

What to learn
in Linear Algebra?

Linear System

System

- A system has input and output (function, transformation, operator)

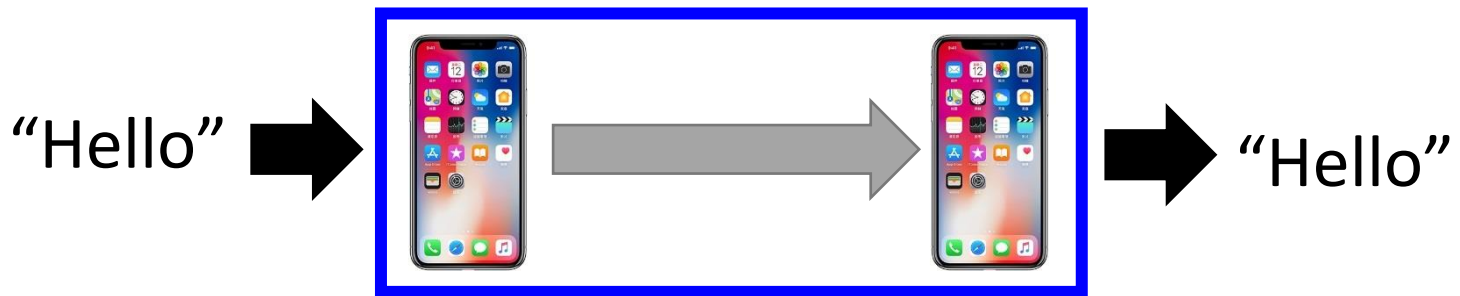
Speech Recognition System



Dialogue System (e.g. Siri, Alexa)

