



Leveraging AI for Enhanced Cost Estimation

GALORATH

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Introduction

We will discuss practical applications of AI and how AI can assist with challenges faced by Estimators with lack of information or experience.



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AI as an Assistant to the Estimator

Increased Complexity is challenging estimators in providing decision makers data for decisions



Challenges /Limitations with AI

AI is NOT THE ANSWER, but a tool to educate and a source of data to increase knowledge



Implementing Practical AI

Assess current estimation processes and identify improvement opportunities.



How AI can be of Value

By increasing accuracy, efficiency, and confidence of estimators who lack data

It looks like you're trying to perform a cost estimate.

Would you like help?



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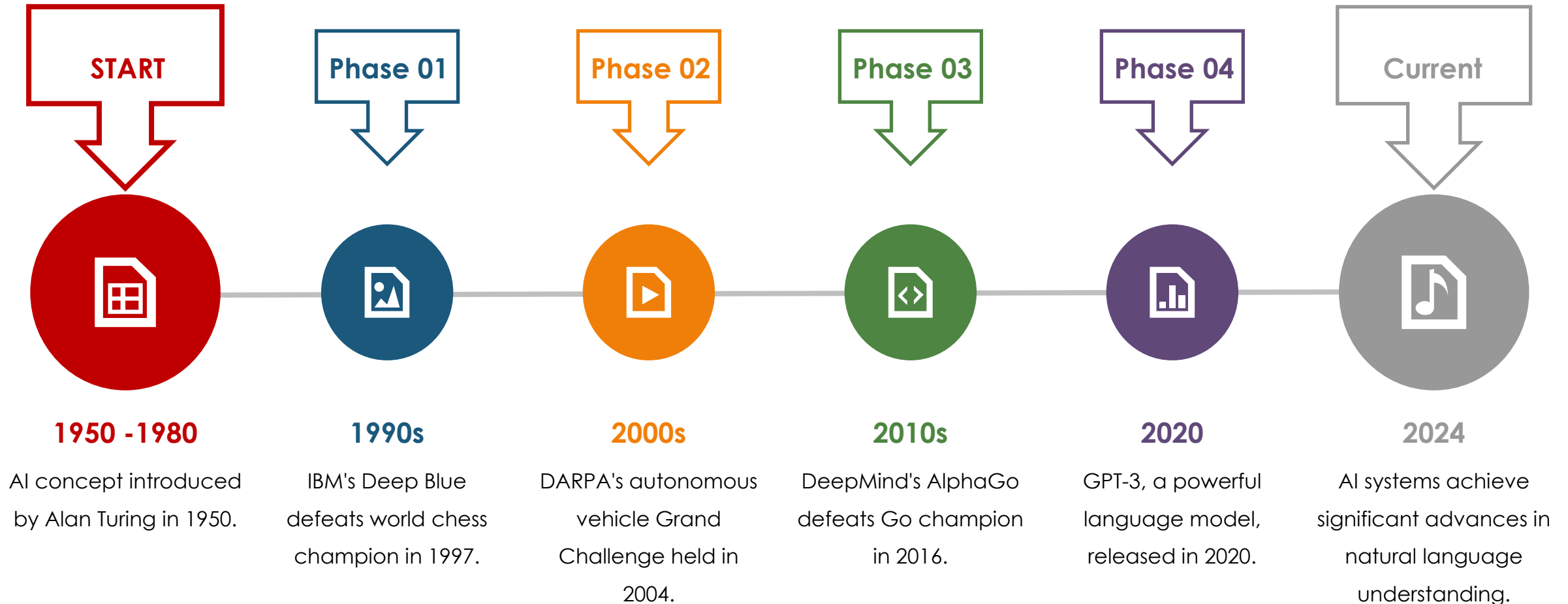


How AI can be of Value

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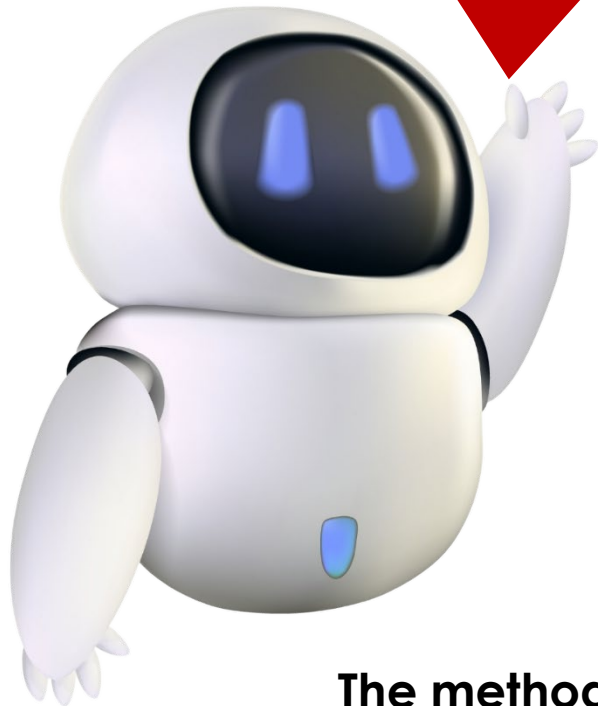
Evolution and Benefits of AI in Cost Estimation



Exponential growth in capabilities is leading to transformation across all lines of business.

