4-1 모션 플래닝의 기초 개념

로봇이 역할을 수행하기까지

01

Task Description

물체를 잡기

02

Perception

카메라로 물체 인식

03

Planning

로봇 기준으로 물체 위치 계산

로봇팔 움직임 계산

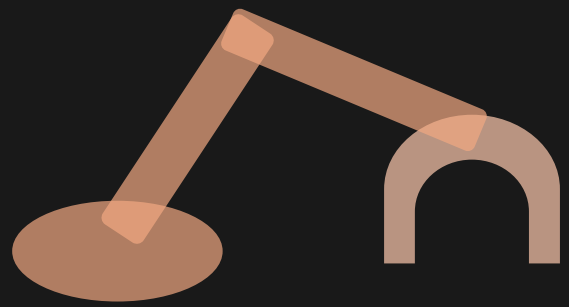
- 충돌이 없을 것
- 제약조건을 만족할 것

04

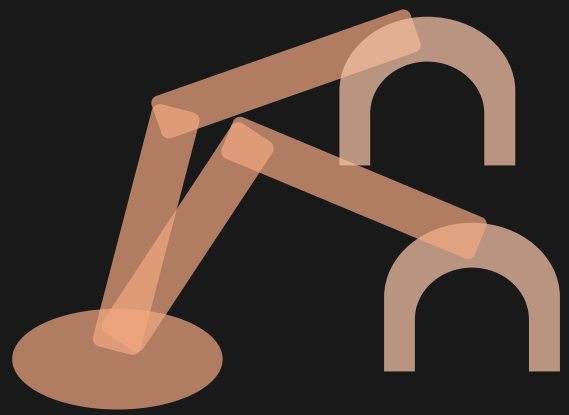
Control

모터를 구동

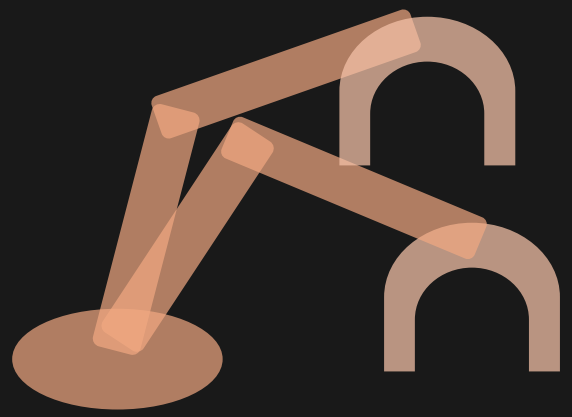
모션 플래닝의 직관적 이해



모션 플래닝의 직관적 이해

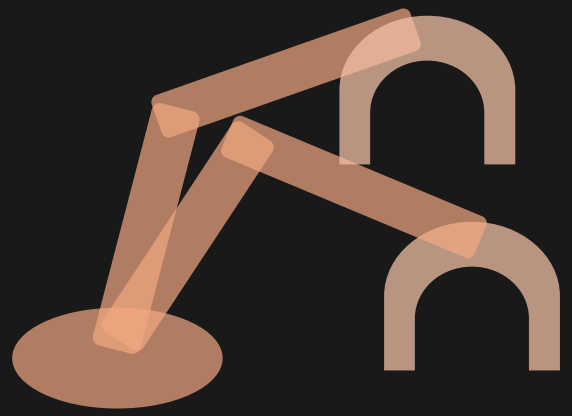


모션 플래닝의 직관적 이해

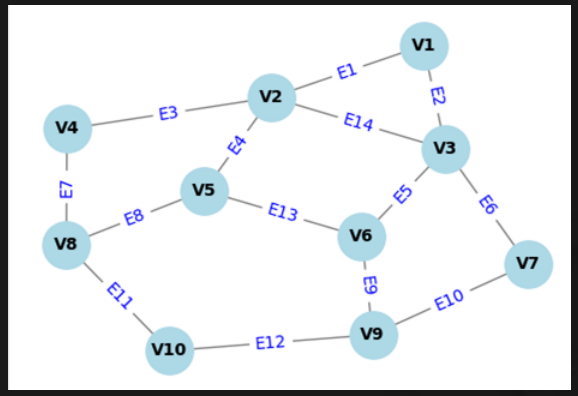


자료 구조로 표현?

모션 플래닝의 직관적 이해



자료 구조로 표현?



Configuration Space (C-Space)

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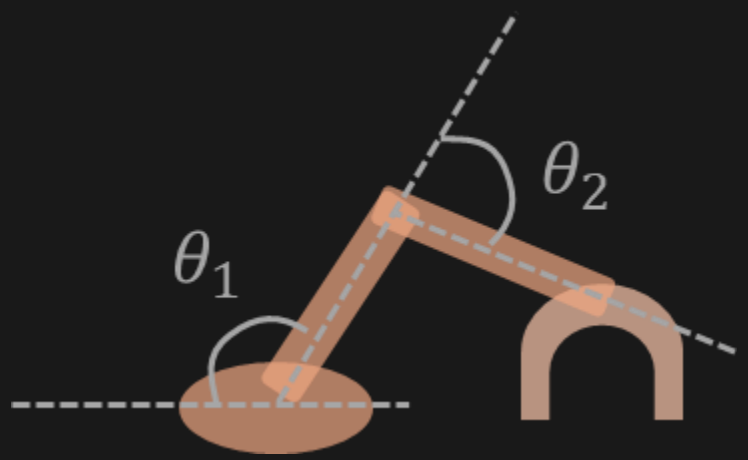

