* **Artificial Intelligence (AI)**:
  + Definition: Refers to the use of technologies to build machines and computers capable of mimicking cognitive functions associated with human intelligence.
  + Functions: Includes tasks like understanding and responding to language, analyzing data, making recommendations, and more.
  + Implementation: Implemented as a set of technologies in a system to enable reasoning, learning, and problem-solving.
* **Machine Learning (ML)**:
  + Subset of AI: Focuses on enabling machines to learn from data without being explicitly programmed.
  + Process: Involves using various models to analyze large datasets, derive insights, and make predictions or decisions.
  + Performance Improvement: ML algorithms improve performance over time as they are trained on more data.
* **Relationship between AI and ML**:
  + AI is the overarching term covering various approaches and algorithms, while ML is a specific subset of AI.
  + Other subfields under AI include deep learning, robotics, expert systems, and natural language processing.
* **Generative AI**:
  + Type of AI capable of producing new content such as text, images, audio, and synthetic data.
  + Applications: Used in conversational bots, content generation, document synthesis, product discovery, etc.
  + Example: Google applies generative AI in products like Google Workspace to automate tasks such as generating summaries of documents.
  + Development Tools: Google provides generative AI APIs to developers for creating customized products and services.
* **Backward Looking Data**:
  + Examples: Daily analyst dashboards, monthly managerial reports.
  + Definition: Data focused on past events, used for calculating metrics and identifying trends.
* **Value Creation with Data**:
  + Need for Future Decisions: To create value, historical data must be used to inform future decisions.
  + Role of Artificial Intelligence (AI) and Machine Learning (ML): Key for unlocking capabilities to make predictive insights and decisions.
* **Example: Maya's Scenario**:
  + Maya leads the strategy team for an international airline.
  + Historical Analysis: Maya examines historical annual reports to establish customer purchasing trends.
  + Limitation: Past data only illustrates what has happened.
  + Transformational Potential: Maya envisions predicting flight satisfaction rates and customer complaints to proactively address issues.
* **Data Requirements for Predictive Insights**:
  + Data Points: Include passenger count, flight duration, satisfaction ratings, complaints, weather reports, seasonal indicators, etc.
  + Predictive Models: ML models analyze data to predict flight quality and customer complaints.
* **Scaling Predictive Insights**:
  + Challenge: Maya needs to predict outcomes for hundreds of flights daily.
  + Value: Ability to dynamically adjust pricing, staffing, and services based on predictions enhances operational efficiency and customer satisfaction.
* **Role of Machine Learning**:
  + Definition: ML teaches computers to solve problems by learning from examples.
  + Application: Maya can leverage ML to uncover predictive insights and optimize airline operations.

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* **Machine Learning's Continuous Improvement**:
  + ML systems enhance themselves with more data, resulting in more accurate results over time.
* **Common Business Problems Solved by ML**:
  + **Replacing or Simplifying Rule-Based Systems**:
    - Example: Google Search's decision on displaying search results for queries like "Giants."
    - ML Solution: Predicting search result ranks based on user interactions with previous search results.
  + **Automating Processes**:
    - Example: Ananda Development automates property inspection processes using a mobile app.
    - ML Solution: Recognizing Thai language speech, automating defect classification using image recognition.
  + **Understanding Unstructured Data**:
    - Example: Ocado uses ML to process customer emails and route them to relevant departments.
    - ML Solution: Identifying sentiment and topics in emails using natural language processing.
  + **Personalization**:
    - Example: YouTube's personalized video recommendations.
    - ML Solution: Providing personalized recommendations based on user preferences and behavior.
* **Importance of Combinations of Models**:
  + Complex business challenges often require combinations of ML models rather than standalone solutions.
* **Additional Applications of ML**:
  + Many more applications exist beyond the discussed examples, including those covered in machine learning courses.

