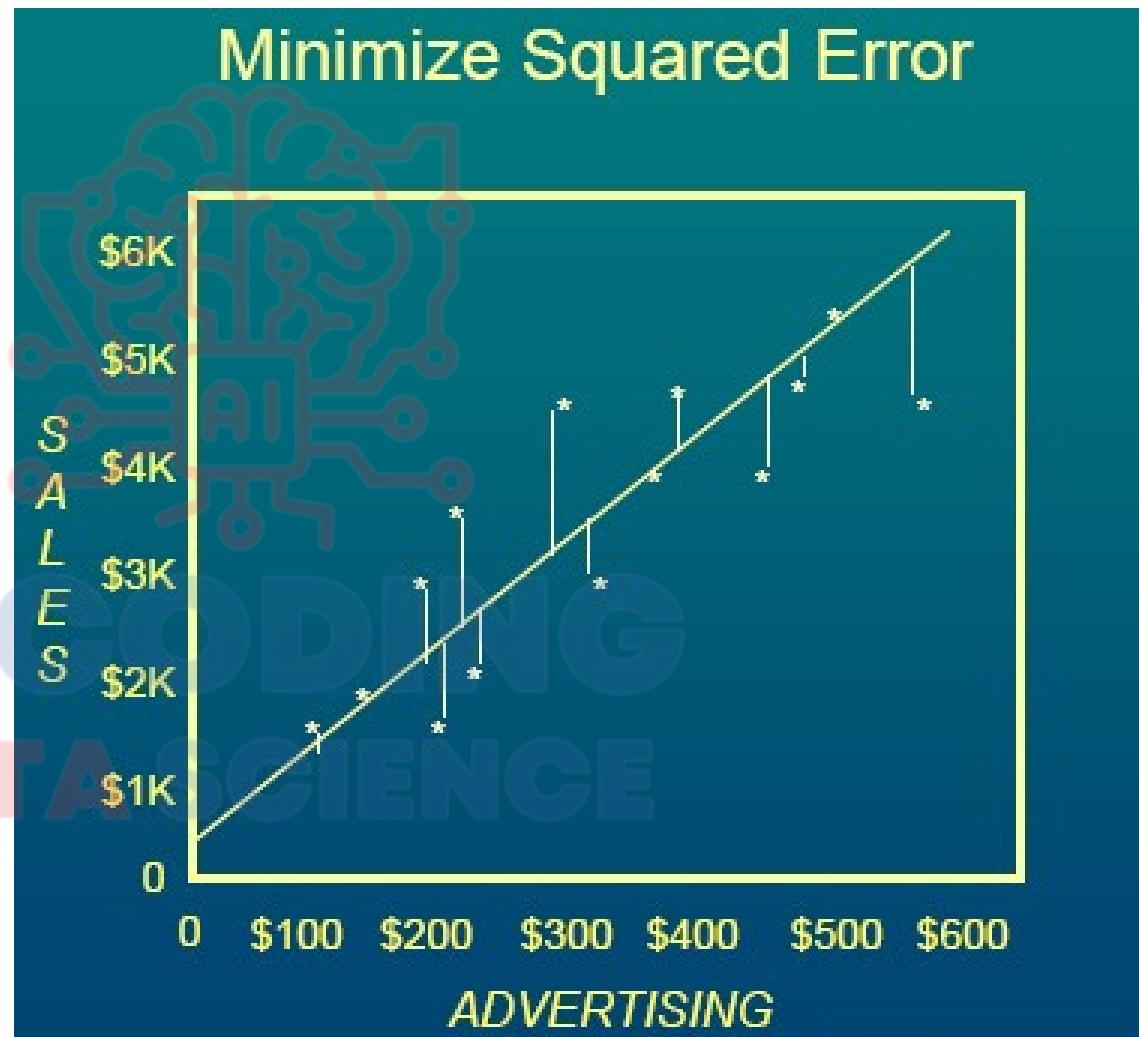
Goal: characterize relationship between advertising and sales