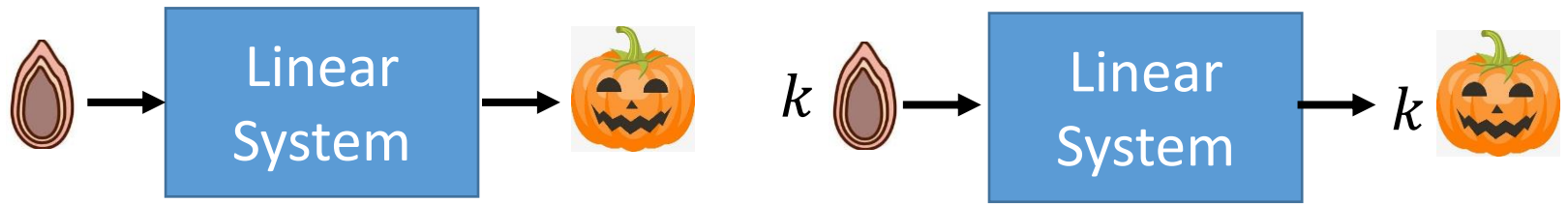


Communication System

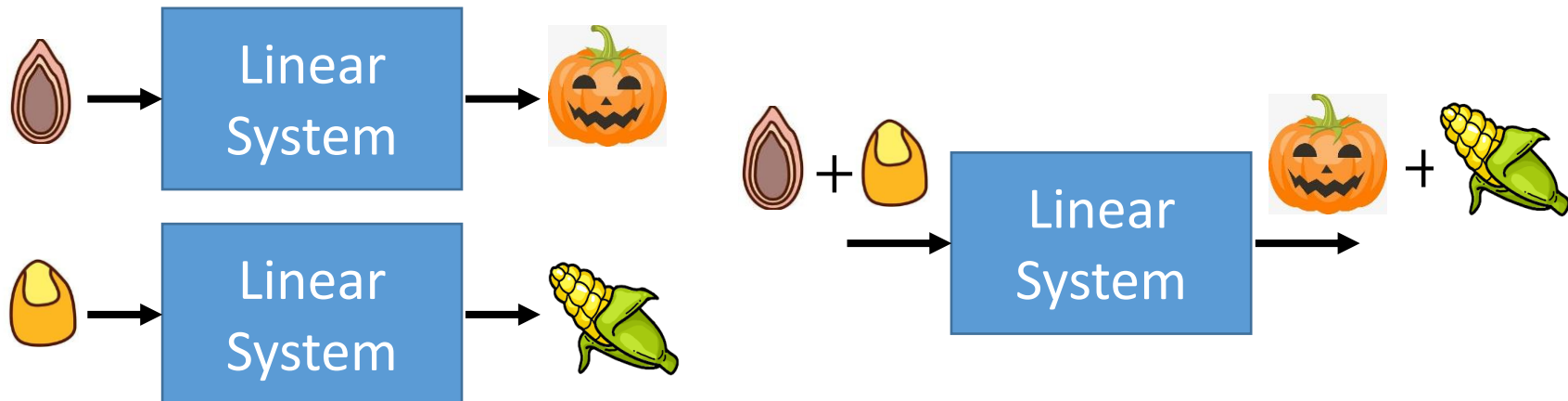


Linear System

- 1. Persevering Multiplication



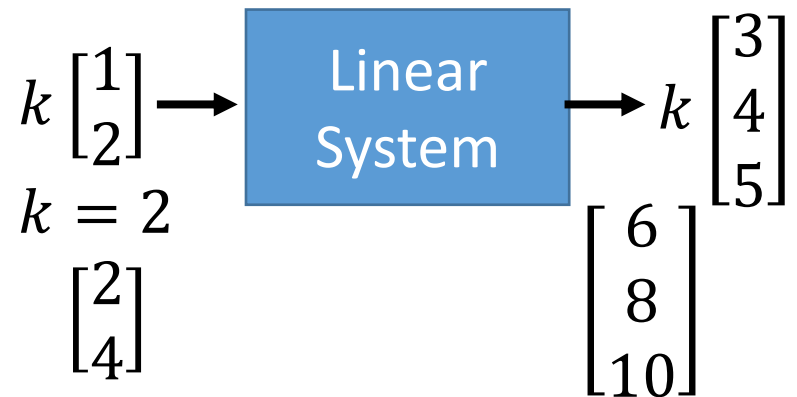
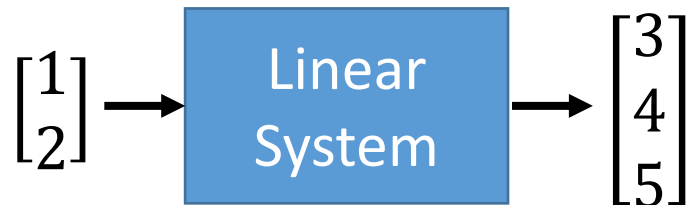
- 2. Persevering Addition