How AI Models feel more familiar

$$P(A | B) = \frac{P(B | A)P(A)}{P(B)}$$



- **Bayesian Inference**

- **Broad Applicability**

- Uses ranges from heuristic to artificial networks

- **Statistical process**

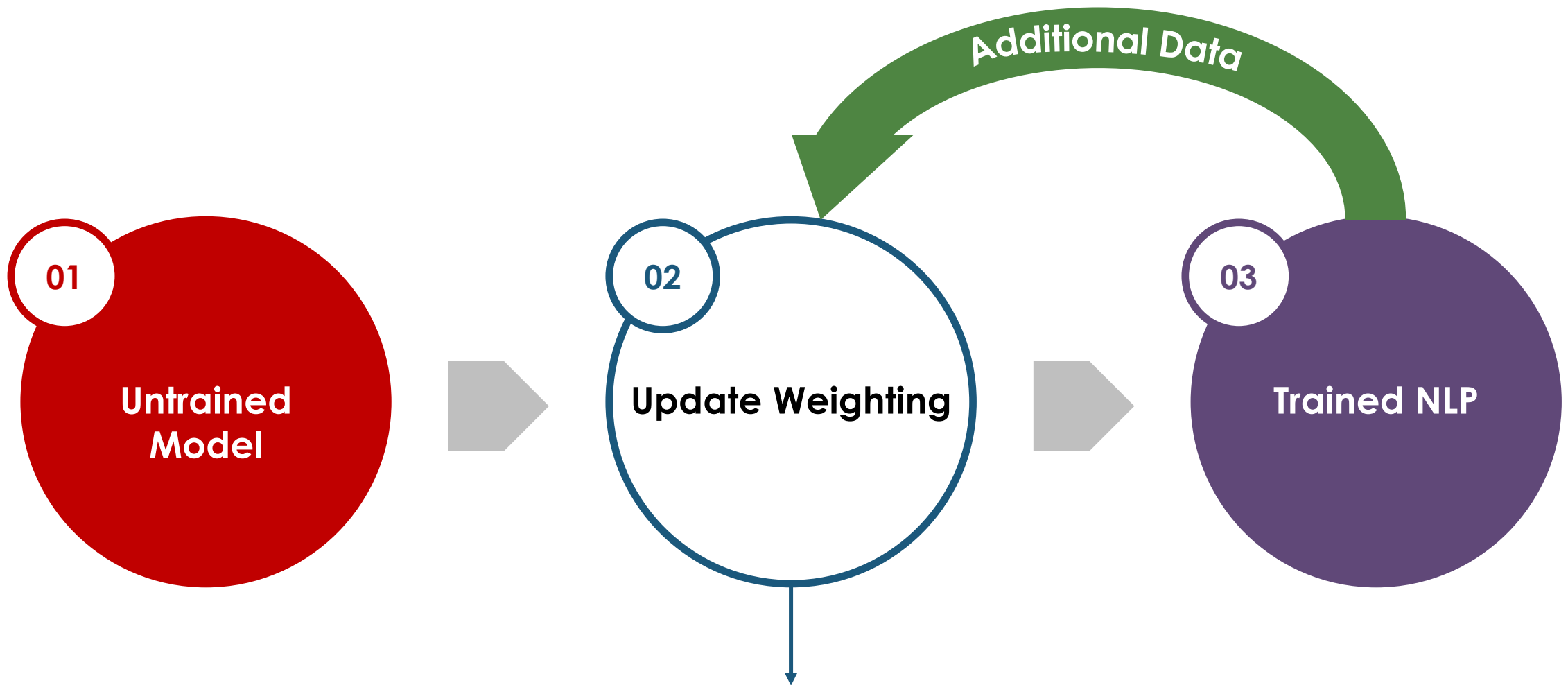
- Describes how prior knowledge can be used to predict future probabilities

- **Bayes Theorem**

- Where predictive probability distribution of the hypothesis, given a set of data, is the product of the prior probability distribution and a likelihood function.