Introduction to Ordinary Least Squares – Simple Regression

Result: equation that predicts sales dollars based on advertising dollars spent

$$\text{Sales} = B_0 + B_1 * \text{Adv.}$$

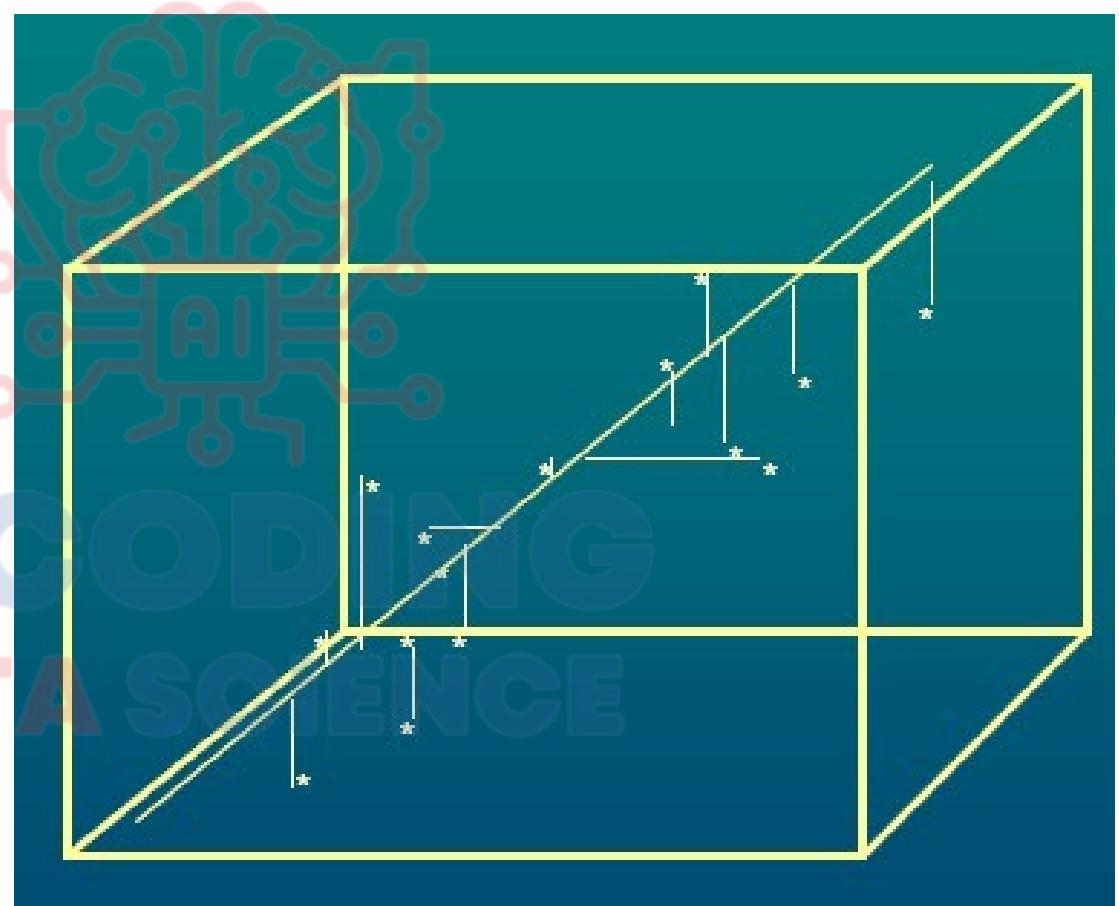


*Minimizes Error sum of squares ,Hence the name
“Ordinary Least Square Regression”*



Introduction to Ordinary Least Squares – Multiple Regression

- Credit card balances
 - payment amount
 - years
 - gender (0/1)
- Minimizes squared error in N-dimensional space



$$\text{Balances} = 2.1774 + .0966 * \text{Payment} + 1.2494 * \text{Months} + .4412 * \text{Gender}$$