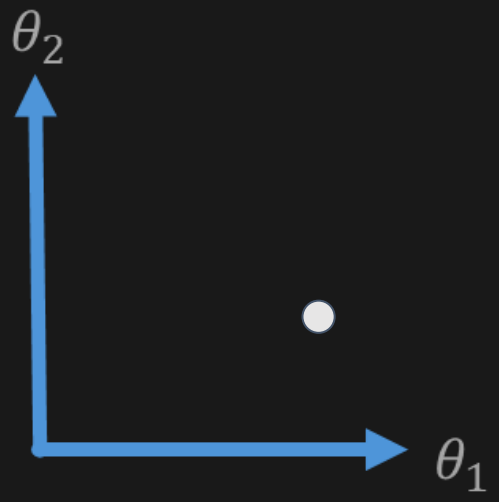

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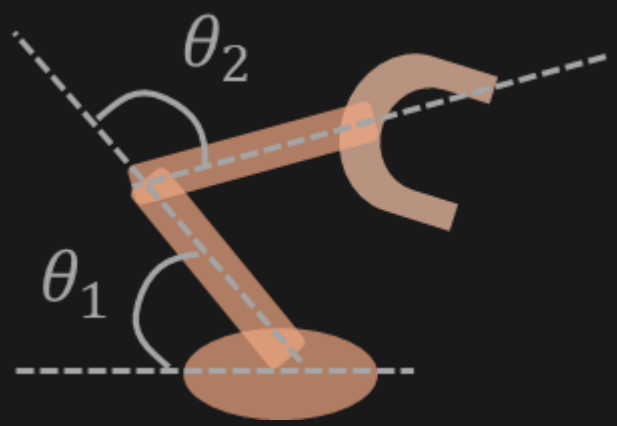

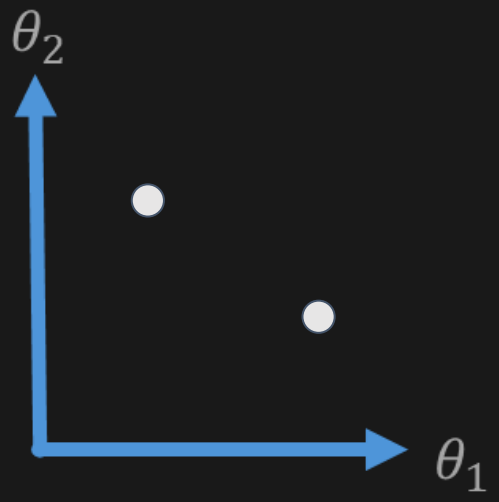

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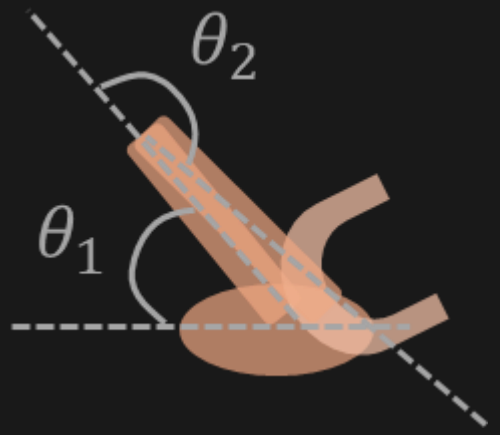

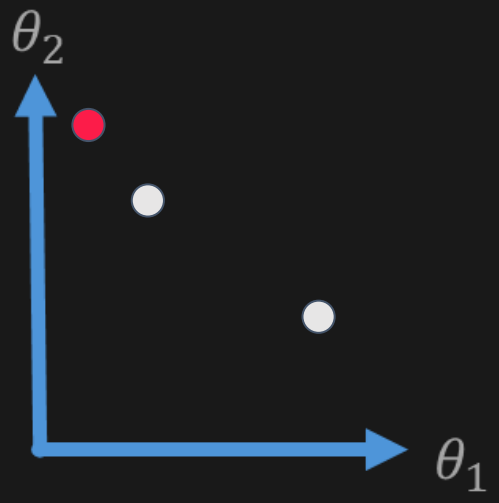

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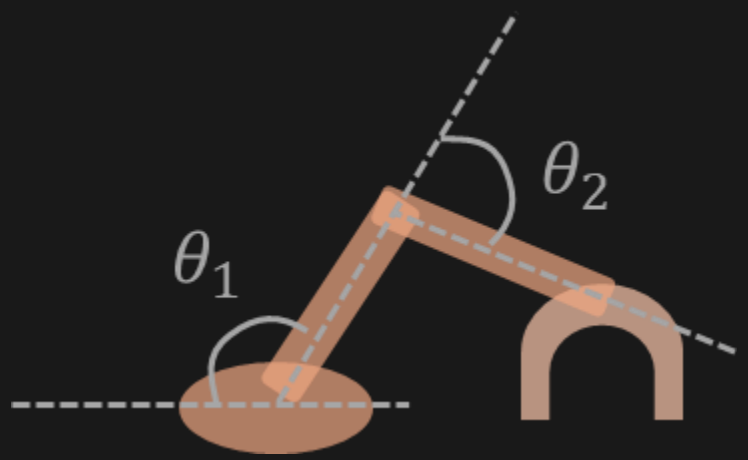

