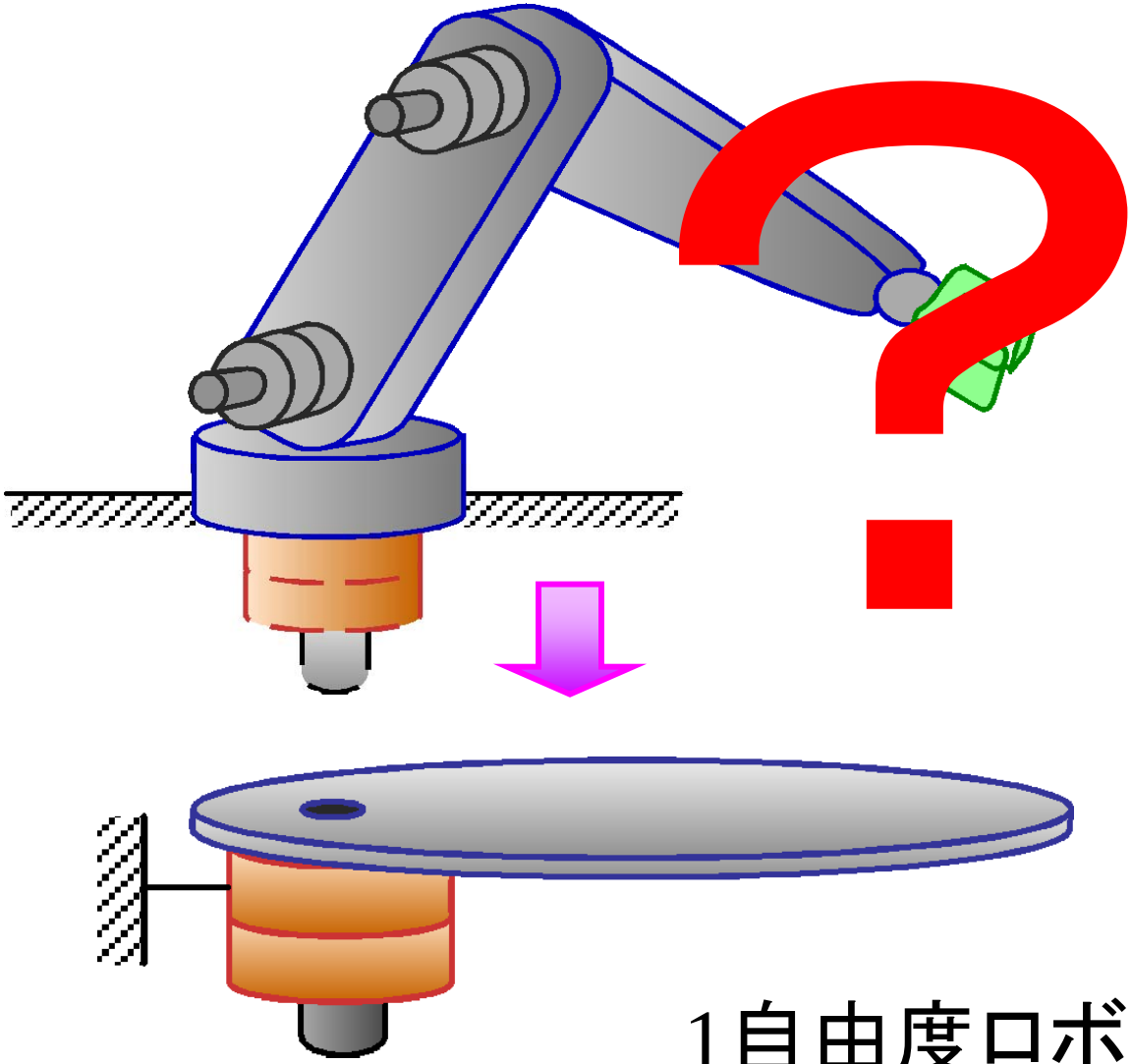
機構学
Part2：機構の自由度

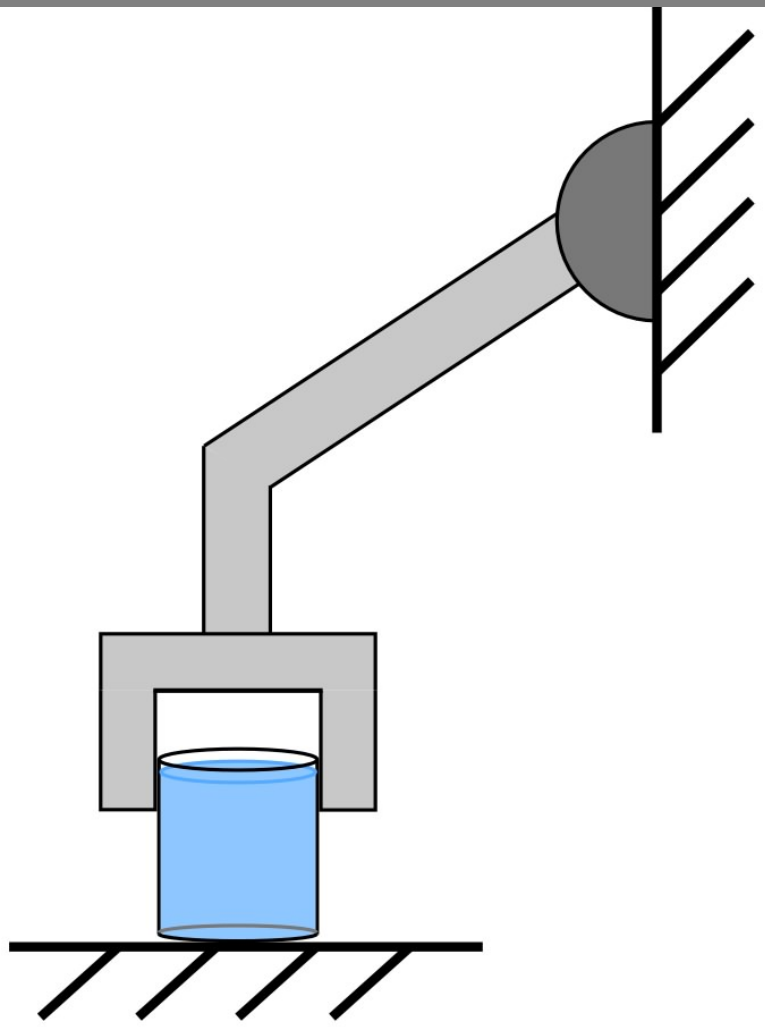
金子真

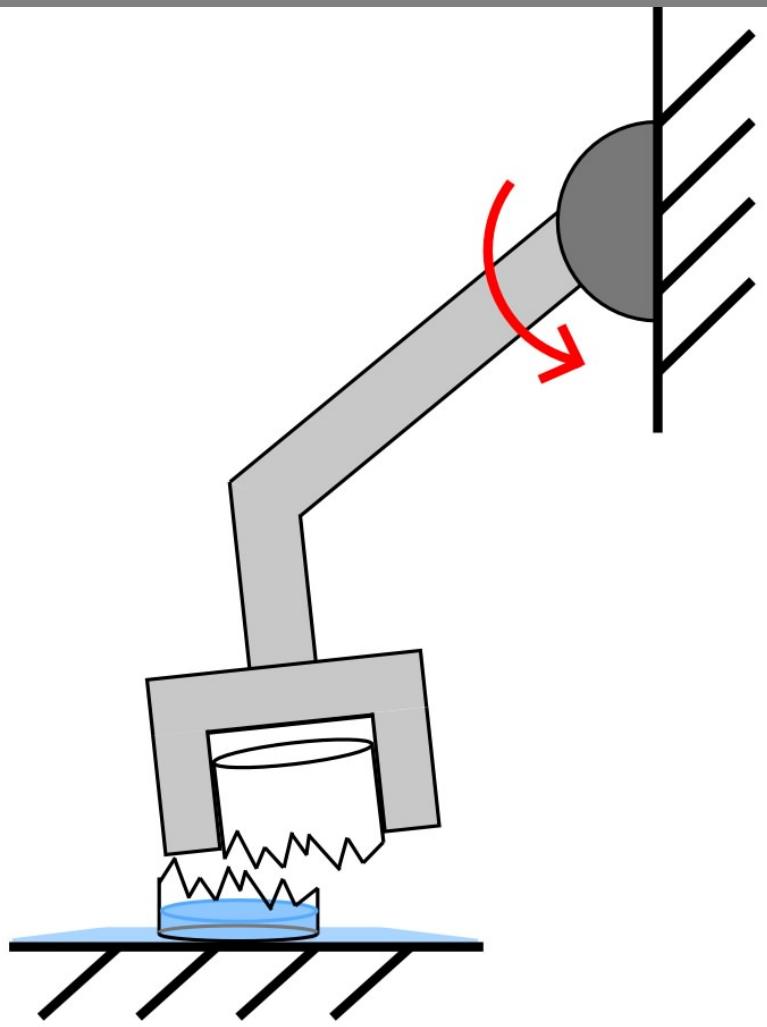
自由度の直感的イメージ



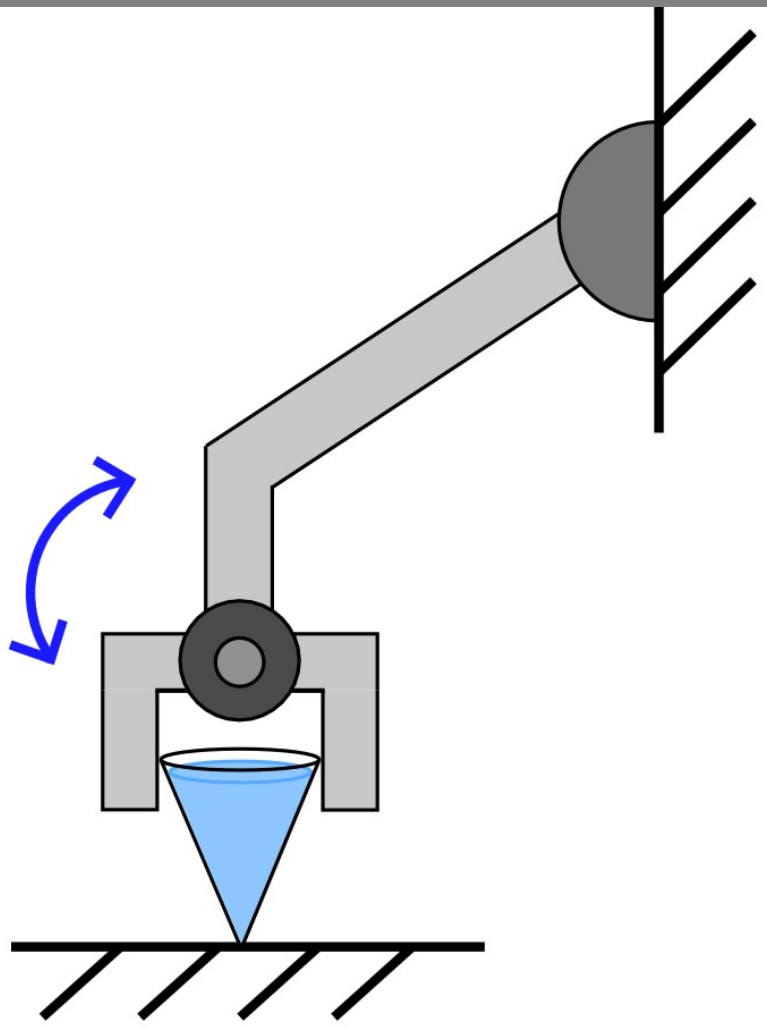
1自由度ロボット