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* **Quality Dimensions of Data for ML Models**:
  1. **Completeness**: All required information is present.
     + Incomplete data affects the model's ability to learn accurate patterns.
  2. **Uniqueness**: Data contains unique records without excessive duplicates.
     + Duplicate records can confuse the model and hinder accurate pattern identification.
  3. **Timeliness**: Data is up-to-date and reflects the current state.
     + Outdated data may lead to predictions based on irrelevant information.
  4. **Validity**: Data conforms to predefined standards and definitions.
     + Ensures data is in an acceptable range and correct format.
  5. **Accuracy**: Data is correct and free from errors.
     + Incorrect data affects the correctness of predictions made by the model.
  6. **Consistency**: Data is uniform and free from contradictions.
     + Inconsistent data, such as variations in naming conventions, can confuse the model.
* **Importance of Quality Data for ML Models**:
  1. ML models rely solely on data to make predictions.
  2. Poor quality data leads to inaccurate predictions and flawed insights.
  3. High-quality data ensures models can effectively learn patterns and make accurate predictions.
* **Ensuring Data Quality**:
  1. Addressing data quality issues involves collecting more high-quality data purposefully.
  2. Attention to completeness, uniqueness, timeliness, validity, accuracy, and consistency is essential to ensure data quality for ML models.
* **Democratization of Machine Learning**:
  + Traditional machine learning on large datasets often requires extensive programming and ML framework knowledge.
  + This restricts solution development to a small subset of individuals within companies, excluding data analysts with limited ML and programming expertise.
* **BigQuery Evolution and BigQuery ML**:
  + BigQuery, initially a data warehouse, has expanded to support the data-to-AI lifecycle.
  + BigQuery ML democratizes ML by enabling data analysts and primary data warehouse users to build and run models using familiar tools like spreadsheets.
  + Predictive analytics becomes accessible for decision-making across the organization without requiring programming in Python or Java.
* **Advantages of BigQuery ML**:
  + ML models are trained and accessed directly within BigQuery using SQL, a language familiar to data analysts.
  + Reduces complexity by eliminating the need for multiple tools.
  + Increases production speed by avoiding data movement and formatting required by Python-based ML frameworks.
* **Integration with Vertex AI**:
  + BigQuery ML seamlessly integrates with Vertex AI, Google Cloud's comprehensive AI and ML platform.
  + Models trained in BigQuery ML can be registered to the Vertex AI model registry and deployed to endpoints for online prediction, enhancing scalability and deployment capabilities.
* **Pre-trained APIs by Google Cloud**:
  + Suitable for organizations lacking specialized data scientists but having business analysts and developers.
  + Offers the quickest and lowest-effort approach to machine learning, albeit with less customization.
* **Features**:
  + Provide access to ML models for common tasks such as image, video, and text analysis.
  + Can be deployed in various environments, including virtual private clouds, on-premises, or Google's public cloud, regardless of ML expertise.
* **Examples**:
  + **Vision API**:
    - Recognizes images, detects faces, objects, text, and sentiment using pre-trained models.
    - Enables labeling and classification of images into predefined categories.
  + **Natural Language API**:
    - Analyzes text syntax, entities, and sentiment.
    - Classifies text into predefined categories, aiding in handling large volumes of messages or comments.
* **Other Pre-trained APIs**:
  + **Cloud Translation API**: Converts text between languages.
  + **Speech-to-Text API**: Converts audio to text.
  + **Text-to-Speech API**: Converts text to high-quality voice audio.
  + **Video Intelligence API**: Recognizes motion and action in videos.
* **Advantages of Google's Pre-trained Models**:
  + Benefit from Google's extensive datasets and ML expertise.
  + Requires less effort from users and provides a faster return on investment due to Google's resources and research.

  **Vertex AI Overview**:

* Unified interface for building machine learning (ML) models using Google Cloud services.
* Enables training models with custom data and managing ML projects.

 **AutoML and Vertex AI**:

* Allows building and training ML models through graphical user interfaces (GUIs), eliminating the need for coding.
* Automatically selects the best ML model and tunes parameters, reducing manual work and ensuring accuracy.
* Enables practitioners to focus on problem-solving rather than ML details.
* Ideal for businesses seeking customized ML models without extensive coding and experimentation.

 **Custom Image Recognition Example**:

* While Vision API can distinguish generic images, it may not suit specialized tasks like identifying good or defective parts in a manufacturing context.
* AutoML Vision allows training models with specialized data, automating the process through an intuitive interface.
* Models can be optimized and deployed directly from the cloud.