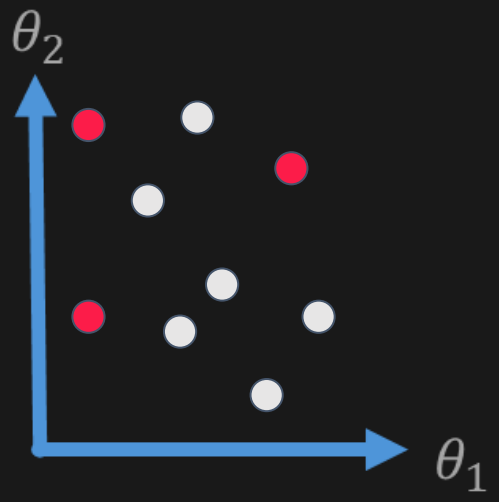

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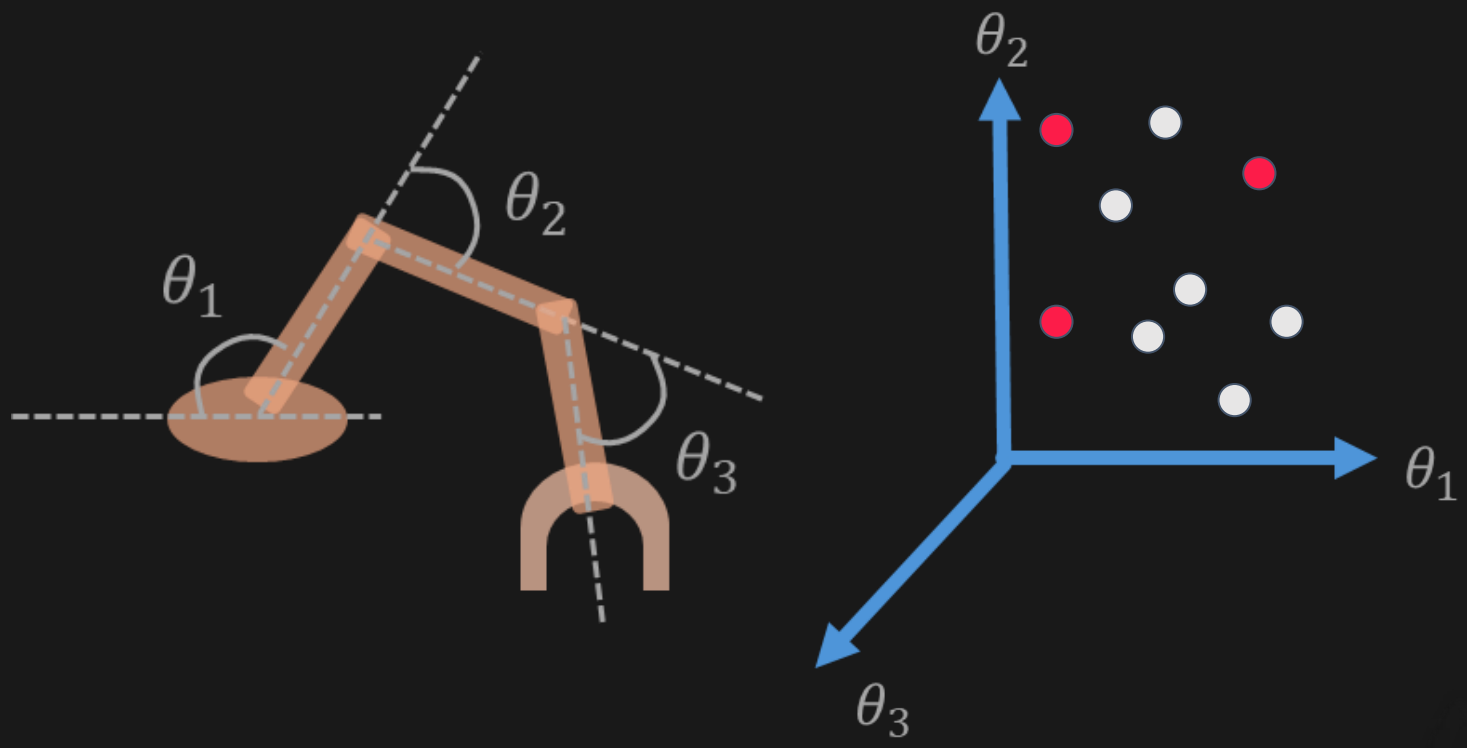

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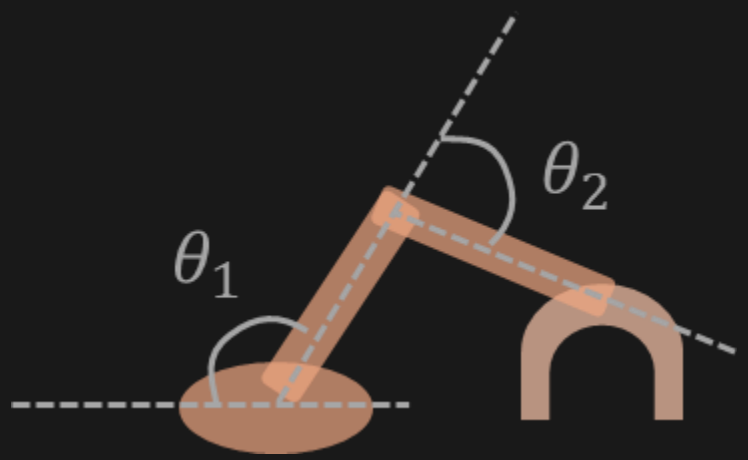