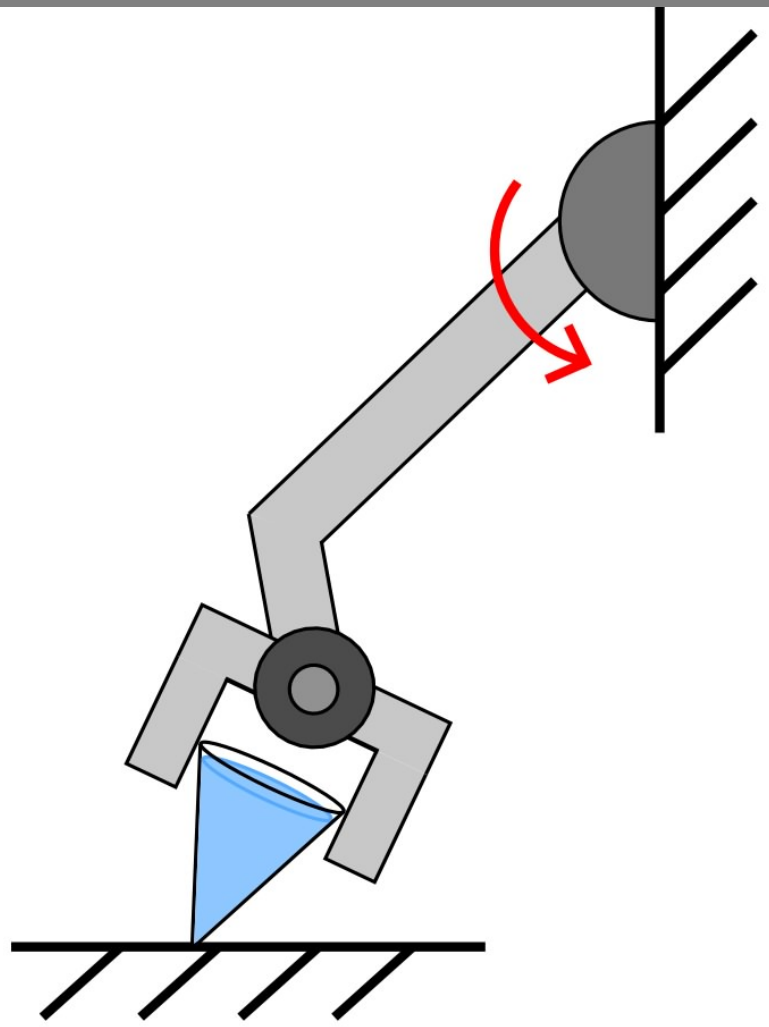
自由度の直感的イメージ





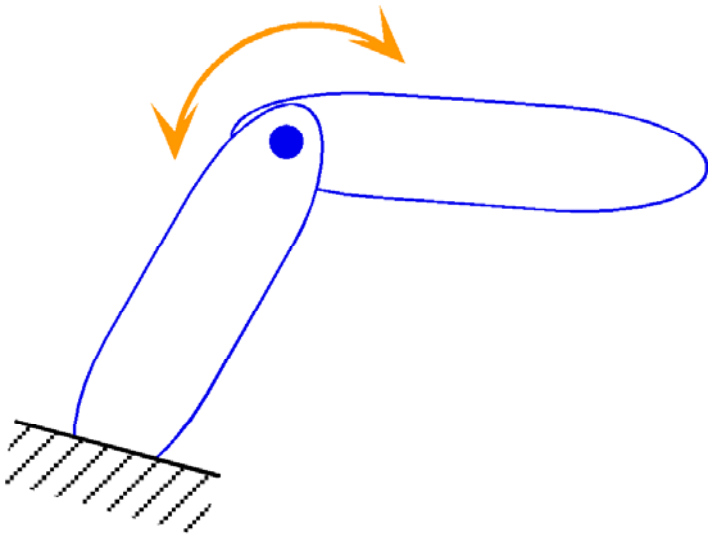
自由度の直感的イメージ



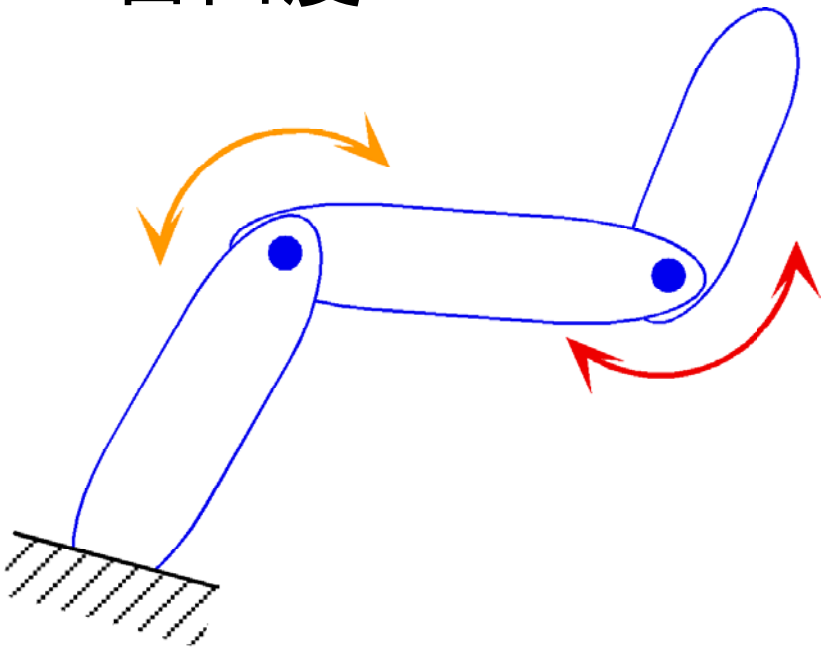


自由度の概念

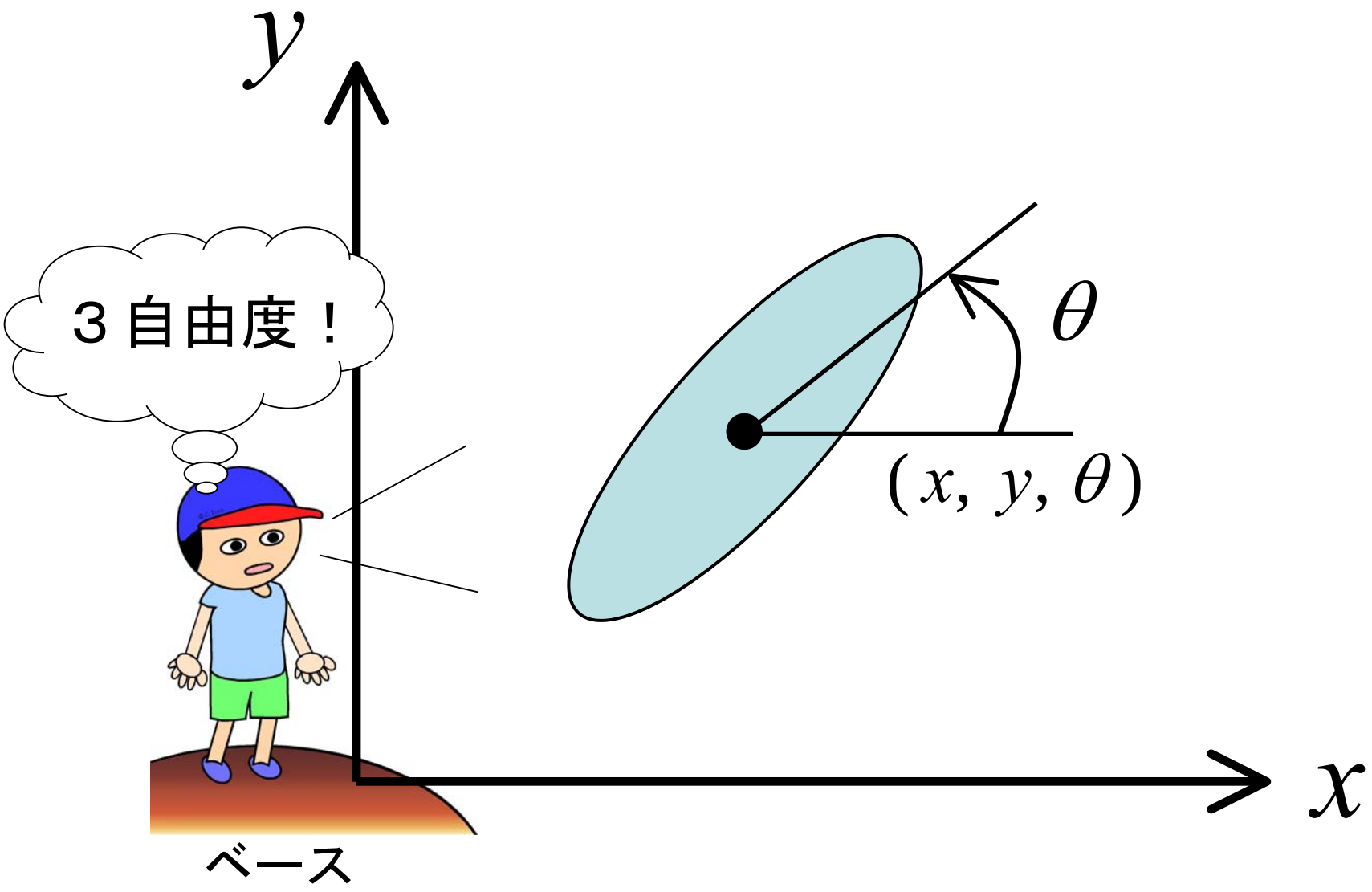
1自由度



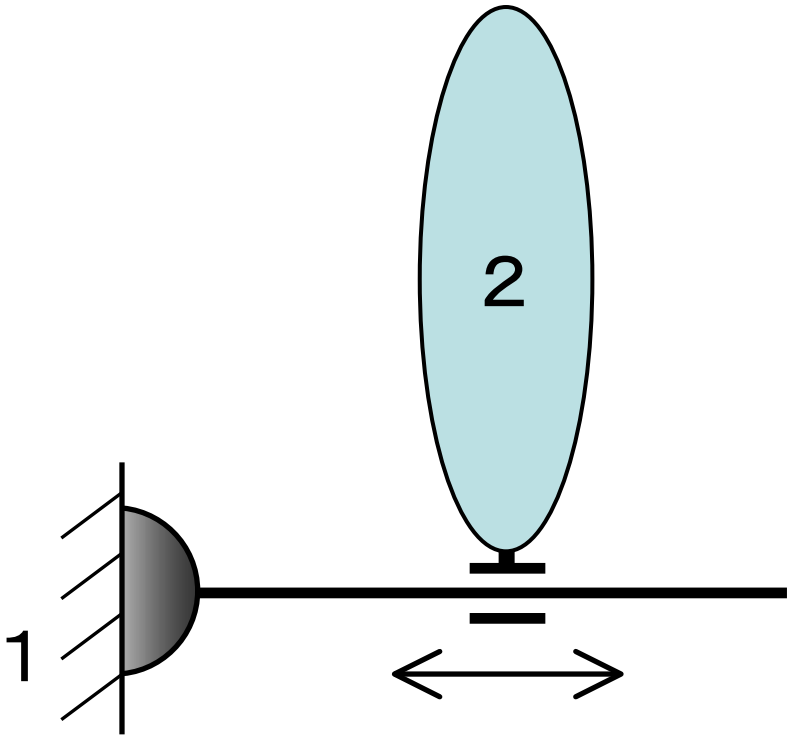