 **AutoML Natural Language**:

* Enables building and deploying custom ML models for tasks like document analysis, categorization, entity recognition, and sentiment analysis.
* Users can upload training data and test models without coding, enhancing customization and flexibility.

 **Google Cloud ML Offerings**:

* Includes various APIs for categorizing videos, converting audio to text, text to audio, natural language understanding, translation, and more.
* Innovative applications often combine multiple ML applications to address complex challenges.

  **Vertex AI for Custom End-to-End ML Models**:

* Allows creation of fully custom ML models trained with proprietary data.
* Provides a comprehensive suite of products to support various stages of the ML workflow, including data gathering, feature engineering, model building, and deployment.

 **Customization Process**:

* Involves a fully customized approach from gathering data to model deployment.
* Requires a specialized team of data scientists and engineers.
* Offers the most specialized ML models tailored to specific business needs, leading to differentiation and innovative outcomes.

 **Tools and Features**:

* Assists programmers with tasks such as virtual machine imaging, data labeling, model training, and predictions.
* Includes pre-built algorithms for various tasks.
* Emphasizes that there's no one-size-fits-all approach, and each use case may require a different combination of tools and products.
* **TensorFlow and Google Cloud's AI Infrastructure**:
  + TensorFlow serves as the foundational infrastructure for machine learning models on Google Cloud.
  + It's an end-to-end open-source platform developed by Google, initially for internal use but now available to everyone.
  + TensorFlow provides a flexible ecosystem of tools, libraries, and community resources for ML innovation and application development.
* **Tensor Processing Unit (TPU)**:
  + Google's custom-developed application-specific integrated circuit (ASIC) designed to accelerate machine learning workloads.
  + TPUs are domain-specific hardware optimized for ML tasks, unlike general-purpose CPUs and GPUs.
  + TPUs offer significantly faster computing speeds compared to GPUs, with a speed increase of over 200 times.
* **Benefits of Cloud TPUs**:
  + Integration of Cloud TPUs across Google products.
  + Cloud TPUs enable state-of-the-art hardware and supercomputing technology accessible through Google Cloud products and services.
  + Example: A full cloud TPU pod can deliver results in 7.9 minutes that would take 26 hours with a state-of-the-art GPU.

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* **Contact Center AI**:
  + Provides models for interacting with customers and supporting human agents.
  + Aims to increase operational efficiency and personalize customer care in contact centers.
* **Document AI**:
  + Extracts and classifies information from unstructured documents like invoices, receipts, and reports.
  + Enables the extraction of data for further analysis or storage in databases.
* **Discovery AI for Retail**:
  + Utilizes machine learning to optimize the ordering of products on e-commerce sites based on historical data.
  + Improves accuracy, relevance, and sales likelihood by learning ideal product ordering for each page.
* **Cloud Talent Solution**:
  + Incorporates AI into job search and talent acquisition processes.
  + Matches candidates to suitable jobs more efficiently and helps employers attract higher-quality candidates.

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When considering which AI and ML solutions to employ, several decisions and trade-offs must be weighed:

1. **Speed**: The timeline for getting the model into production is a crucial factor. Pre-trained APIs require minimal setup time as the model training has already been completed. Custom training typically takes the longest, while solutions like AutoML and BigQuery ML offer a middle ground.
2. **Differentiation**: Organizations must determine how unique their model needs to be. Out-of-the-box solutions like image recognition and chatbots offer quick deployment for common use cases. Alternatively, Vertex AI provides full control over the ML workflow, allowing for highly bespoke models.
3. **Expertise Required**: Infusing AI into business processes necessitates various roles, including data engineers, data scientists, and ML engineers. Organizations should assess their current team and develop a strategy for acquiring the necessary expertise, whether through upskilling, hiring, or working with external consultants.
4. **Effort Required**: Building an AI solution entails factors such as problem complexity, available data, and team experience. Google Cloud offers solutions for projects of varying complexities, but all AI endeavors demand significant time, effort, and expertise to yield meaningful impacts on business operations.