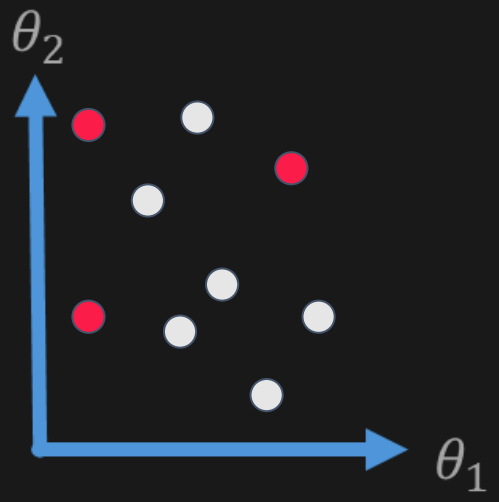

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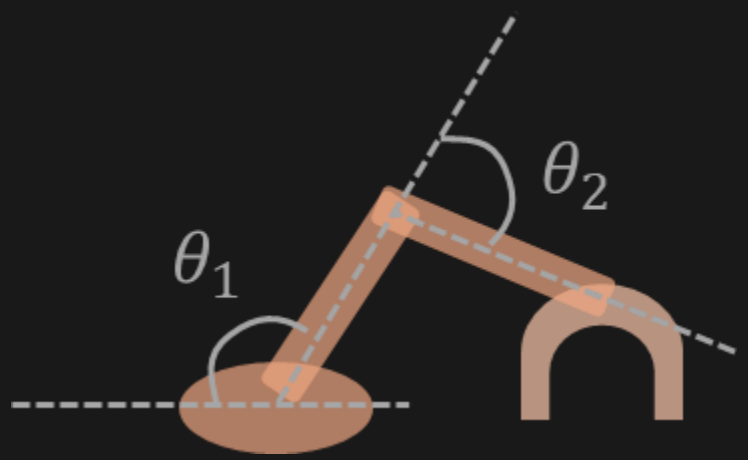
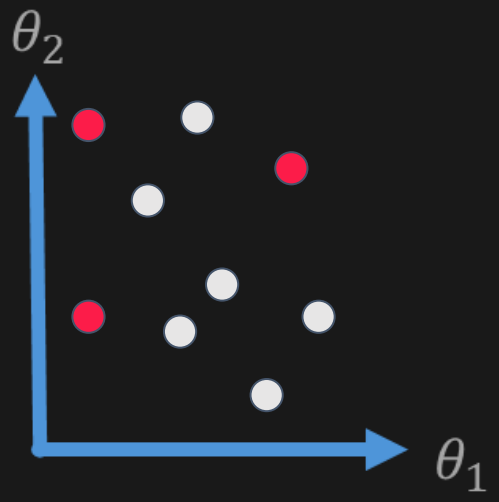




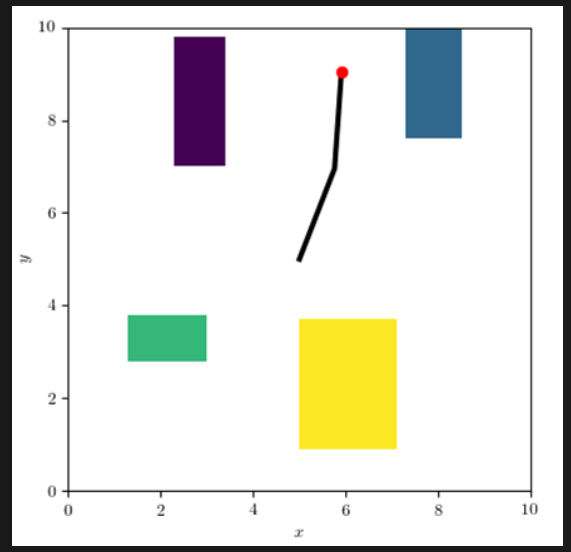
“Work / Task Space”

- 사람이 보는 세상
- 로봇이 3차원으로 어떻게 움직이는지 관찰 가능

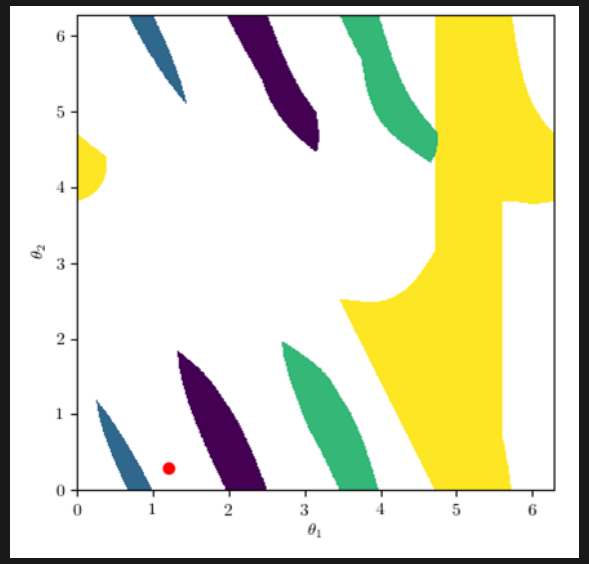
“Configuration / Joint Space”