2自由度



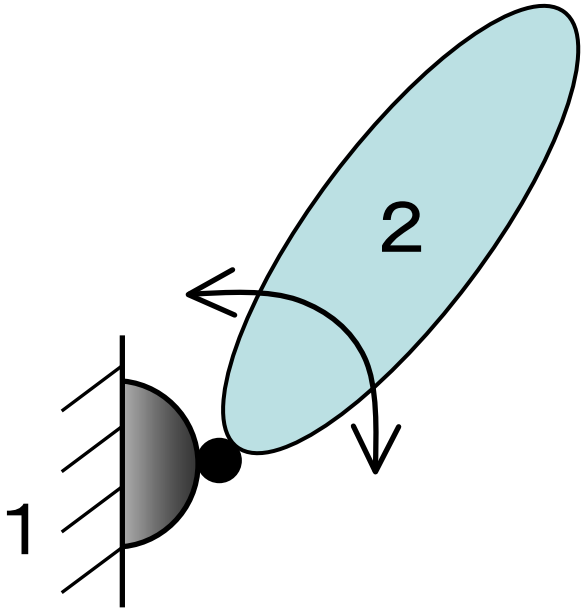
平面上に置かれた自由物体の自由度



平面機構の関節の自由度の種類

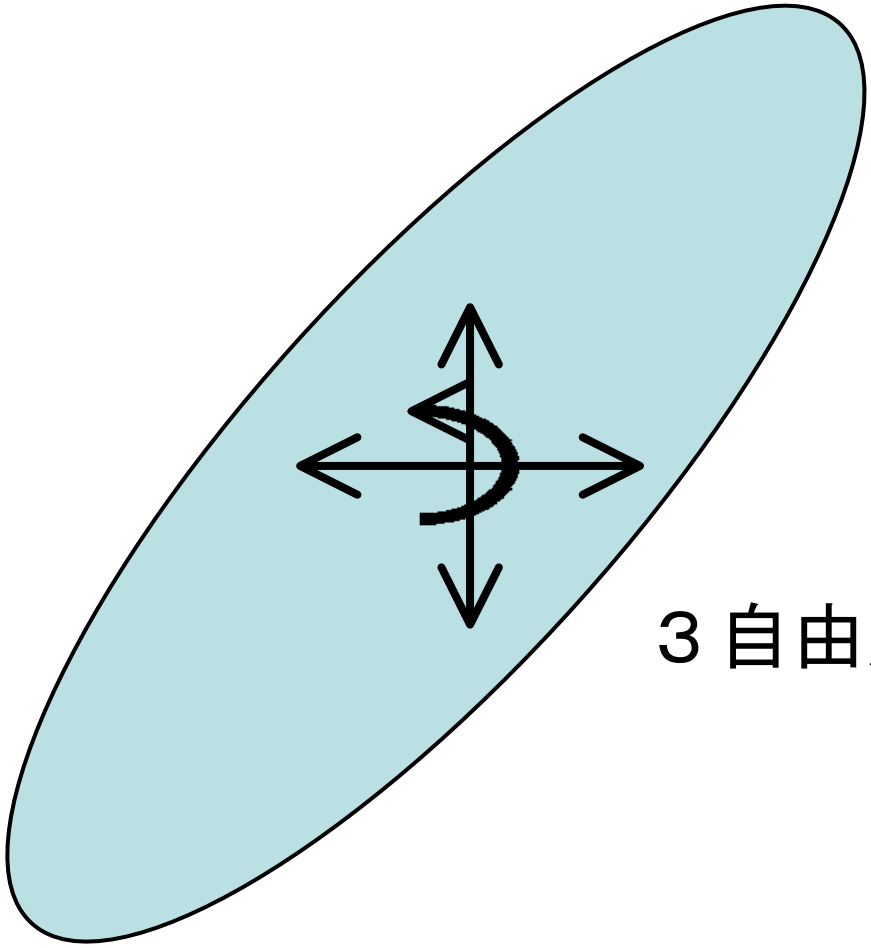


１自由度（並進）



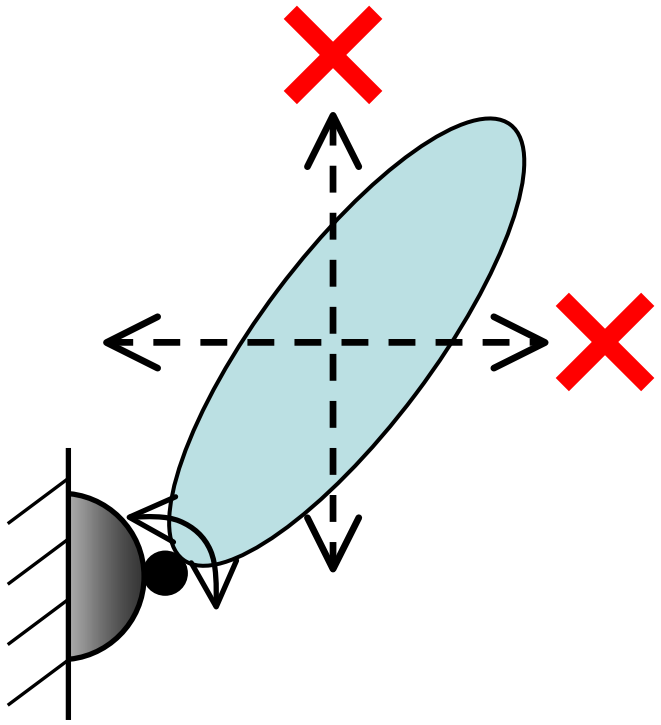
１自由度（回転）

自由度と拘束度との関係



３自由度