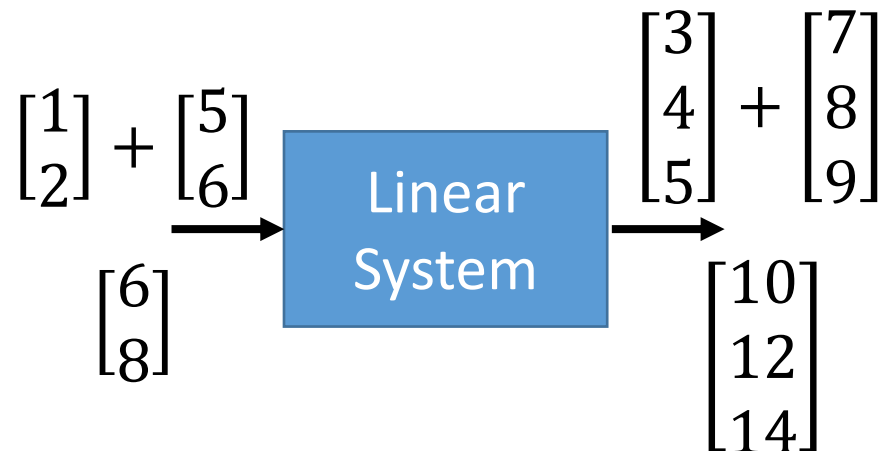
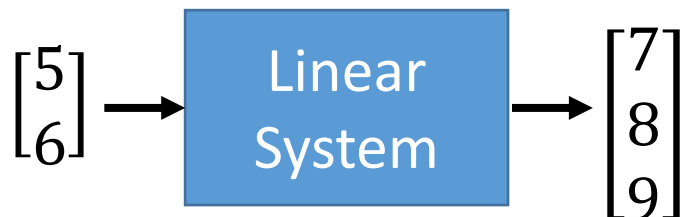
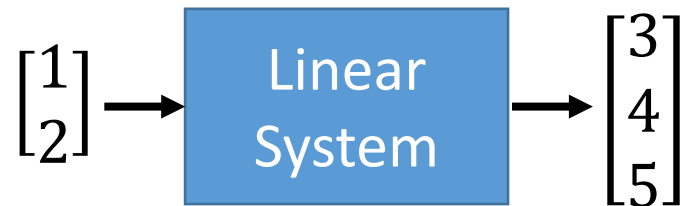
Linear System

When the input and output are vectors

- 1. Persevering Multiplication

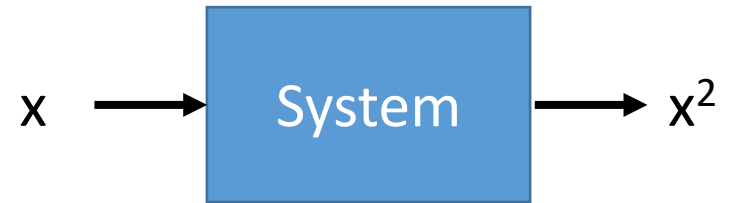


- 2. Persevering Addition

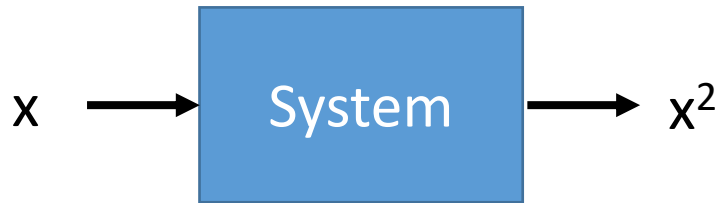


Are they *Linear*?

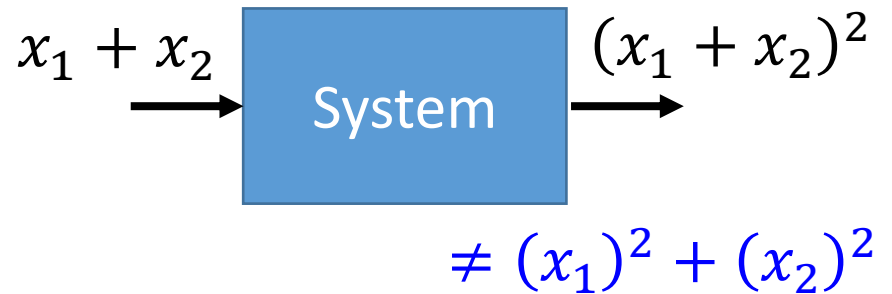
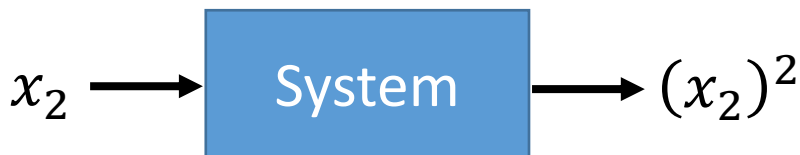
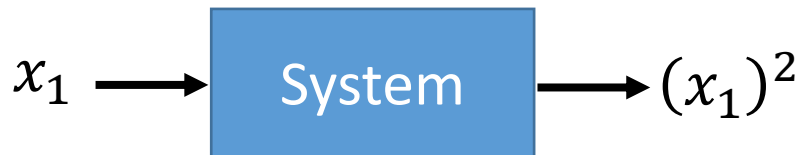
Linear? **NO**