- 로봇이 보는 세상
- 로봇을 하나의 점으로 표현 가능

Configuration Space (C-Space)

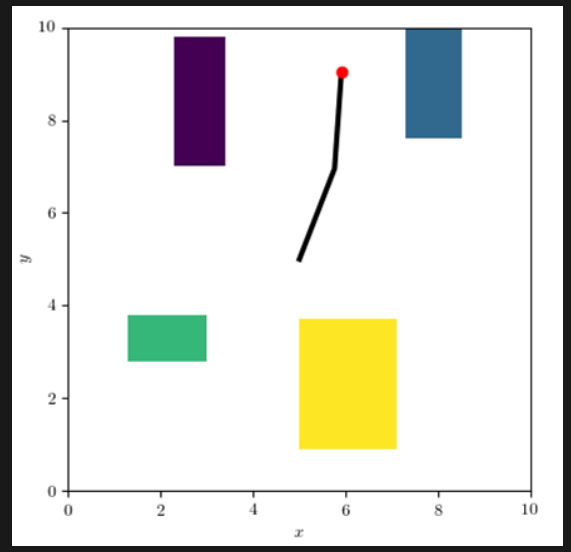


"Work / Task Space"



"Configuration / Joint Space"

Configuration Space (C-Space)



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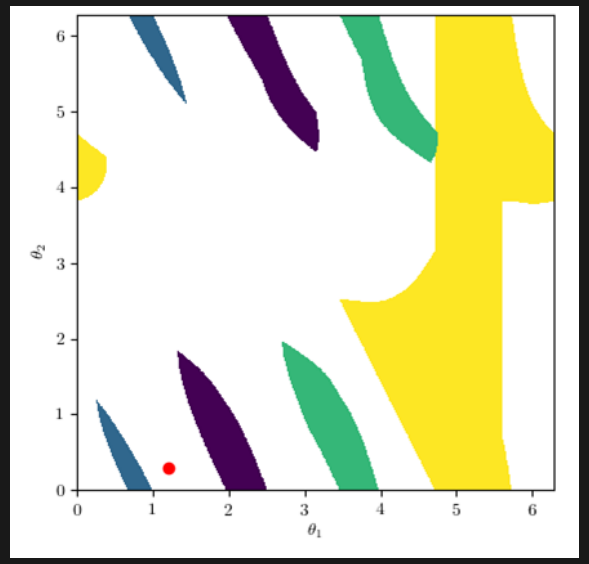

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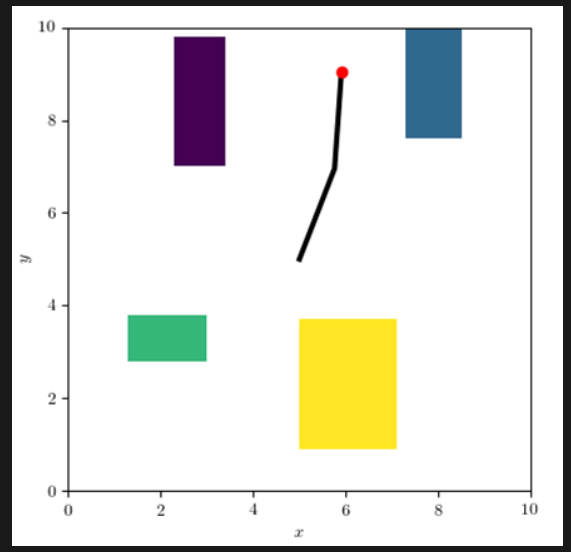

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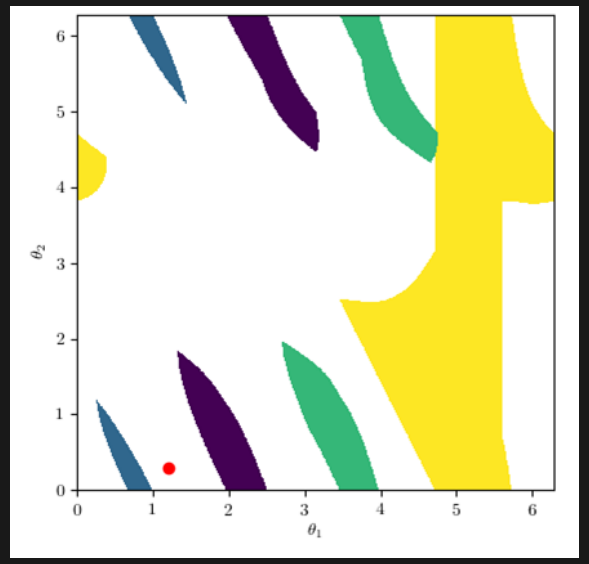
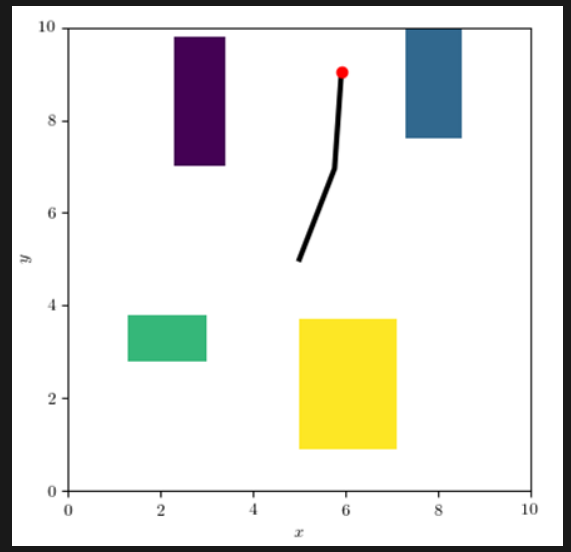
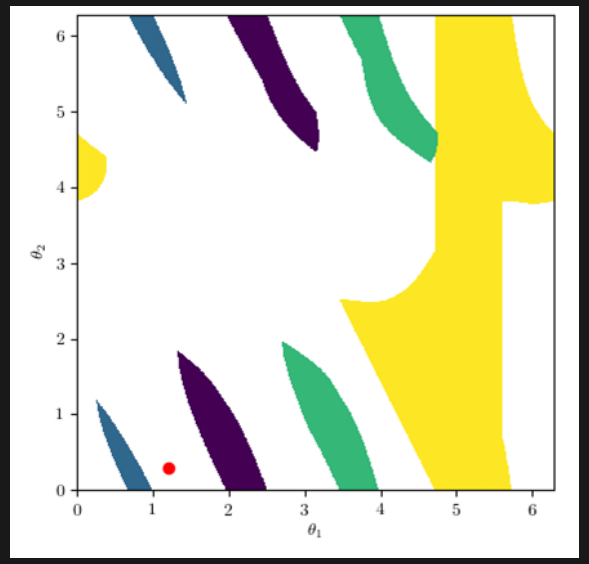