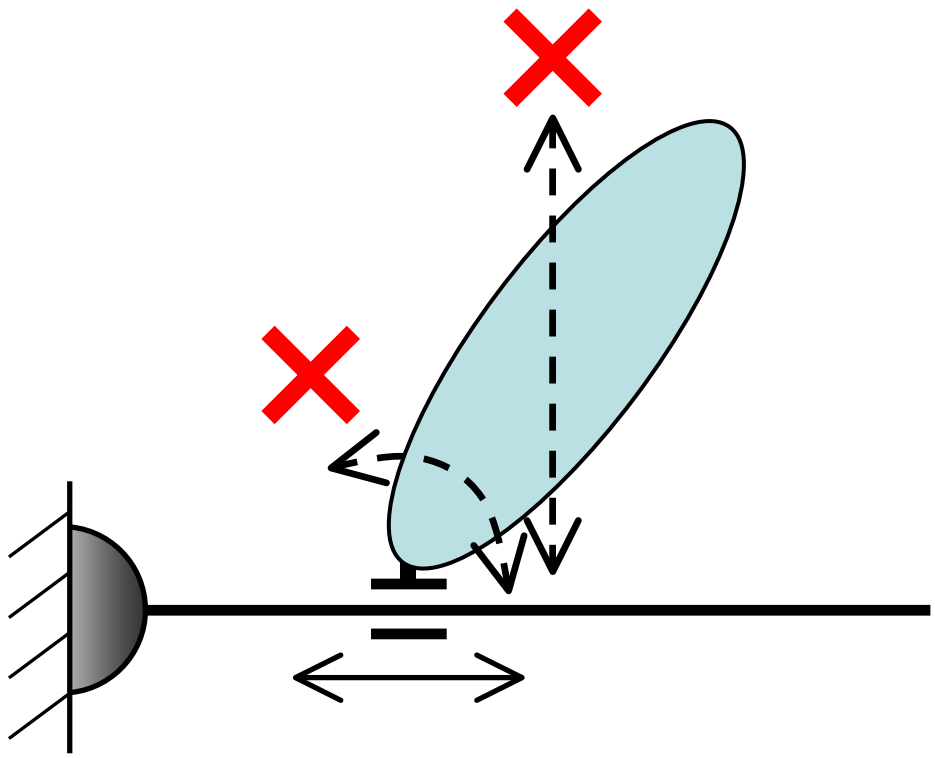
自由度と拘束度との関係



自由度：１（回転）

拘束度：２

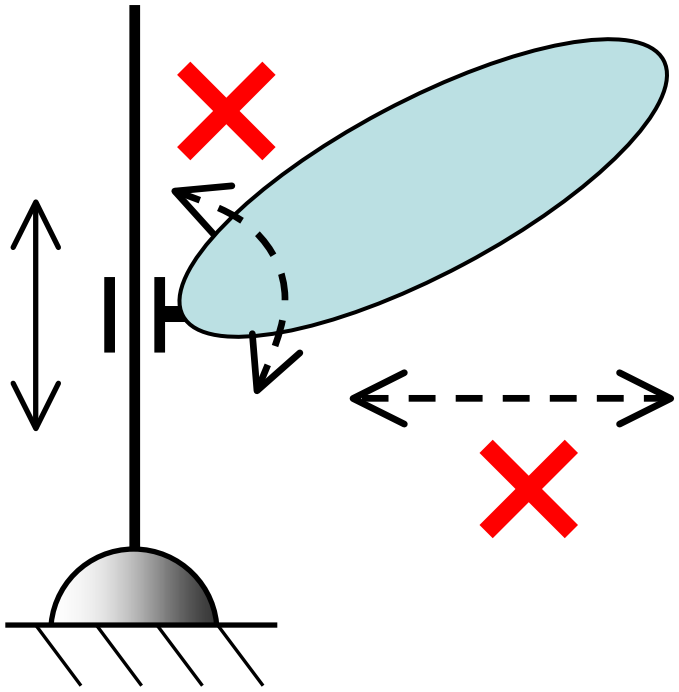
自由度と拘束度との関係



自由度：１（水平方向並進）

拘束度：２

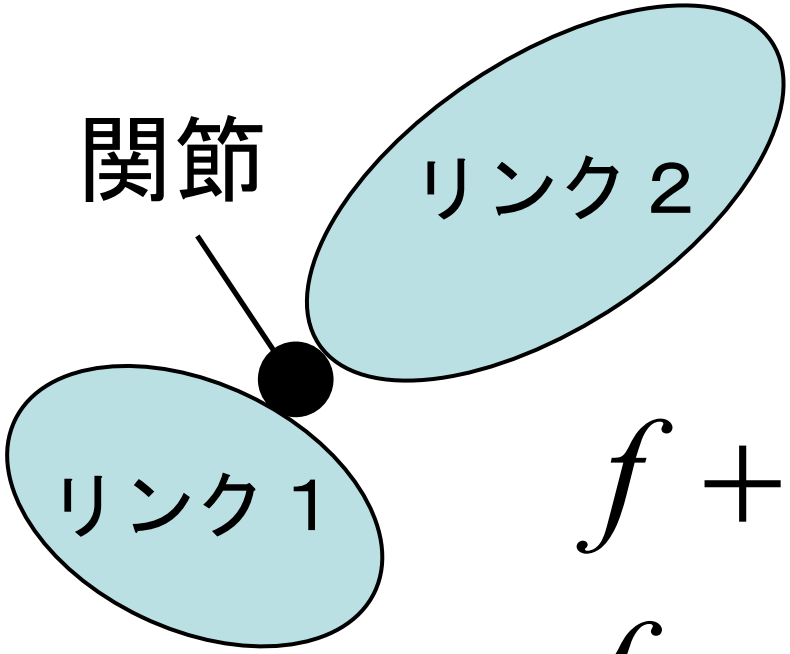
自由度と拘束度との関係



自由度：１（垂直方向並進）

拘束度：２

関節の自由度と拘束度との関係