The methods behind AI models are based on commonly used practices

Neural and Bayesian Networks

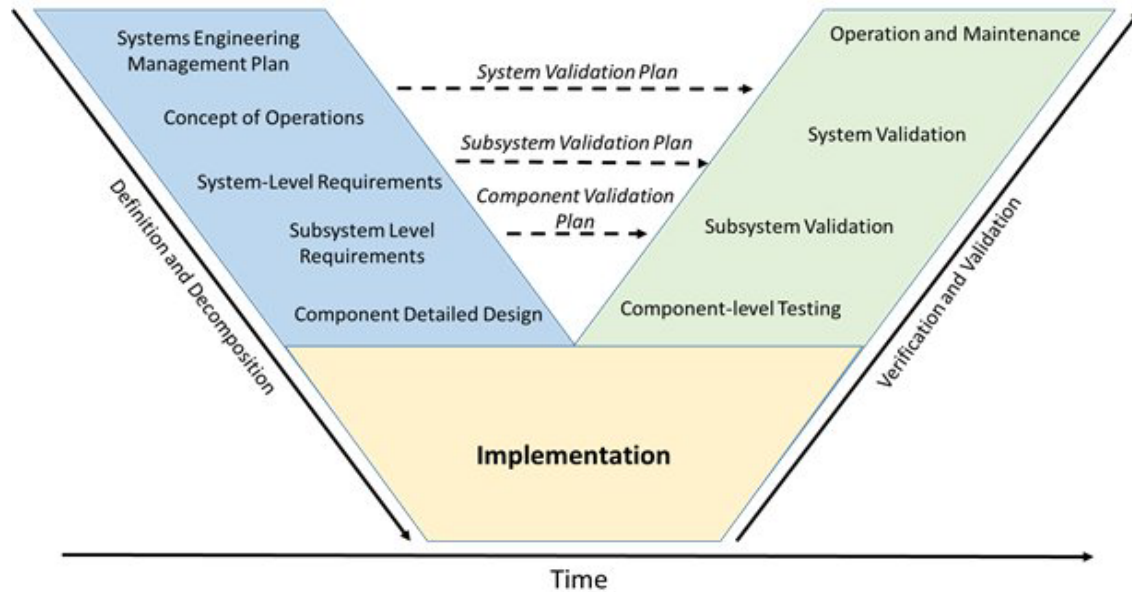


Describes learning, or the updating of a hypothesis given additional data

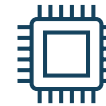
Methodology



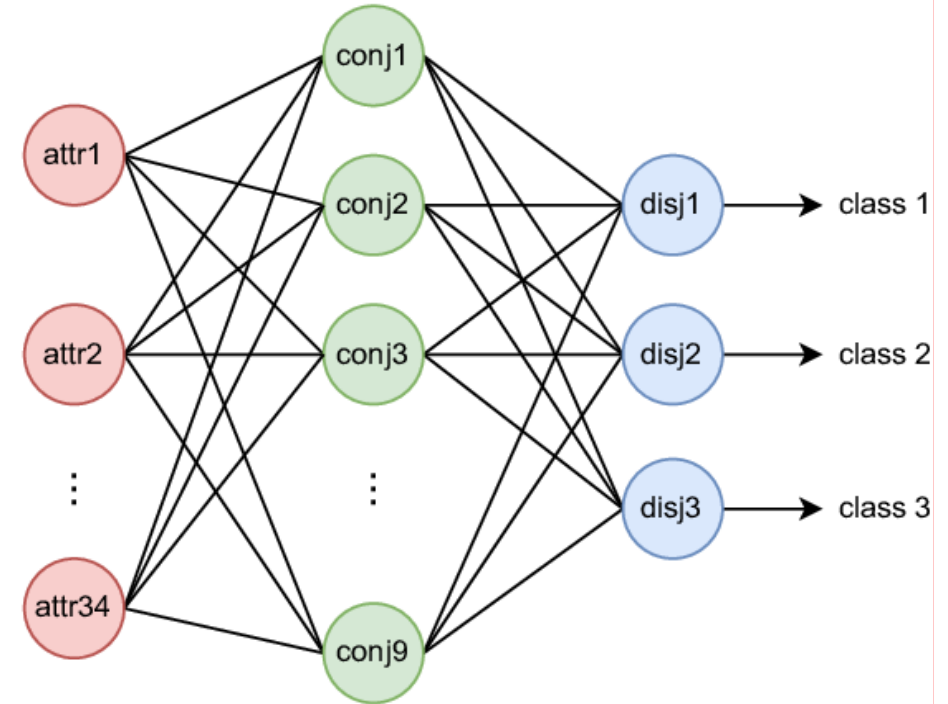
Operational Requirements
Constrained Parameter Space
Algorithmic, Rules-Based
Optimize for Solution