"Configuration / Joint Space"

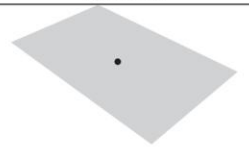
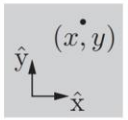
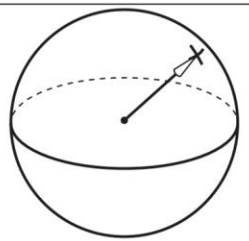
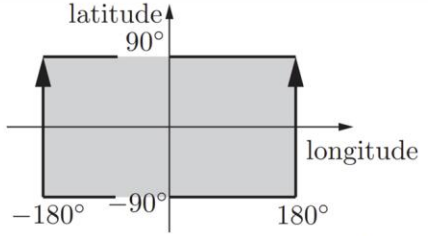
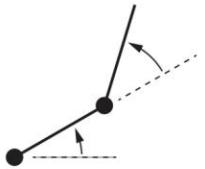
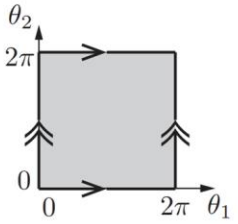
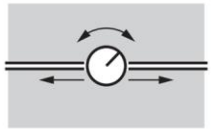
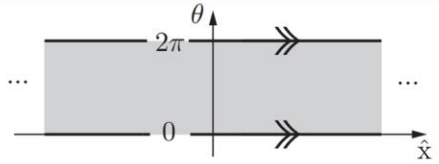
- 로봇이 보는 세상
- 로봇을 하나의 점으로 표현 가능
- C-free & C-obstacle
- 다관절 로봇의 경우, 매우 복잡한 구조 (고차원 공간)

Configuration Space (C-Space) - Topological Space





Configuration Space (C-Space) - Topological Space

system	topology	sample representation
 point on a plane	 $\mathbb{E}^2$	 $\mathbb{R}^2$
 spherical pendulum	 S^2	 $[-180°, 180°) \times [-90°, 90°]$
 2R robot arm	 $T^2 = S^1 \times S^1$	 $[0, 2\pi) \times [0, 2\pi)$
 rotating sliding knob	 $\mathbb{E}^1 \times S^1$	 $\mathbb{R}^1 \times [0, 2\pi)$

