EECS 16B
Designing Information Devices and Systems II

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Announcements

- HW 9 due date moved to Saturday 3/30
- MT 2 covers lecture material through end of this week
- student support meetings
  - 15 minutes 1-on-1 with course staff, any topic
  - sign up after spring break

Today

- review - controllability
- orthogonal / orthonormal vectors and matrices
- Gram-Schmidt / QR decomposition

To determine controllability, one must generally look at:

1. the input signal
2. the ***B*** matrix only
3. the ***A*** and ***B*** matrices
4. the ***A*** and ***B*** matrices, and the input signal

Controllability

$$\vec{x}[i] = A^i \vec{x}[0] + \sum_{k=0}^{i-1} A^{i-1-k} B \vec{u}[k]$$

Controllability

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$$\vec{x}[i] = A^i\vec{x}[0] + \begin{bmatrix} A^{i-1}B & A^{i-2}B & \cdots & AB & B \end{bmatrix} \begin{bmatrix} \vec{u}[0] \\ \vec{u}[1] \\ \vdots \\ \vec{u}[i-2] \\ \vec{u}[i-1] \end{bmatrix}$$

True or False: Given a well-designed system with n states and m inputs, I can drive the system to any target state even if n >> m.

1. True
2. False

Controllability

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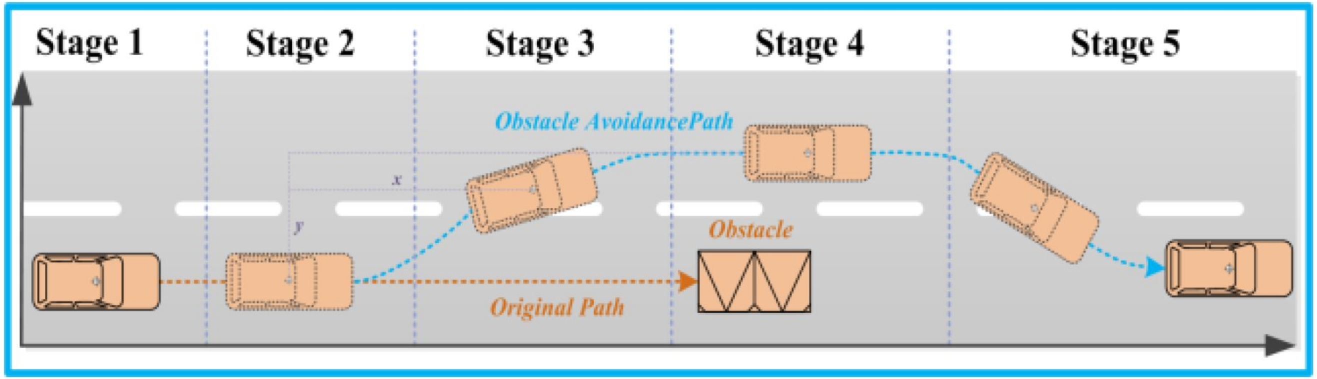
Controllability



$$\dot{x} = \begin{bmatrix} -2 & -1 \\ 0 & -3 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

Is this system stable?

1. yes
2. no

$$\dot{x} = \begin{bmatrix} -2 & -1 \\ 0 & -3 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

Is this system controllable?

1. yes
2. no

Controllability - SpaceX Starship

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- two stages
  - starship spacecraft
  - booster

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- 2.5x thrust relative to Saturn V
- fully reusable
- 3/14 launch
- 3/14 re-entry