Systems Engineering

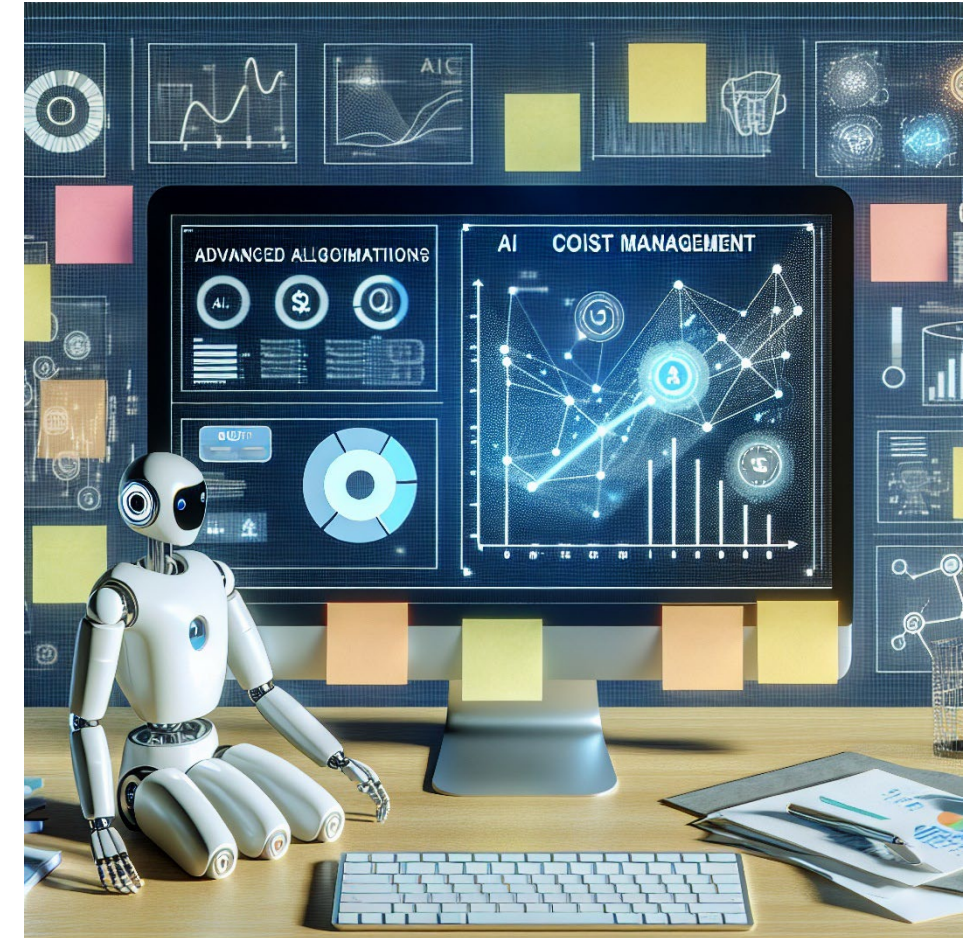
