



GST 16 — Characteristics, States, and Change

Formal Description

A **characteristic** (or property) is a feature common to entities that may be used to classify or distinguish them.

A **variable** is a characteristic capable of taking different values.

The **state** of an entity is the set of characteristics that apply to it at a given time.

A **change of state** is a change in the set of characteristics that apply to an entity.

A **continuum change of state** is a gradual change in characteristics that may culminate in an observable transformation.

Plain English Explanation

So far, we have examined what exists in terms of entities, how those entities are arranged through configuration and structure, and how they interact through relationships and causality. The next step is to understand how we describe entities and how they change over time.

Every entity has characteristics, which are the features we use to describe it. For example, a ball has properties such as size, colour, and temperature; a person has attributes such as height, age, and knowledge; and a system has characteristics such as structure and behaviour. These characteristics define what an entity is like at any given moment.

Some characteristics can vary, and these are known as variables. For instance, temperature can increase or decrease, speed can change, and population can grow or decline. A variable is therefore simply a characteristic that can take different values.

The state of an entity is the complete set of its characteristics at a particular moment in time. It can be understood as a snapshot of the entity at that instant. For example, the current temperature of a room, the position and speed of a moving car, or the condition of a system at a given moment all describe its state.

When one or more characteristics change, the state of the entity changes. This is known as a change of state. Examples include water heating up, a car accelerating, or a person learning something new. These changes are the way in which systems evolve over time.

Some changes occur gradually and continuously. Temperature may rise slowly, a plant may grow over time, or a population may increase incrementally. These continuous changes of state can accumulate, eventually producing visible transformations, new behaviours, or new system properties. In this way, small changes can lead to significant effects.

This concept is fundamental to systems theory. Events bring about changes of state, and systems are defined by how their states change over time. Behaviour, in this sense, is the pattern of state changes exhibited by a system. Without change of state, nothing would happen and systems would remain static.



STATE AND CHANGE OF STATE

1

INITIAL STATE

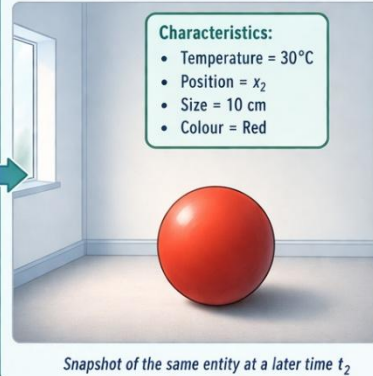
State at Time t_1



2

CHANGED STATE

State at Time t_2

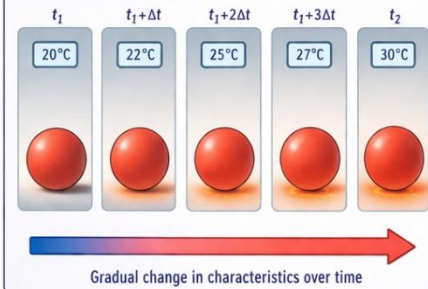


3

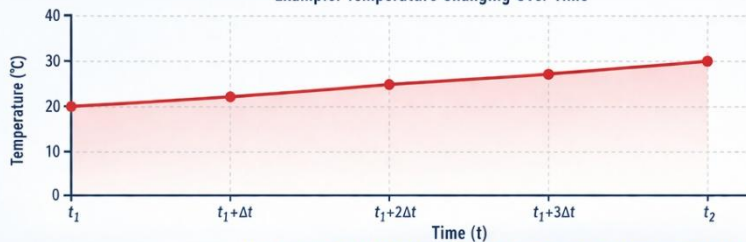
CONTINUOUS CHANGE OF STATE

From t_1 to t_2

The state changes gradually through a continuum of intermediate states.



Example: Temperature Changing Over Time



States capture "what is" at a moment in time. Change of state captures "what happens" as characteristics vary over time.

Key Points:

- A state is the set of all characteristics of an entity at a particular moment in time.
- Change of state occurs when one or more characteristics (variables) change.
- Changes can be discrete (from t_1 to t_2) or continuous (gradual over time).
- The pattern of state changes over time is the behaviour of the system.

Examples

Example 1 – Heating Water

Water in a kettle:

- initial state → cool
- final state → hot

☞ Temperature increases → **change of state**

Example 2 – A Moving Car

A car:

- position changes
- speed changes

☞ These are changes in state over time.

Example 3 – Learning

A person learns something new:

- knowledge increases
- behaviour may change

☞ This is a change of state in a cognitive system.



Example 4 – Population Growth

A population:

- number of individuals increases over time

👉 A gradual, continuous change of state.

Provenance and Links

This module draws on foundational concepts from physics, dynamical systems theory, and systems science concerning the description of entities in terms of their properties and the way those properties change over time.

The concept of a system being describable in terms of its properties at a given moment is central to physics, where the state of a system is defined by a set of variables that specify its condition at a particular time. This approach is fundamental to classical mechanics and thermodynamics, where the evolution of systems is analysed in terms of changes in state over time.

The representation of change as the evolution of state is further developed in dynamical systems theory, including the work of Henri Poincaré, where systems are understood in terms of trajectories through a space of possible states. In this context, variables define the dimensions of the system, and behaviour corresponds to patterns of state change over time.

The distinction between continuous and discrete change reflects core ideas in both mathematics and physics, where some processes evolve gradually while others involve abrupt transitions.

Continuous change is often described using differential equations, while discrete change may be represented through stepwise or event-driven models.

The use of variables to describe changing characteristics is also central to systems modelling and cybernetics, where systems are analysed in terms of measurable quantities and their evolution. This perspective underpins modelling, simulation, and the analysis of system behaviour across a wide range of disciplines.

Within General Systems Theory, these ideas support a unified understanding of how entities are described, how their states are defined, and how change occurs over time. They provide the foundation for analysing system dynamics, behaviour, and the thermodynamic processes explored in subsequent modules.

Practical Exercise

Choose a real-world example (e.g. an object, a system, or a process).

1. Identify at least **three characteristics**
2. Identify which of these are **variables**
3. Describe the **state** of the system at one moment
4. Describe how the state **changes over time**
5. Reflect:
 - What causes the change of state?

👉 Write a short paragraph describing your example.