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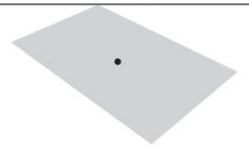
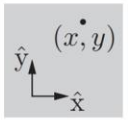
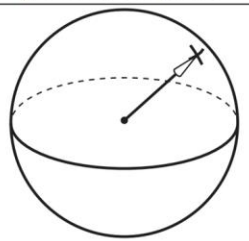
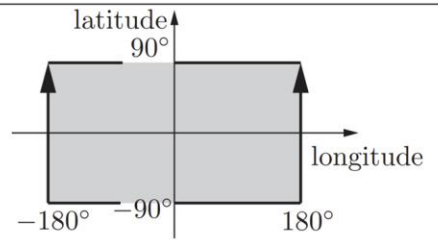
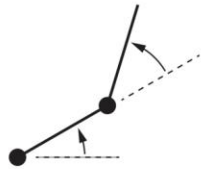
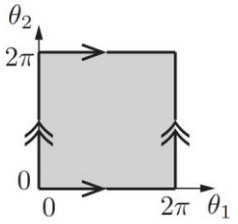
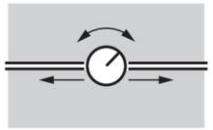
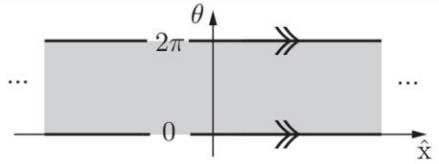
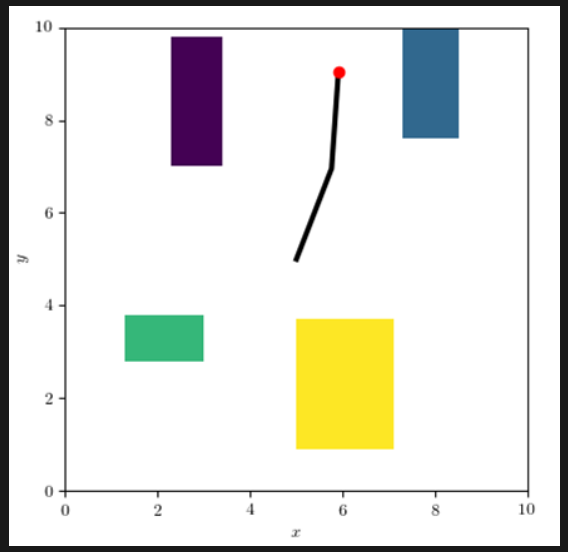
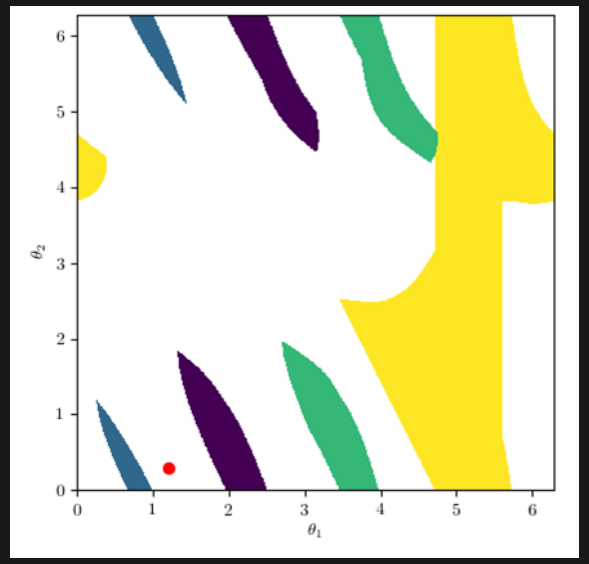
 point on a plane	 $\mathbb{E}^2$	 $\mathbb{R}^2$
 spherical pendulum	 S^2	 $[-180°, 180°) \times [-90°, 90°]$
 2R robot arm	 $T^2 = S^1 \times S^1$	 $[0, 2\pi) \times [0, 2\pi)$
 rotating sliding knob	 $\mathbb{E}^1 \times S^1$	 $\mathbb{R}^1 \times [0, 2\pi)$

Configuration Space (C-Space) - 모션 플래닝

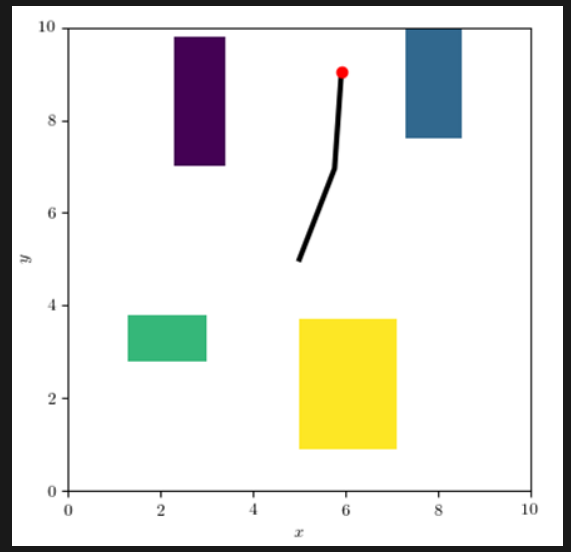


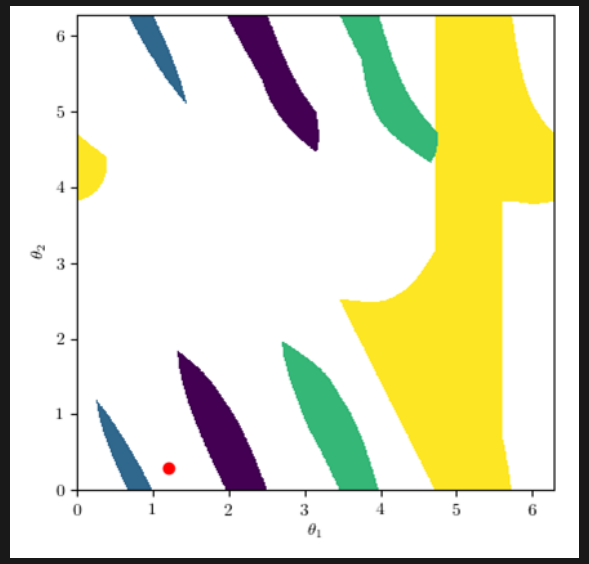
"Work / Task Space"



"Configuration / Joint Space"