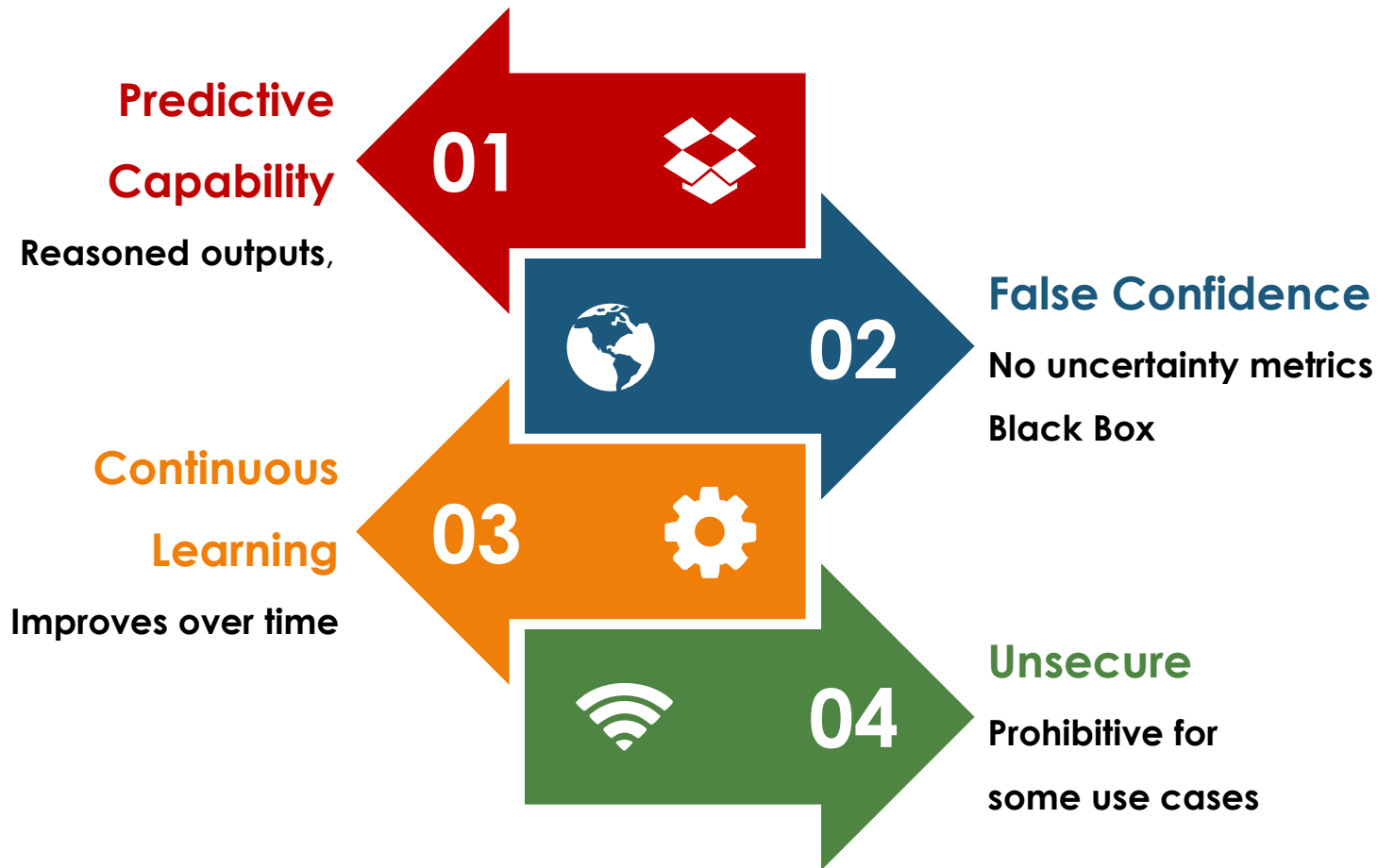