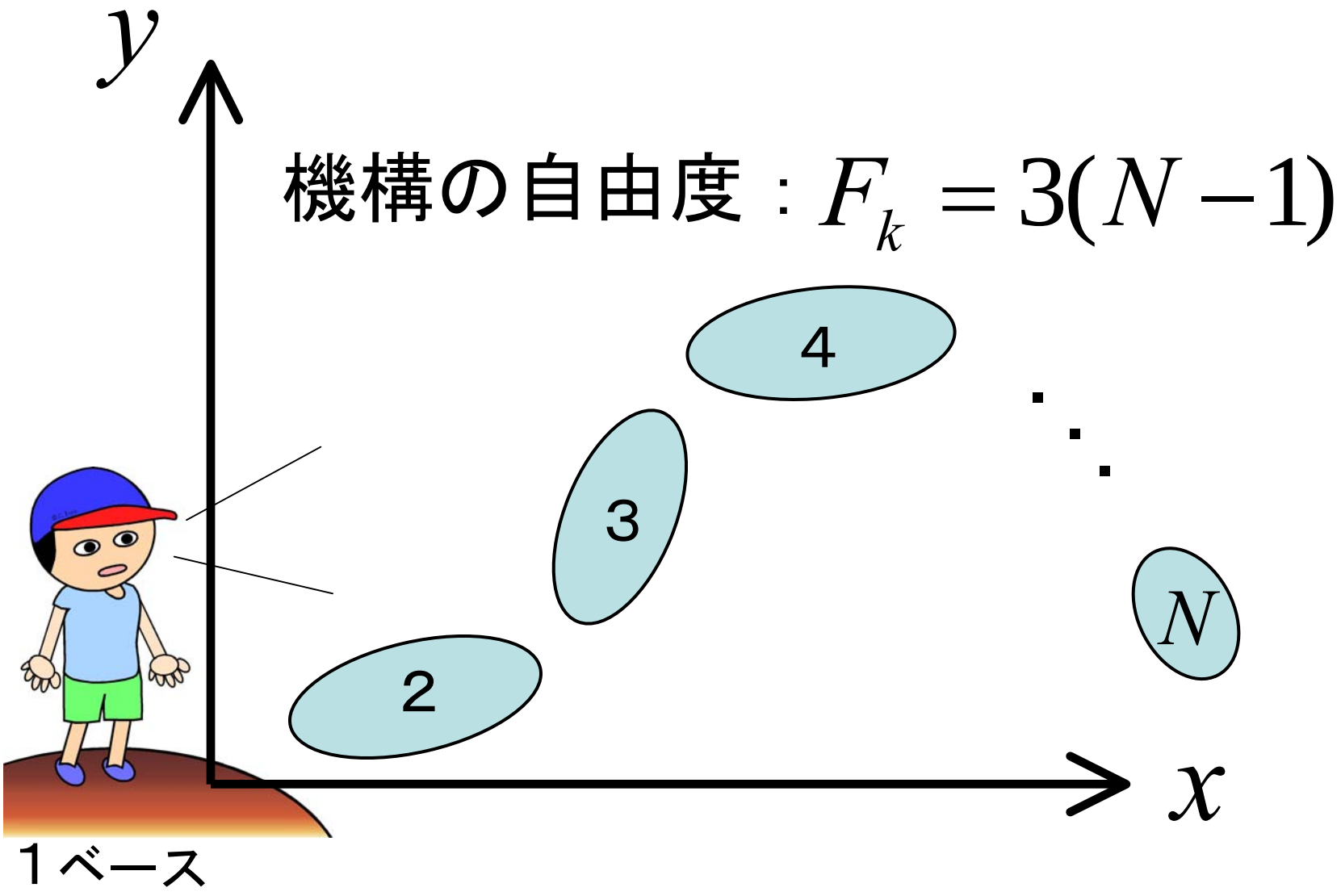


$$f + u = 3$$

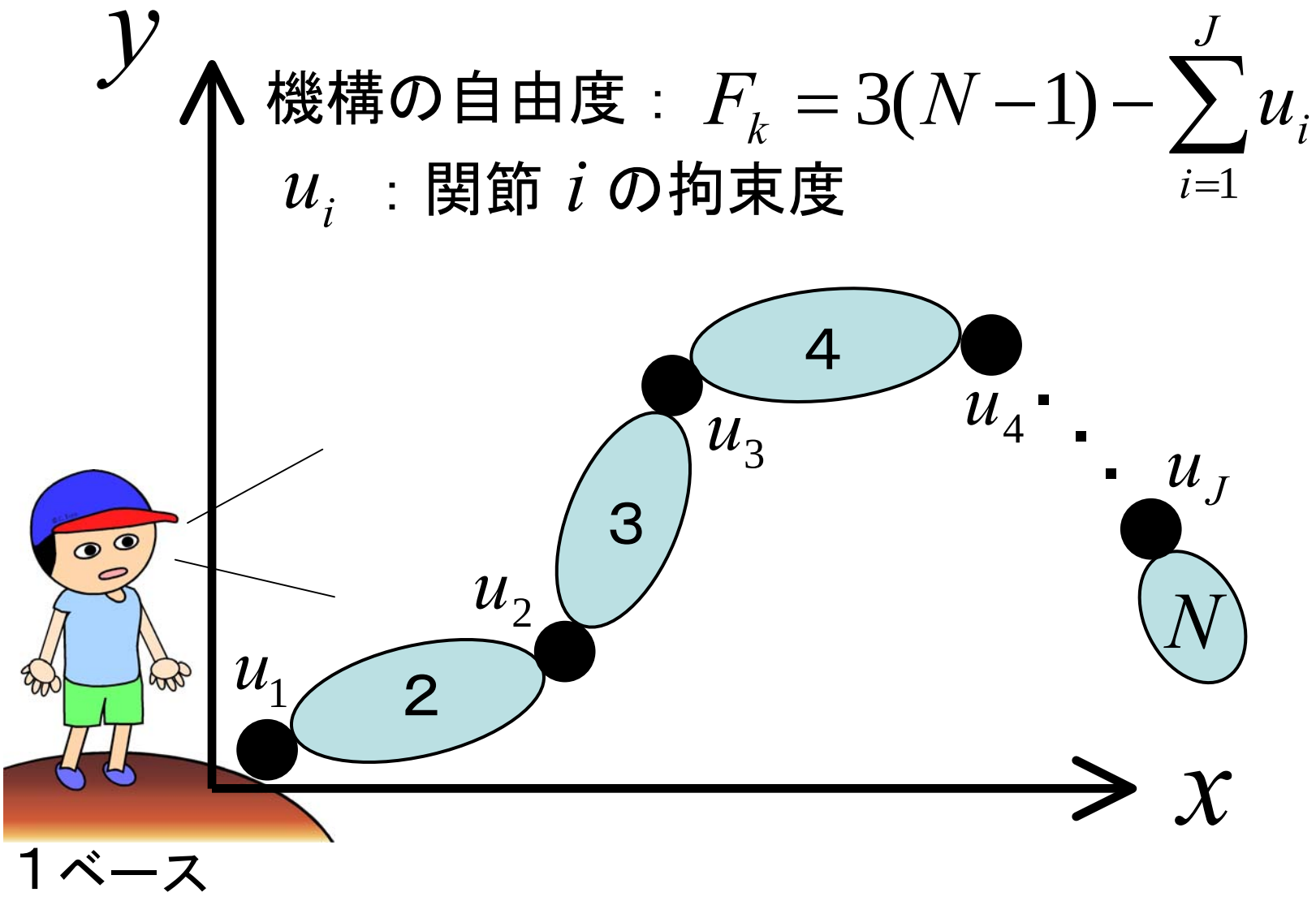
f ：自由度

u ：拘束度

リンクと関節が複数になったら？



リンクと関節が複数になったら？

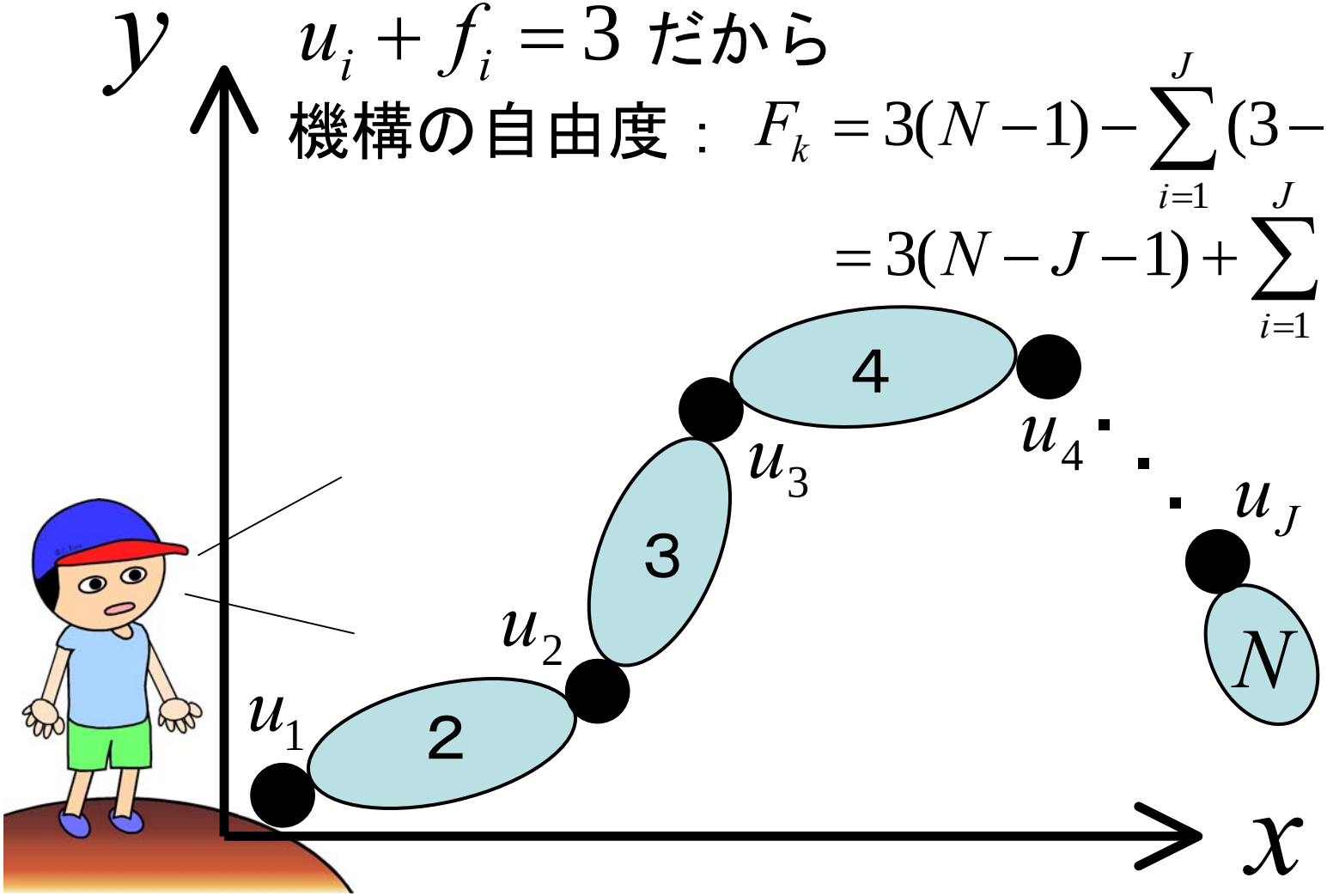


リンクと関節が複数になったら？

$u_i + f_i = 3$ だから