OLS Model Assumptions

1. Linearity

Model is linear in parameters

$$Y_i = a + b_1 X_{1i} + b_2 X_{2i} + \dots + b_p X_{pi} + e_i$$

2. Spherical Errors

Error distribution is Normal with mean 0 & constant variance

$$e_{2i} \sim \text{Normal}(0, \sigma)$$

3. Zero Expected Error

The expected value (or mean) of the errors is always zero

$$E(e_i) = 0 \text{ for all } i$$

4. Homoskedasticity

The errors have constant variance

$$\text{Variance}(e_i) = \text{constant for all } i$$

5. Non-Autocorrelation

The errors are statistically independent from one another. This implies the data is a random sample of the population

$$\text{corr}(e_i, e_j) = 0 \text{ for all } i \neq j$$

6. Non-Multicollinearity

The independent variables are not collinear

$$\text{Covariance } (X_i, X_j) = 0$$



Steps in OLS Regression

Assume all OLS assumptions hold

Run regression in software (R/Python)

Check if assumptions really hold

Check if Fit is good

Check Hypothesis testing results
i.e. variable significance

Iterate to make “BEST” model



Applications of OLS

Regression in Business



Sales
Prediction
Models

Marketing
Effectiveness
Models

Ad.
Effectiveness
Models

Profitability
Models

Capital
Expenditure
Model

Claims
Forecasting
Models

Chare-off
Prediction
Models

Macro
Economic
Models

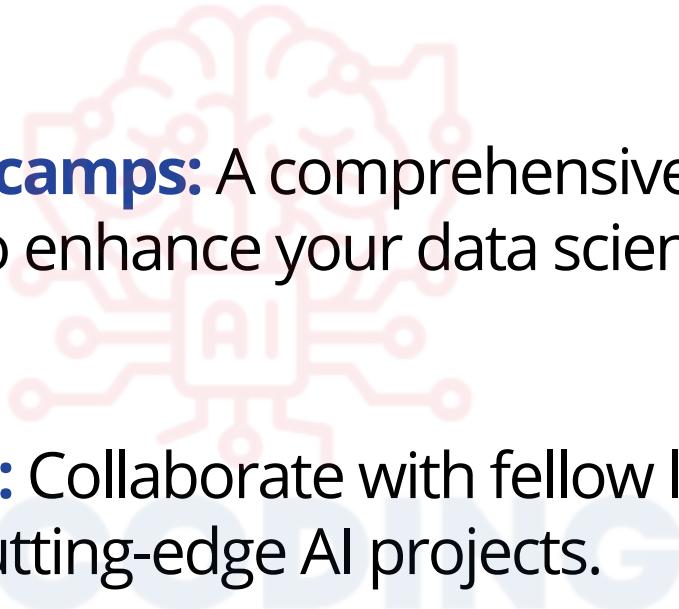
Just a few of
them



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Next Steps

1. **Advanced Visualization Workshops:** Dive deeper into the intricacies of data visualization with hands-on workshops.



2. **Data Science Bootcamps:** A comprehensive, project-based learning experience to enhance your data science skills.

3. **AI Innovation Hub:** Collaborate with fellow learners and industry experts on cutting-edge AI projects.

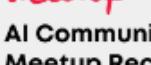
4. **Community Webinars:** Regular webinars on the latest trends, tools, and best practices in AI and Data Science.

5. **Peer-to-Peer Learning:** Engage in discussion forums, group projects, and mentorship programs.



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Take Action Now

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<p>Meetup RECORDINGS</p> <p>AI Community Meetup Recordings</p>  <p>Decoding DataScience</p> <p>Meetup Sessions Meetup Sessions recordings for all speakers</p>	<p>@decodingdatasience</p> <p>Ready to use Resume Template</p>  <p>By Mohammad Arshad</p> <p>Ready to Use Resume Te... Introducing our Ready to Use Resume Template - the perfect to...</p>	<p>@decodingdatasience</p> <p>LinkedIn Profile Optimization 20 Checklist</p>  <p>By Mohammad Arshad</p> <p>LinkedIn Profile Optimizati... Introducing our LinkedIn Profile Optimization 20 Checklist - the...</p>	<p>Sep 16 Sat</p> <p>19th AI Community Meetup</p> <p>Saturday, 16 September 4:00PM – 5:00PM ⏰ Online</p> <p>With Mohammad Arshad</p> <p></p> <p>I'm Going</p>
			<p>Sep 17 Sun</p> <p>Data Science/AI Career Talk</p> <p>Sunday, 17 September 12:00PM – 1:00PM ⏰ Online</p> <p>With Mohammad Arshad</p> <p></p> <p>I'm Going</p>



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