Operational Requirements
Unconstrained Parameter Space
Probabilistic, Concept-Based
Marginalize for Distribution



Conceptual Model

Strengths and Weaknesses



Challenges with AI for Cost Estimators



1. Data Quality and Availability
2. Model Complexity
3. Bias and ethics in AI Algorithms
4. Integration with Existing Systems
5. User Trust and Adoption
6. Continuous Learning and Updating
7. Compliance Issues

Understanding the challenges with AI will help us create best practices

Practical Steps to Implement AI

- **Start with Clear Objectives and Pilot Projects:**

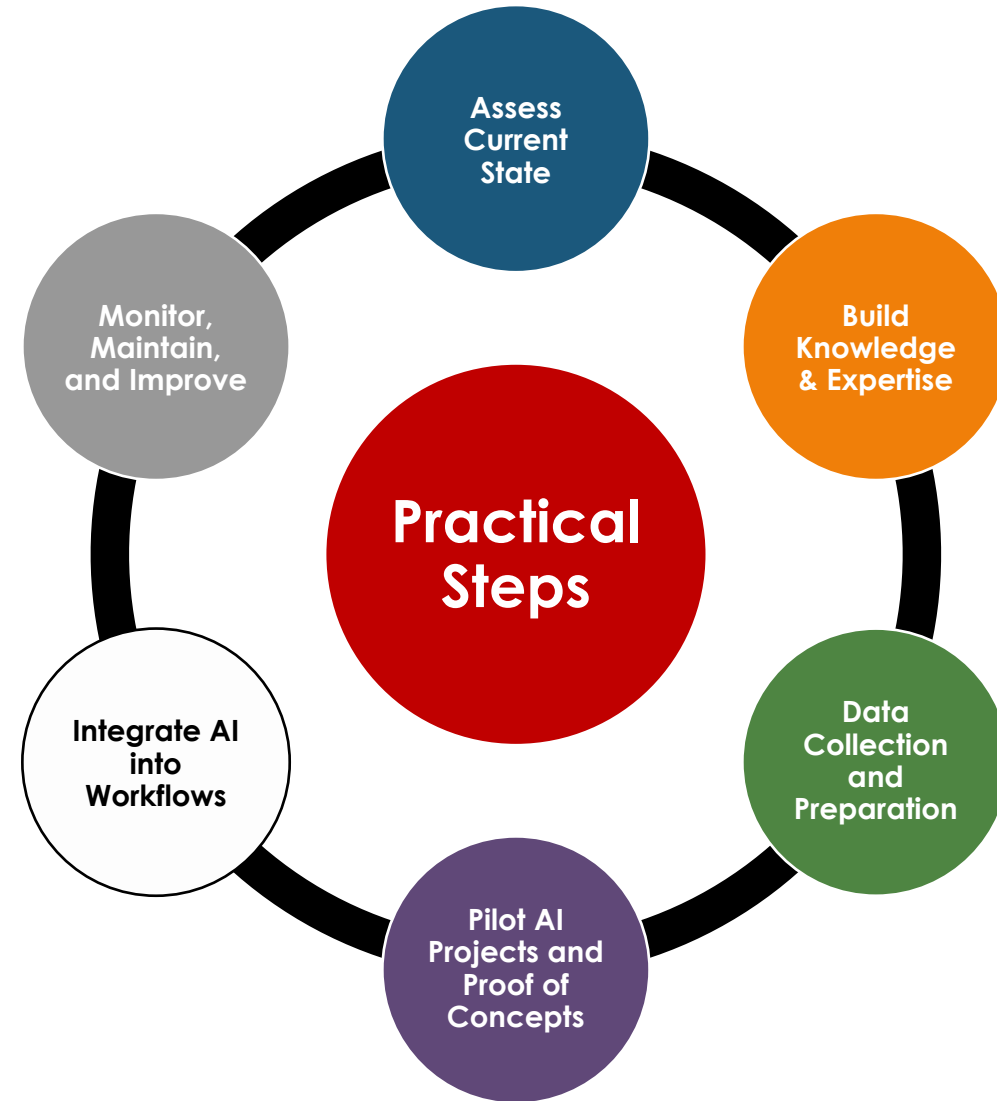
- Define specific goals for AI integration (e.g., improve accuracy, automate data analysis).
- Begin with pilot projects to test AI models and gather insights before scaling up.

- **Ensure High-Quality Data and Continuous Monitoring:**

- Collect and cleanse comprehensive historical data to train accurate AI models.
- Continuously monitor AI performance and update models to maintain reliability and relevance.

- **Invest in Education and Integration:**

- Educate and train staff on AI technologies and their applications in cost estimation.
- Seamlessly integrate AI tools into existing workflows to enhance efficiency without causing disruption.

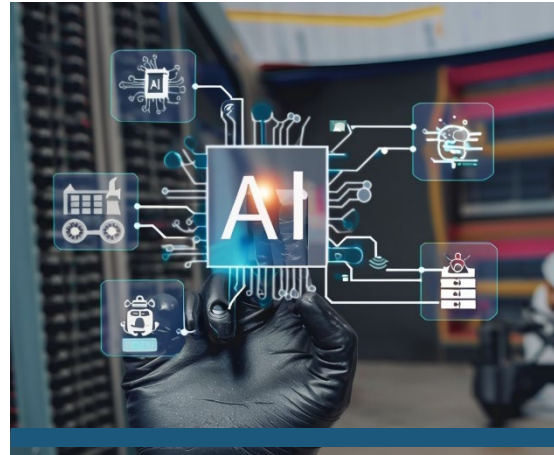


How AI can be of Value



01. Writing Scripts

Benefits: Drive Efficiency: Reduces manual effort and saves time. Improve Accuracy: Minimizes human errors in script creation.



02. Building WBS

Benefits: Comprehensive Coverage: Ensures all aspects of the project are covered. Consistency: Maintains consistency across WBS elements.



03. Spec Translation

Benefits: Precision: Enhances the precision of hardware-related cost assessments. Speed: Accelerates the estimation process

AI in Action - Examples



- Examples of assistive data and information generated using AI.
 - Scripts
 - WBS
 - Specification Collection and Translation
- Audience Prompts

Script Example

Backup

VBA Script Example Question

“Provide Excel VBA code that will run a Monte Carlo risk simulation based on the following assumptions in the “Risk Assumptions” Tab: 1) Normal Distribution; 2) Low Point is in Cell B2; 3) Mean is in Cell C2; High Point is in Cell D2; and the number of iterations is in Cell E2. The simulation will create a new “Risk Runs” worksheet and save the values iteratively beginning in Cell B2.”