機構の自由度： $F_k = 3(N-1) - \sum_{i=1}^{J}(3-f_i)$

$= 3(N-J-1) + \sum_{i=1}^{J} f_i$

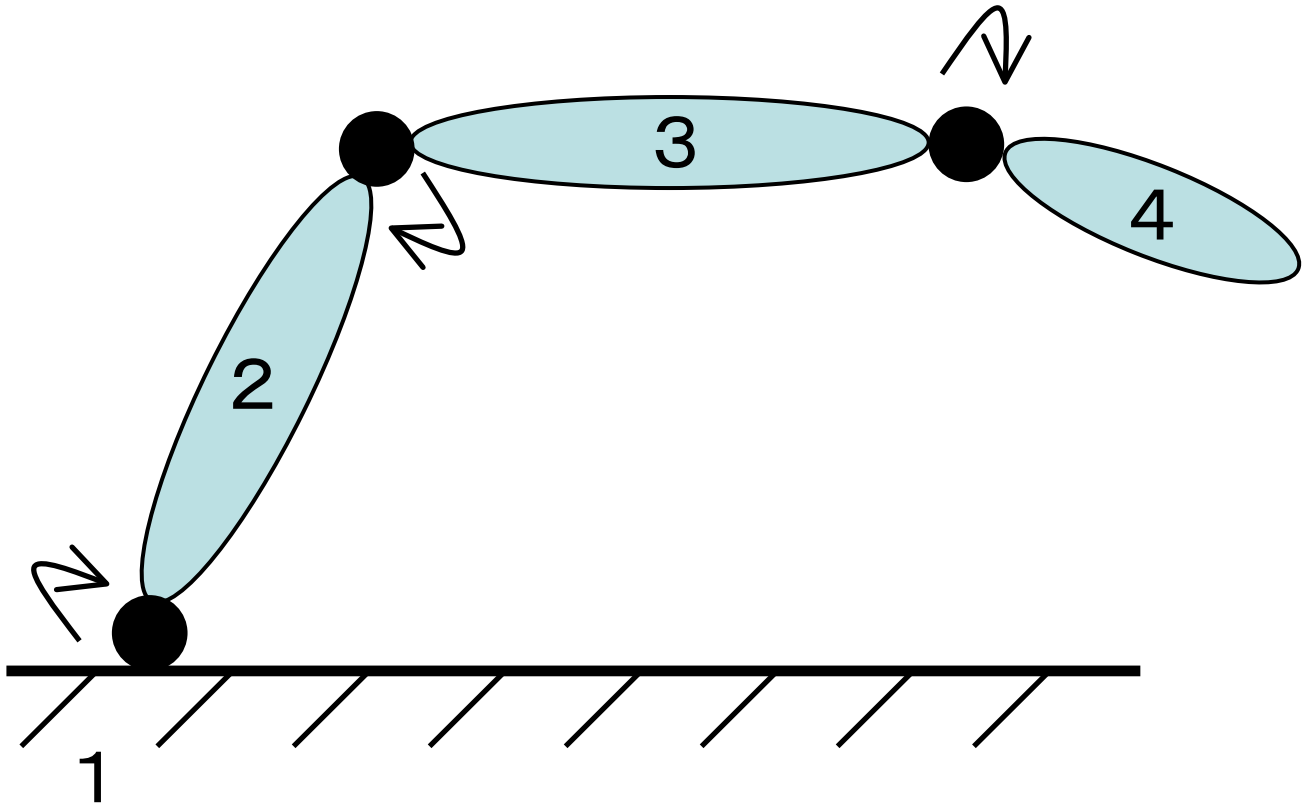


例題1

$N = 4\ ,\ J = 3$

$f_1 = f_2 = f_3 = 1$

$F_k = 3$

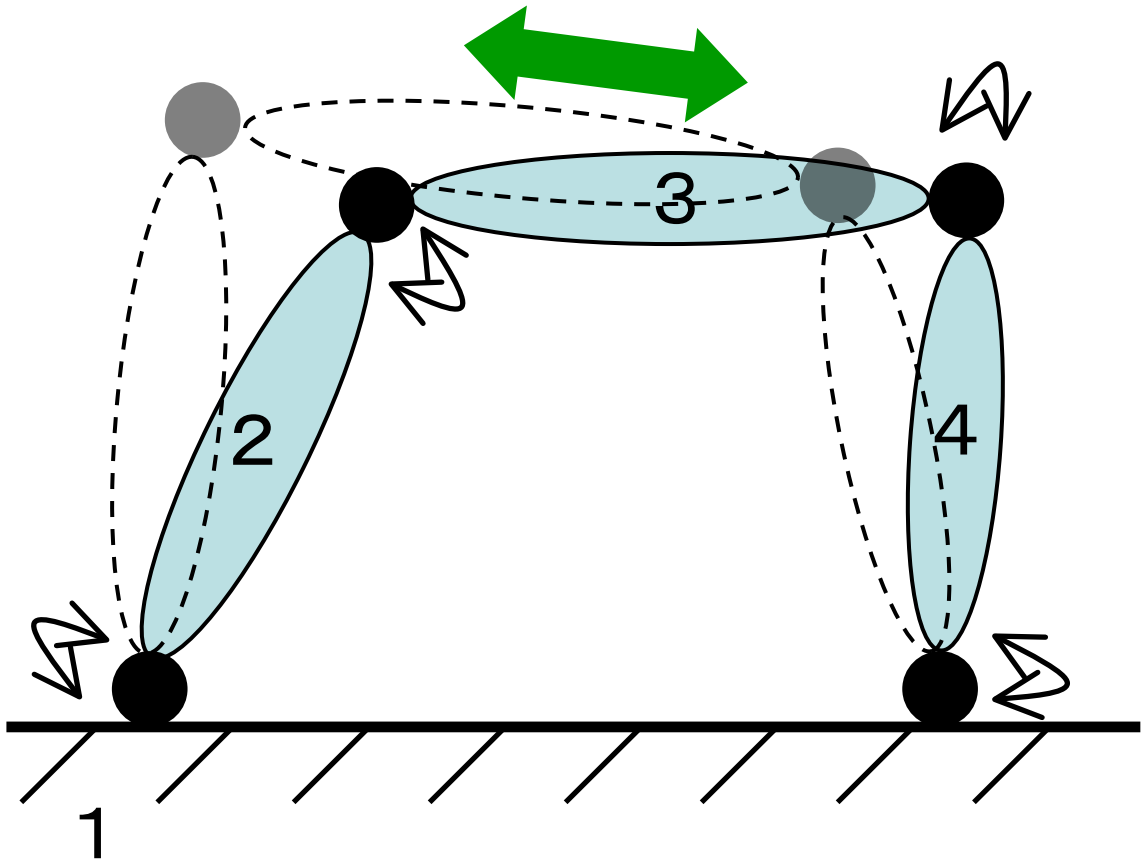


例題2