- 1. Persevering Multiplication



- 2. Persevering Addition

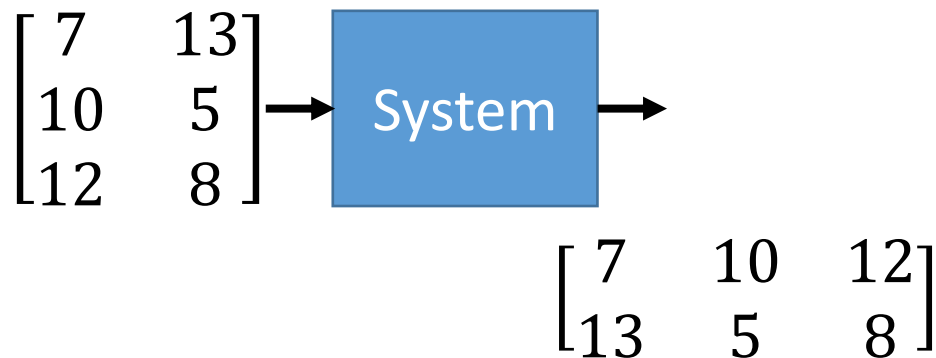
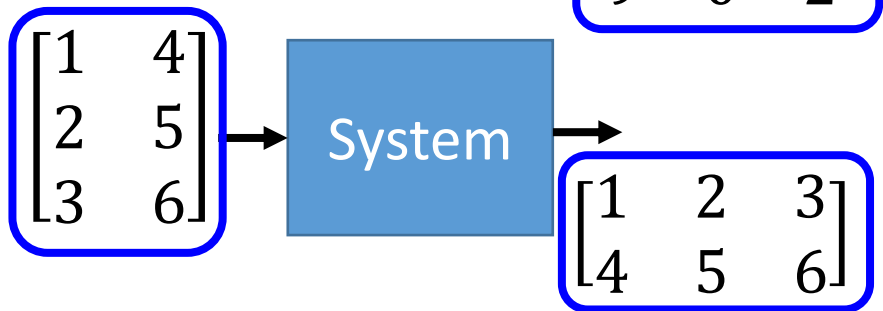