Configuration Space (C-Space) - 모션 플래닝



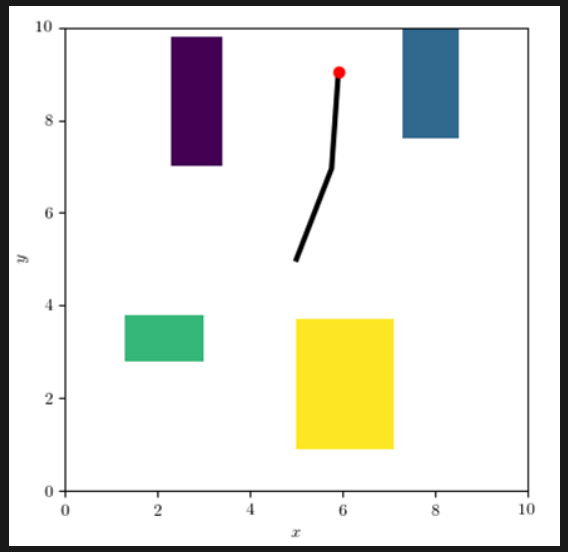


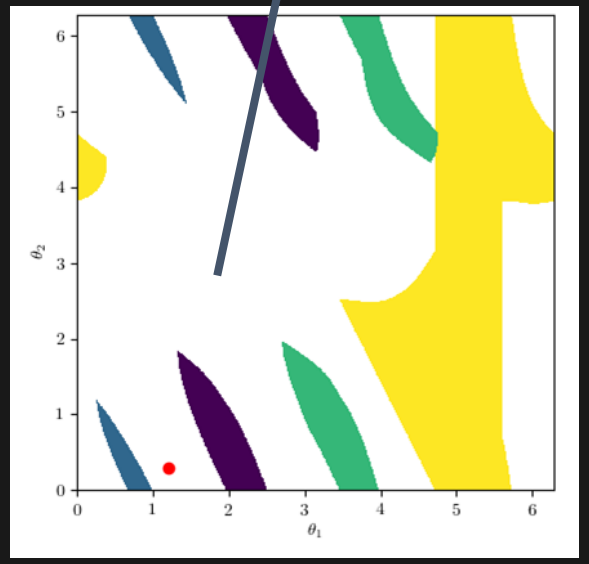
"Work / Task Space" → "Configuration / Joint Space"

Q1) 어떻게 C-Space 를 생성/해석 할 것인가?
Hint) Forward & Inverse Kinematics

Configuration Space (C-Space) - 모션 플래닝

Q2) 어떻게 경로를 알아낼 것인가?
Hint) 그래프 자료 구조 & 탐색 알고리즘

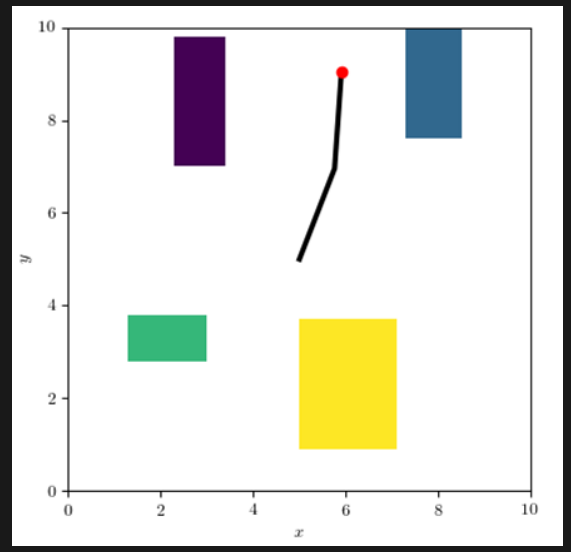




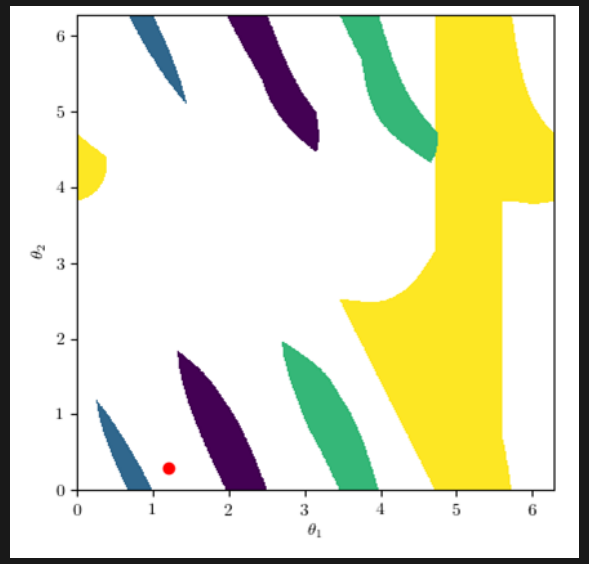
"Work / Task Space" → "Configuration / Joint Space"

Q1) 어떻게 C-Space 를 생성/해석 할 것인가?
Hint) Forward & Inverse Kinematics

모션 플래닝이 어려운 이유



“Work Space / Task Space”



“Configuration Space”

- 고차원 공간에 대한 해석이 필요
- 연속적 공간

모션 플래닝의 두 가지 기법

샘플링 기반 (Sampling-based)

- 샘플링 기법을 활용
- C-Space 전체를 해석하기보다는, 일부 정보만을 추출하여 경로를 찾는 방법
- 불연속적

모션 플래닝

최적화 기반 (Optimization-based)

- 최적화 기법들을 활용
- C-Space 안에서 목적 함수를 만족하는 경로를 찾는 방법
- 연속적

강의 요약

01

Work Space / Task Space

02

Configuration Space / Joint Space

C-free

C-obstacle

고차원 공간

Topological Space

03

샘플링 기반

04

최적화 기반