$$N = 4\ ,\ J = 4$$

$$f_1 = f_2 = f_3 = f_4 = 1$$

$$F_k = 1$$

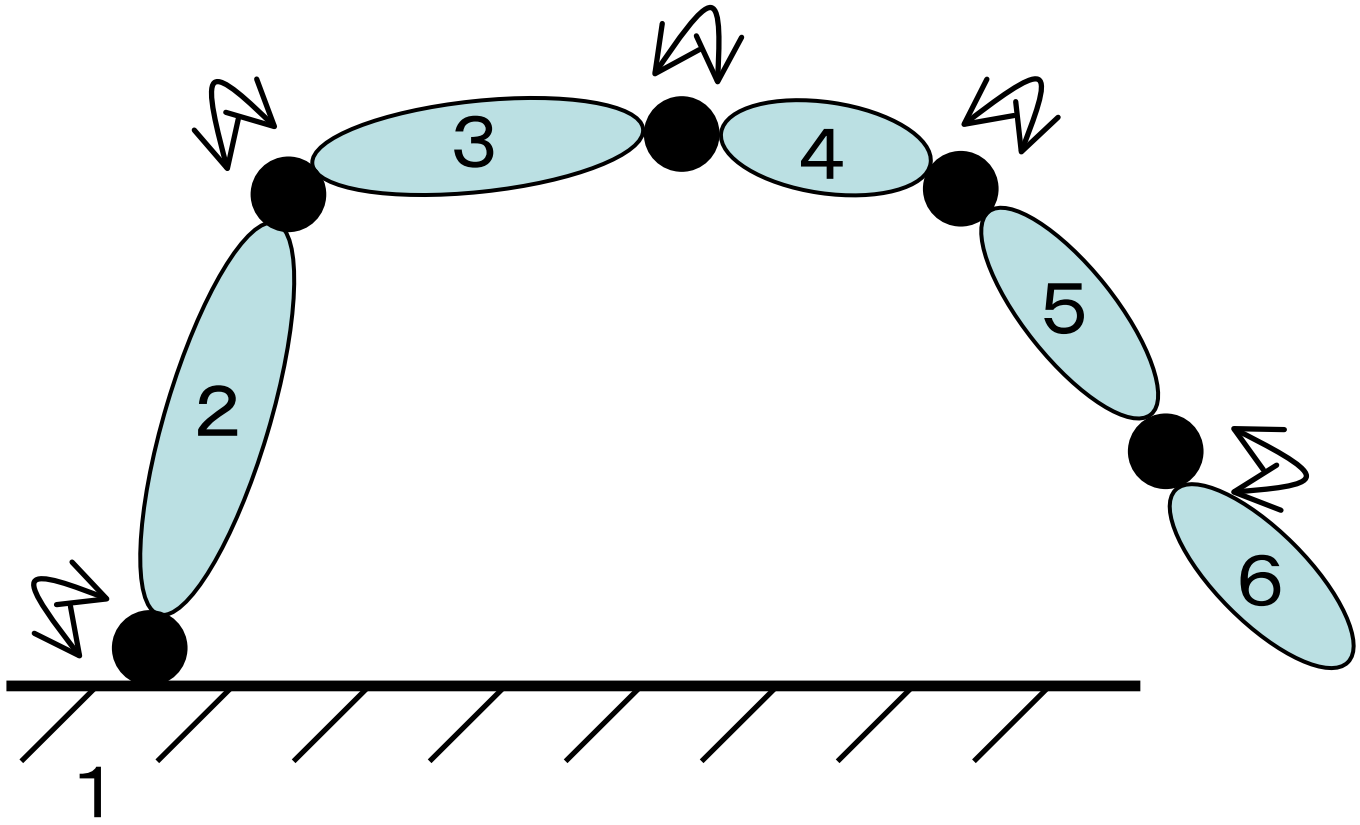


例題3

$N=6\ ,\ J=5$

$f_1=\cdots f_5=1$

$F_k=5$

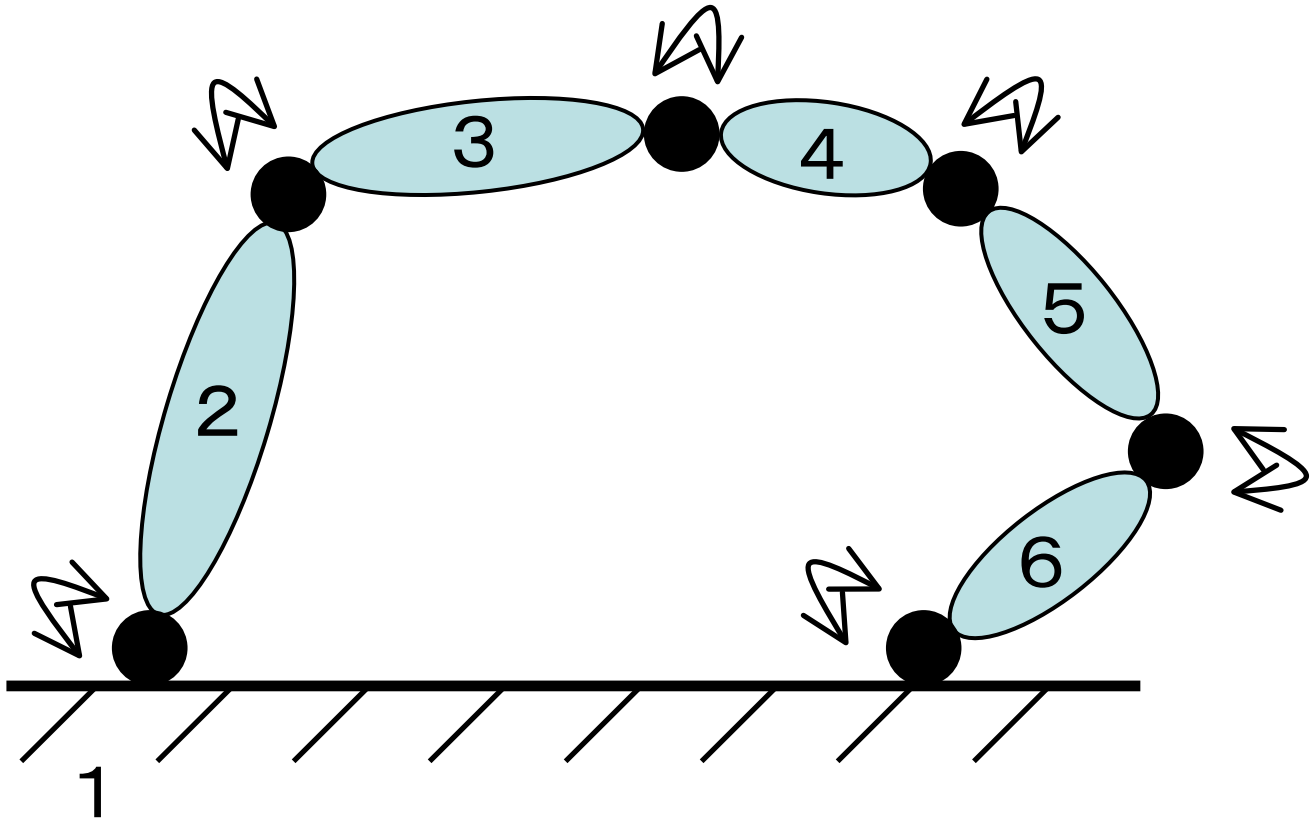


例題4

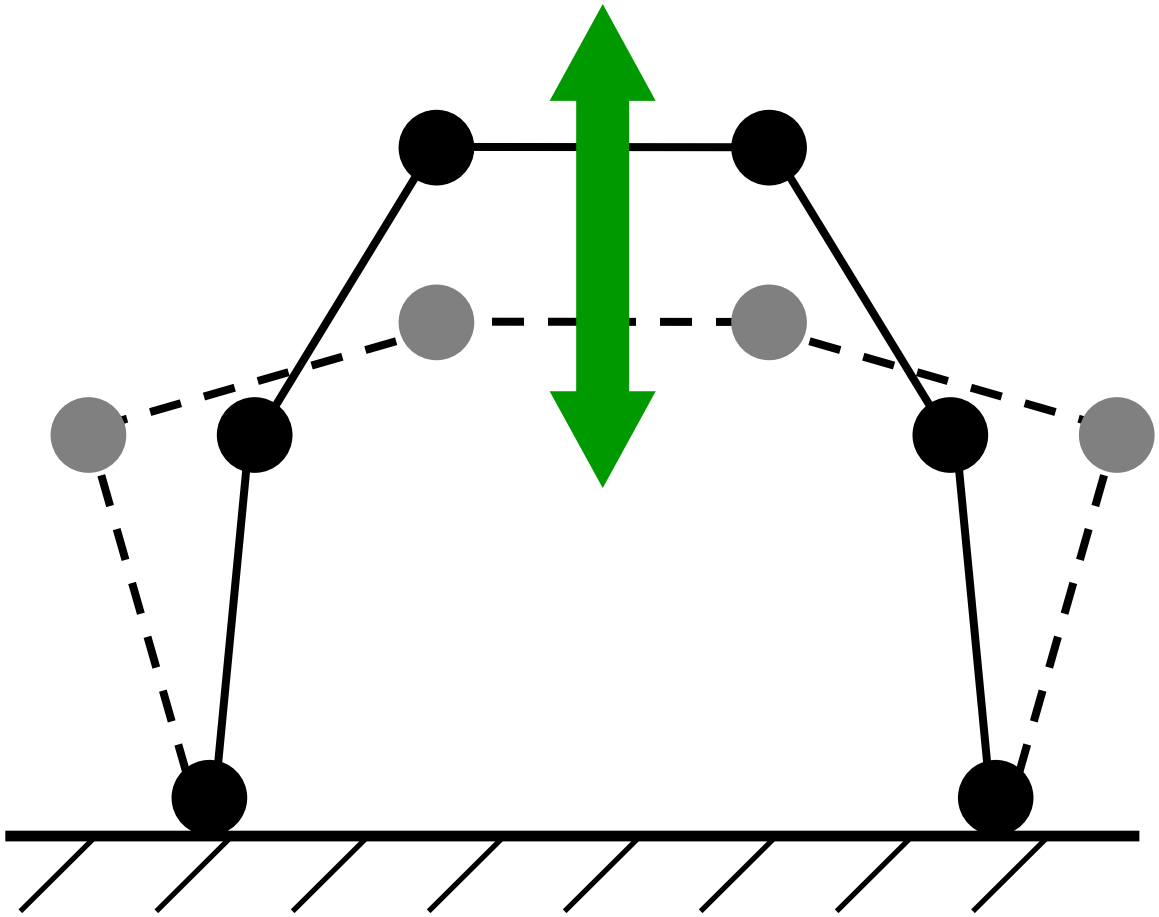
