**Question - 1:**

An AI-drivers autonomous car is traveling to drop a passenger to a train station. The goal is to reach the destination on time. The GPS shows a route that passes through a traffic signal, it turns red and the estimated wait time is 2 mins. The car detects that making a legal u-turn and taking an alternate road could save time. But the alternate road takes longer time and unpredictable.

(a). Would you think the goal-based agent perfectly fit with above scenario, if it is, draw the diagram and state the reason?

(b). How the outcomes improve by adding utility in above diagram. And find the best outcome from previous?

**1 (a). Goal-Based Agent Fit & Diagram**

Yes, a **goal-based agent** is an excellent and perfectly fitting choice for this scenario.

**Reasoning for Fit:** A goal-based agent is designed to achieve a predefined, explicit objective. In this case, the autonomous car's absolute primary objective is to **"reach the destination (train station) on time."** This agent type excels at reasoning about sequences of actions to reach a desired future state. It uses its perceptions (from GPS, traffic light, time) to understand the current situation, predict the outcomes of various actions (e.g., waiting at the light vs. taking an alternate route), and then select the path that is expected to lead most effectively to its "on-time" goal. It constantly monitors its progress towards this goal and adjusts its plan as new information becomes available.

**Diagram of a Goal-Based Agent for this Scenario:**

**1 (b). Improving Outcomes by Adding Utility**

While a goal-based agent aims for "on time," it may not always choose the *most optimal* or *least risky* path if multiple paths lead to the goal. This is where a **utility-based agent** significantly enhances decision-making.

**How Outcomes Improve with Utility:**

A utility-based agent goes beyond simply achieving the goal; it strives to achieve the goal in the most desirable way possible, maximizing a numerical "utility" function. This function quantifies the desirability of different outcomes, allowing the agent to weigh various factors and make more nuanced decisions.

For this scenario, adding utility means considering:

1. **Time Value:** Not just being "on time," but perhaps valuing being *early* more than being *just on time*, and penalizing being *late* heavily.
2. **Predictability/Certainty:** Higher utility is assigned to outcomes with known, predictable arrival times. Unpredictability (like the alternate road) introduces significant negative utility due to increased risk and uncertainty.
3. **Risk Aversion:** The agent can be programmed to be risk-averse, meaning it prefers a guaranteed, albeit slightly slower, outcome over a potentially faster but highly uncertain one. This is crucial given the "unpredictable" nature of the alternate route.
4. **Passenger Comfort/Satisfaction:** Although not explicitly stated, a real-world utility function might also consider minimizing sudden maneuvers or unnecessary detours that could reduce passenger comfort.

**Finding the Best Outcome with Utility:**

Let's evaluate the two main options with a utility perspective:

- **Option 1: Continue Straight (Wait at Red Light)**
    - **Outcome:** Arrival at Current Time + 2 mins (wait) + Remaining Travel Time.
    - **Utility Assessment:** This path offers high certainty. The 2-minute delay is fixed and known. The overall arrival time is highly predictable. If this results in arriving *on time* or *only slightly late*, its utility would be high due to its reliability.
- **Option 2: Legal U-Turn + Alternate Road**
    - **Outcome:** Arrival at Current Time + U-turn Time + Unpredictable Alternate Road Travel Time.
    - **Utility Assessment:** The description states this road "could save time" but "takes longer time and unpredictable." This is a significant red flag for a utility-based agent.

        - The "could save time" offers a potential for higher utility (if it works out).
        - However, "takes longer time" and "unpredictable" introduce strong negative utility. "Unpredictable" implies a wide range of possible outcomes, including significantly longer travel times, unknown hazards, or getting lost.
    - The *expected utility* of this path would be significantly lowered by the high variance and the possibility of a very poor outcome.

**Question - 2**:

**"Analyze these three customer reviews using the five-step NLP pipeline (lexical analysis, syntactic analysis, semantic analysis, discourse integration, and pragmatic analysis):**

1. Fast delivery and well-packaged. The product works perfectly.
2. Terrible experience. The item arrived broken and late.
3. The color was slightly different from the picture, but still nice.

**Solution:**

Here's an end-to-end NLP steps breakdown of all three reviews in parallel.

| NLP Step | Application in Customer Review Analysis |
|---|---|
| **1. Lexical Analysis** | - **Break each review into words & punctuation.**<br>- **Review 1 tokens:** ["Fast", "delivery", "and", "well-packaged", ".", "The", "product", "works", "perfectly", "."]<br>- **Review 2 tokens:** ["Terrible", "experience", ".", "The", "item", "arrived", "broken", "and", "late", "."]<br>- **Review 3 tokens:** ["The", "color", "was", "slightly", "different", "from", "the", "picture", ",", "but", "still", "nice", "."] |
| **2. Syntactic Analysis** | - **Identify subject, verb & object (or complement) in each sentence.**<br>- **Sent 1a:** *Subject:* delivery / packaging<br>*Verb:* is (implied "is fast", "is well-packaged")<br>- **Sent 1b:** *Subject:* product *Verb:* works *Object/complement:* perfectly<br>- **Sent 2a:** *Subject:* experience *Verb:* is (implied "is terrible")<br>- **Sent 2b:** *Subject:* item *Verb:* arrived *Object/complement:* broken and late<br>- **Sent 3:** *Subject:* color *Verb:* was *Complement:* slightly different from the picture; [conj "but"] *Subject:* (it) *Verb:* is *Complement:* still nice |
| **3. Semantic Analysis** | - **Determine polarity/meaning of key phrases in all three.**<br>- Review 1: "fast delivery" → **positive**, "well-packaged" → **positive**, "works perfectly" → **positive**<br>- Review 2: "terrible experience" → **negative**, "arrived broken" → **negative**, "late" → **negative**<br>- Review 3: "color was slightly different" → **slightly negative**, "but still nice" → **positive** |
| **4. Discourse Integration** | - **Connect across sentences to capture overall context/contrast.**<br>- The user is **highly satisfied** with speed, packaging, and product performance.<br>- The user is **strongly dissatisfied** with item condition and delivery punctuality.<br>- The user notes a **minor mismatch** in appearance but still feels positively about the product.<br>- Overall: mixed review with **both praise and criticism**, balancing positives (delivery & quality) against negatives (damage, delay, color variance). |
| **5. Pragmatic Analysis** | - **Infer underlying intent or suggestion.**<br>- Review 1 intent: *Praise* — reinforce that fast shipping & good packaging are valued.<br>- Review 2 intent: *Complaint* — alert seller to improve handling and timeliness.<br>- Review 3 intent: *Constructive feedback* — suggest aligning product photos more closely with actual color.<br>- Overall: user **wants** consistently reliable shipping & packaging, **avoids** damaged/late deliveries, and **hopes** for accurate product representation. |