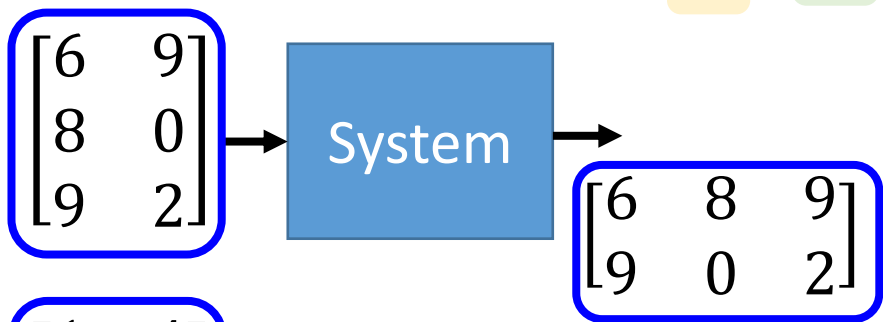
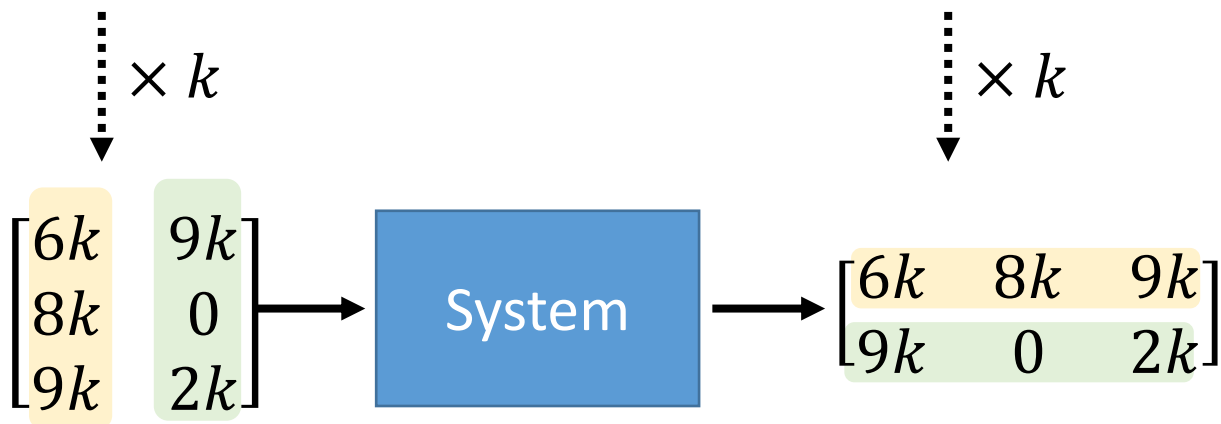
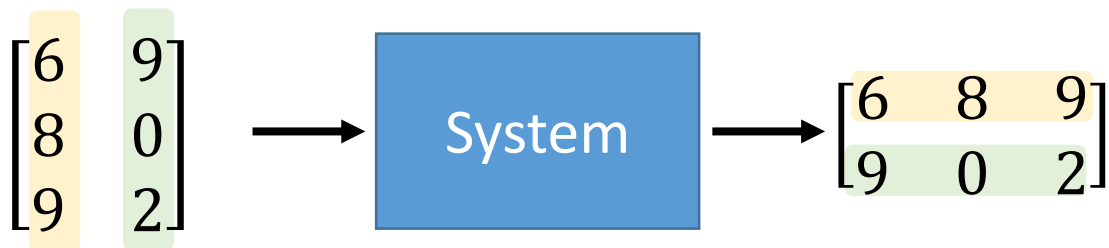