[Link to Example](#)

VBA Script Example: AI response

```
Sub MonteCarloSimulation()  
    Dim i As Long  
    Dim numIterations As Long  
    Dim lowPoint As Double  
    Dim mean As Double  
    Dim highPoint As Double  
    Dim stdDev As Double  
    Dim randomValue As Double  
    Dim riskRunsSheet As Worksheet  
    Dim riskAssumptionsSheet As Worksheet  
  
    ' Set the risk assumptions sheet  
    Set riskAssumptionsSheet = ThisWorkbook.Sheets("Risk Assumptions")  
  
    ' Read the inputs from the "Risk Assumptions" sheet  
    lowPoint = riskAssumptionsSheet.Range("B2").Value  
    mean = riskAssumptionsSheet.Range("C2").Value  
    highPoint = riskAssumptionsSheet.Range("D2").Value  
    numIterations = riskAssumptionsSheet.Range("E2").Value  
  
    ' Calculate the standard deviation assuming a symmetric distribution  
    stdDev = (highPoint - lowPoint) / 6
```

```
    ' Create a new "Risk Runs" worksheet  
    On Error Resume Next ' Ignore error if sheet already exists  
    Set riskRunsSheet = ThisWorkbook.Sheets("Risk Runs")  
    If riskRunsSheet Is Nothing Then  
        Set riskRunsSheet =  
        ThisWorkbook.Sheets.Add(After:=ThisWorkbook.Sheets(ThisWorkbook.Sheets.Count))  
        riskRunsSheet.Name = "Risk Runs"  
    Else  
        riskRunsSheet.Cells.Clear ' Clear existing data if sheet already exists  
    End If  
    On Error GoTo 0 ' Reset error handling  
  
    ' Add headers to the "Risk Runs" sheet  
    riskRunsSheet.Range("B1").Value = "Iteration"  
    riskRunsSheet.Range("C1").Value = "Value"  
  
    ' Seed the random number generator  
    Randomize  
  
    ' Run the Monte Carlo simulation
```

```
        riskRunsSheet.Cells(i + 1, 2).Value = i  
        riskRunsSheet.Cells(i + 1, 3).Value = randomValue  
    Next i  
  
    ' Autofit columns for better visibility  
    riskRunsSheet.Columns("B:C").Autofit  
  
    ' Notify the user that the simulation is complete  
    MsgBox "Monte Carlo risk simulation complete.", vbInformation  
End Sub
```

Non-VBA Script Example: Question

“Provide a non-VBA method in Excel that will run a Monte Carlo risk simulation based on the following assumptions in the “Risk Assumptions” Tab: 1) Normal Distribution; 2) Low Point is in Cell B2; 3) Mean is in Cell C2; High Point is in Cell D2; and the number of iterations is in Cell E2. The simulation will create a new “Risk Runs” worksheet and save the values iteratively beginning in Cell B2.”

Non-VBA Script Example: Response

6. Generate Random Values Using Normal Distribution:

- In cell **B2** of the "Risk Runs" worksheet, enter the following formula to generate a random value based on the normal distribution:

```
=NORMINV(RAND(), 'Risk Assumptions'!C2, 'Risk Assumptions'!F2)
```

- Drag this formula down to the number of iterations specified in cell **E2** of the "Risk Assumptions" worksheet.

- “Drag this formula down to the number of iterations specified in cell E2 of the “Risk Assumptions” worksheet.”
- An example of an AI “hallucination” instance when AI generates incorrect response

WBS Example

Backup

WBS Example Prompt

“I am looking to use the SEER suite of models for estimating the development of a military attack helicopter. Please act as an experienced SEER user and provide all results in SEER-compatible format. Specifically, I need the following:

1. Work Breakdown Structure (WBS): Provide a detailed WBS for a military attack helicopter. Use Mil Std 881 where possible
2. Mass Range for Each WBS Element: Estimate the mass range (least, likely, and most) for each WBS element, assuming the use of lightweight composites where appropriate and a speed exceeding 120 miles per hour.
3. SEER KBASES: Identify the appropriate SEER KBASES to be used for each WBS element.
4. Software Size Range: Estimate the software size range (least, likely, and most) for the avionics software, which should be in C++ and include up to 70% software reuse. Tie this estimate into the WBS.
5. Major Risks: Identify the major risks in the estimate.
6. Additional Questions: Provide five additional questions I should ask the Program Manager to better understand the project requirements.”

WBS Prompt Example: AI response

1. Airframe

- 1.1 Structure
 - 1.1.1 Fuselage
 - 1.1.2 Wings/Rotors
 - 1.1.3 Empennage
 - 1.1.4 Landing Gear
- 1.2 Propulsion
 - 1.2.1 Engines
 - 1.2.2 Fuel System
- 1.3 Electrical Systems
 - 1.3.1 Power Distribution
 - 1.3.2 Wiring and Connectors
- 1.4 Avionics
 - 1.4.1 Flight Control Systems
 - 1.4.2 Navigation Systems
 - 1.4.3 Communication Systems

2. Mission Equipment

- 2.1 Weapons Systems
 - 2.1.1 Guns and Ammunition
 - 2.1.2 Missiles
- 2.2 Sensors