以左上到右下的對角線為軸進行翻轉

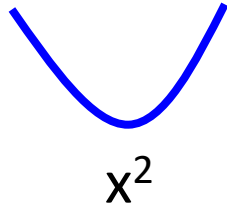
Linear?

Transpose

YES

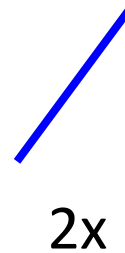


Linear? **YES**



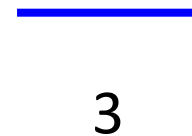
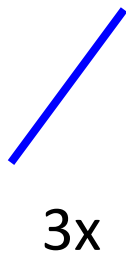
$$f \rightarrow f'$$

$$g \rightarrow g'$$

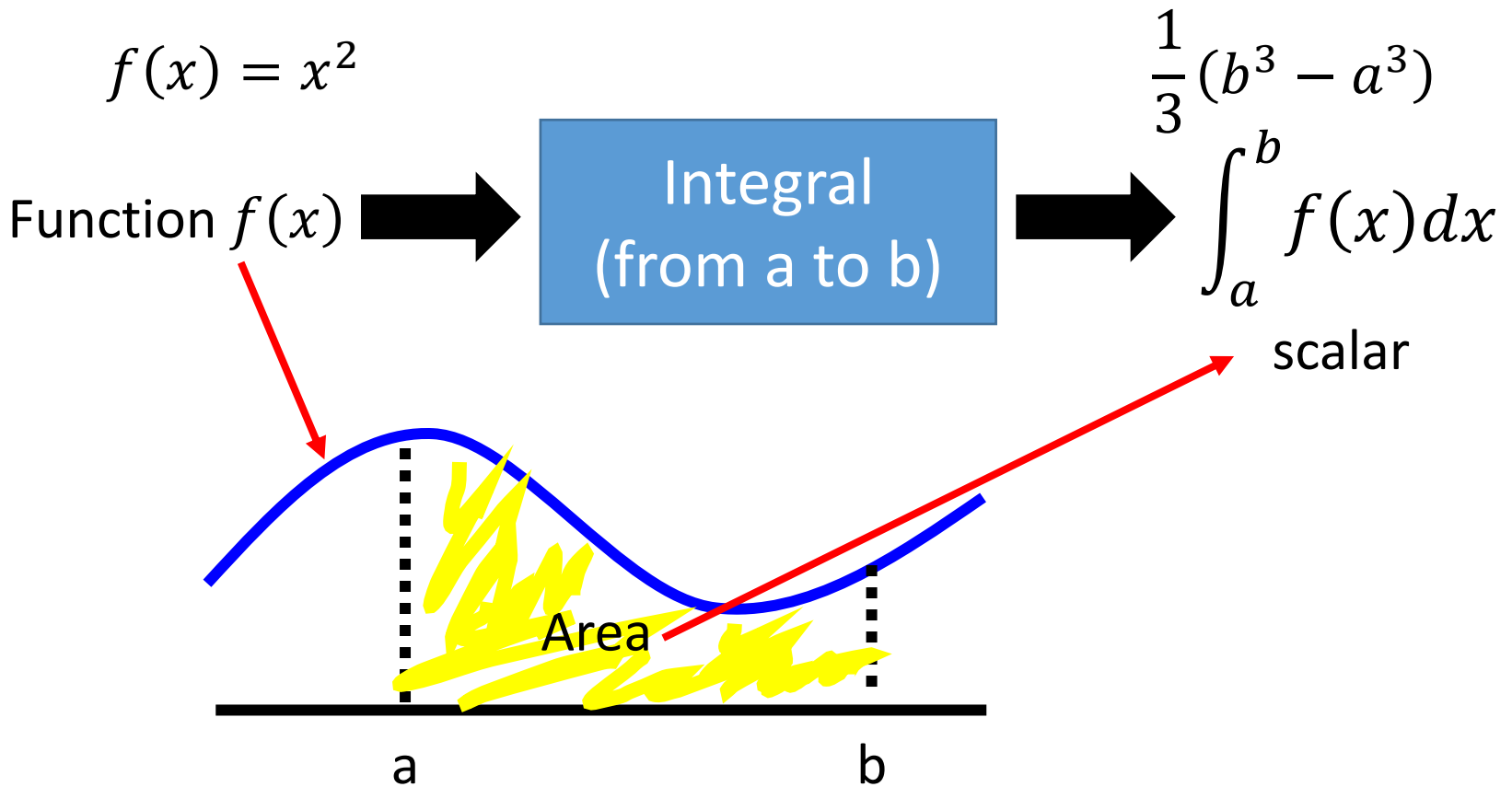


$$kf \rightarrow kf'$$

$$f + g \rightarrow f' + g'$$



Linear?



Linear? **YES**

$$f(x) \longrightarrow \int_a^b f(x) dx$$

Persevering
Multiplication

$$kf(x) \longrightarrow \int_a^b kf(x) dx$$
$$= k \int_a^b f(x) dx$$

Persevering
Addition

$$f(x) \longrightarrow \int_a^b f(x) dx \quad g(x) \longrightarrow \int_a^b g(x) dx$$
$$f(x) + g(x) \longrightarrow \int_a^b [f(x) + g(x)] dx$$
$$= \int_a^b f(x) dx + \int_a^b g(x) dx$$