- 2.2.1 Radar
- 2.2.2 Electro-Optical/Infrared (EO/IR) Systems

3. Software Development

- 3.1 Avionics Software
 - 3.1.1 Flight Control Software (C++)
 - 3.1.2 Navigation Software (C++)
 - 3.1.3 Communication Software (C++)
 - 3.1.4 Weapons Integration Software (C++)

4. Integration and Test

- 4.1 System Integration
- 4.2 Ground Testing
- 4.3 Flight Testing

5. Support and Training

- 5.1 Maintenance Support
- 5.2 Training Systems
 - 5.2.1 Simulators
 - 5.2.2 Training Manuals

Mass Ranges

WBS Element	Least (lbs)	Likely (lbs)	Most (lbs)
1.1 Structure	2,000	2,500	3,000
1.1.1 Fuselage	1,000	1,200	1,400
1.1.2 Wings/Rotors	600	800	1,000
1.1.3 Empennage	200	300	400
1.1.4 Landing Gear	200	200	200
1.2 Propulsion	1,500	2,000	2,500
1.2.1 Engines	1,200	1,500	1,800
1.2.2 Fuel System	300	500	700
1.3 Electrical Systems	200	300	400
1.3.1 Power Distribution	100	150	200
1.3.2 Wiring and Connectors	100	150	200
1.4 Avionics	400	600	800
1.4.1 Flight Control Systems	100	200	300
1.4.2 Navigation Systems	100	200	300
1.4.3 Communication Systems	200	200	200
2.1 Weapons Systems	800	1,000	1,200
2.1.1 Guns and Ammunition	300	400	500
2.1.2 Missiles	500	600	700
2.2 Sensors	300	400	500
2.2.1 Radar	150	200	250
2.2.2 EO/IR Systems	150	200	250
3.1 Avionics Software	N/A	N/A	N/A
4.1 System Integration	100	150	200
4.2 Ground Testing	100	150	200
4.3 Flight Testing	150	200	250
5.1 Maintenance Support	100	150	200
5.2 Training Systems	200	300	400
5.2.1 Simulators	150	200	250
5.2.2 Training Manuals	50	100	150

Risks

- Technical Complexity:
 - Risk: High complexity in integrating advanced avionics and weapon systems.
 - Mitigation: Conduct thorough system integration testing and employ expert system engineers.
- Schedule Delays:
 - Risk: Potential delays due to unforeseen technical challenges or supply chain issues.
 - Mitigation: Implement robust project management practices and maintain flexibility in the schedule.
- Cost Overruns:
 - Risk: Budget overruns due to underestimation of development and testing costs.
 - Mitigation: Use detailed cost estimation tools (SEER-H and SEER-SEM) and include contingency reserves.
- Software Integration:
 - Risk: Challenges in integrating reused software components with new development.
 - Mitigation: Conduct compatibility testing and ensure thorough documentation of reused components.
- Regulatory Compliance:
 - Risk: Difficulty in meeting all military and aviation regulatory requirements.
 - Mitigation: Engage with regulatory bodies early and conduct regular compliance audits.

Questions for the PM

- Scope and Requirements:
 - What are the specific mission profiles and operational requirements for the attack helicopter?
- Budget and Funding:
 - What is the allocated budget for this project, and are there any funding constraints?
- Schedule and Milestones:
 - What are the key milestones and deadlines for the project, and how flexible are these dates?
- Technology and Innovation:
 - Are there any specific technologies or innovations that must be incorporated into the helicopter design?
- Stakeholder Expectations:
 - Who are the key stakeholders, and what are their primary concerns or expectations regarding the project?

Translation Example

Backup

Spec Translation Example Prompt

“Identify by Bell 429 model and extract performance data from publicly available specifications data for the Bell 429 helicopters and place it in a table that provides data by several lift off weights for hovering altitude, cruise speed, and endurance.”

Bell 429 Helicopter Performance Data

Lift-Off Weight (lbs)	Hovering Altitude (IGE)	Hovering Altitude (OGE)	Cruise Speed (knots)	Endurance (hours)
7,000	11,000 ft	8,000 ft	150 knots	4.5 hours
6,800	11,500 ft	8,500 ft	150 knots	4.7 hours
6,500	12,000 ft	9,000 ft	152 knots	5.0 hours
6,000	12,500 ft	9,500 ft	155 knots	5.2 hours
5,500	13,000 ft	10,000 ft	157 knots	5.5 hours

Conclusion and Future Directions

It is a Brave New World



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AI can be an Assistant to the Estimator



Challenges must be Overcome



Implement Practical AI that works for
your organization



AI can be an immediate force
multiplier to estimators