$N = 6\ ,\ J = 6$

$f_1 = \cdots f_6 = 1$

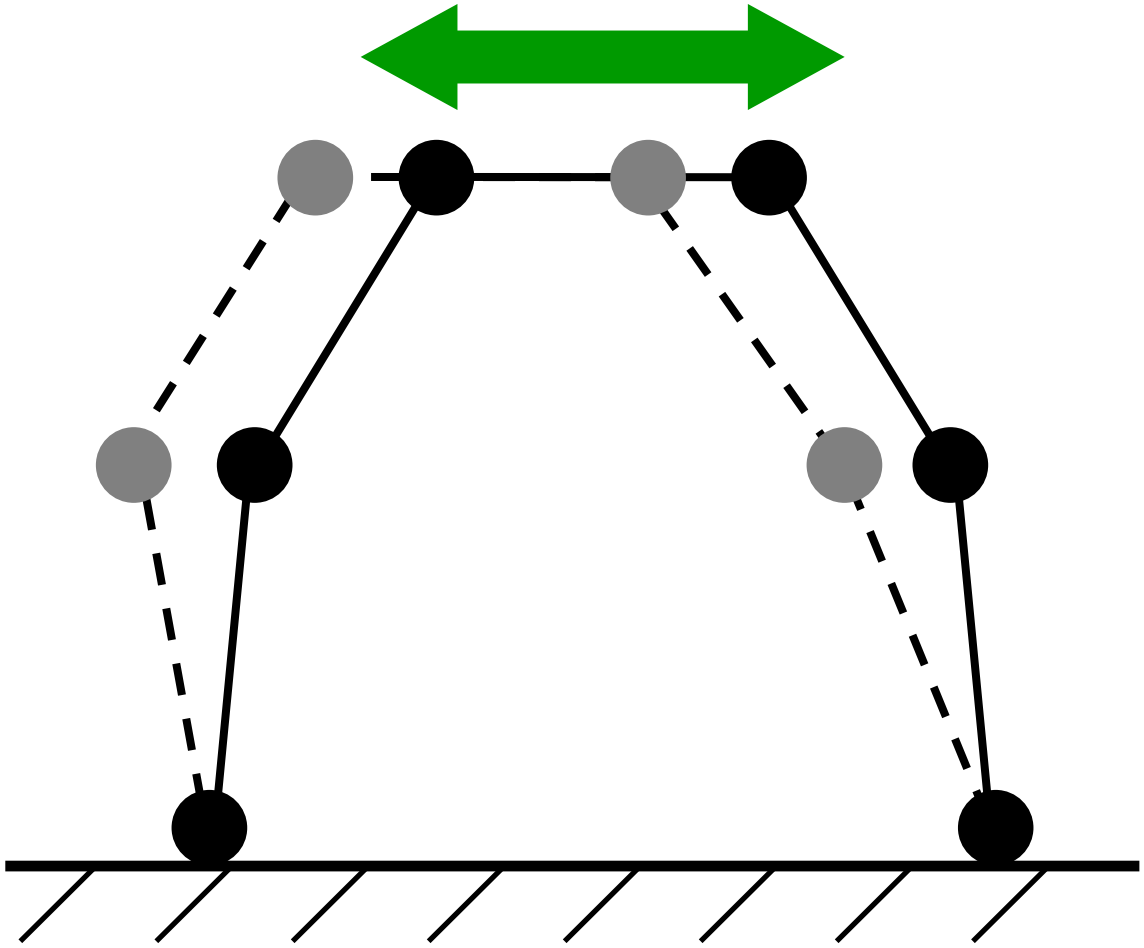
$F_k = 3$



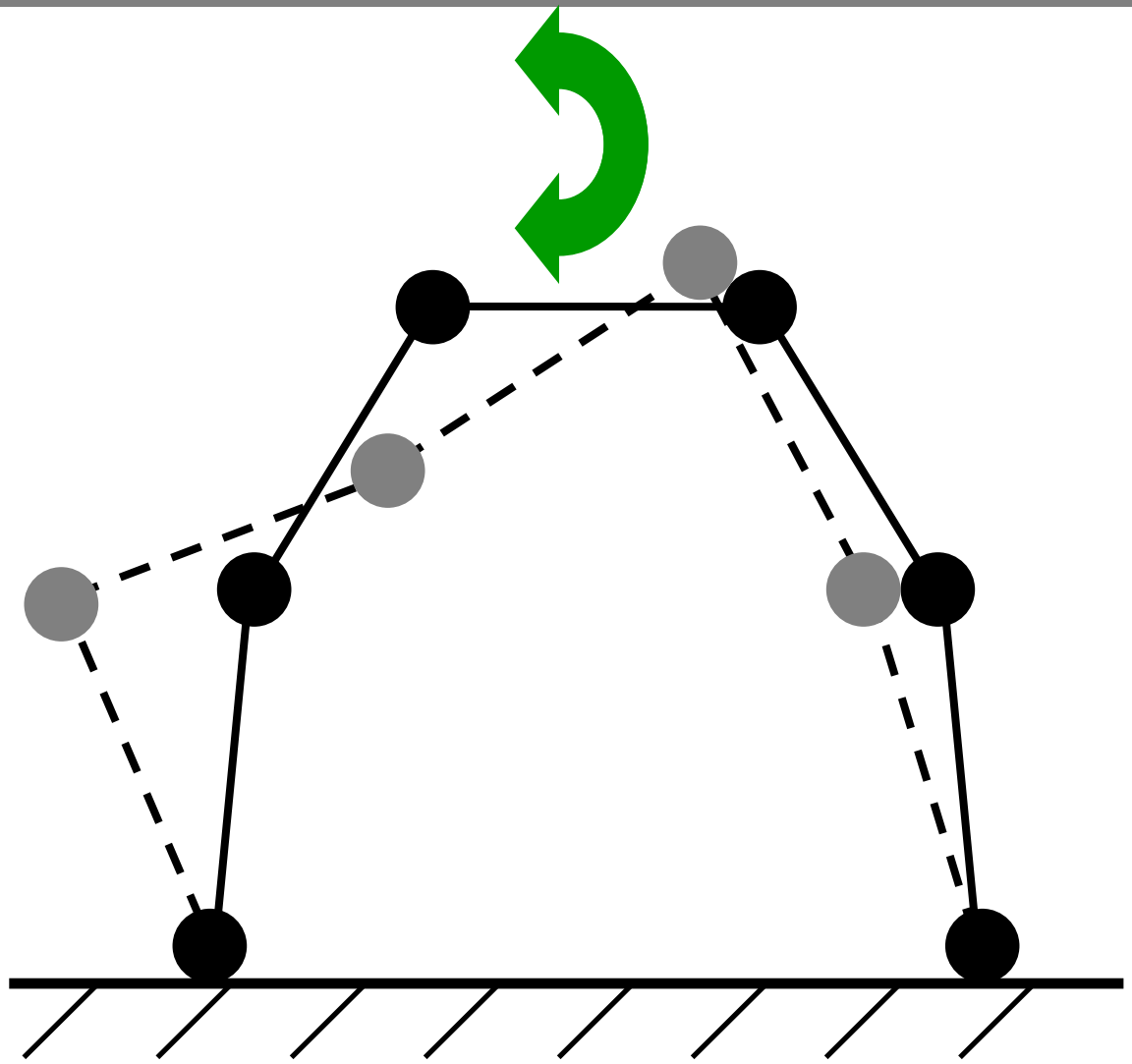
$F_k = 3$ の物理的意味



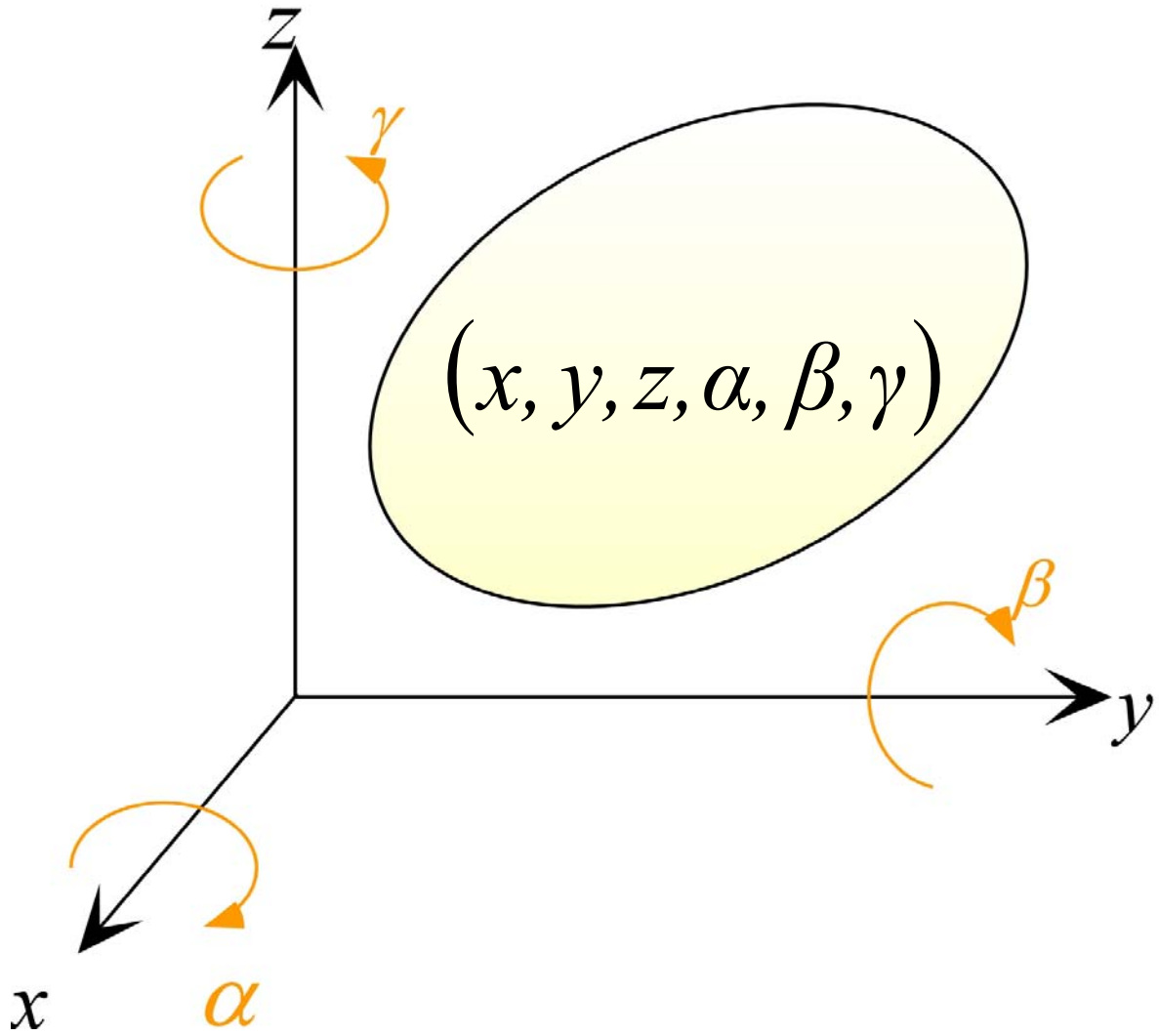
$F_k = 3$ の物理的意味



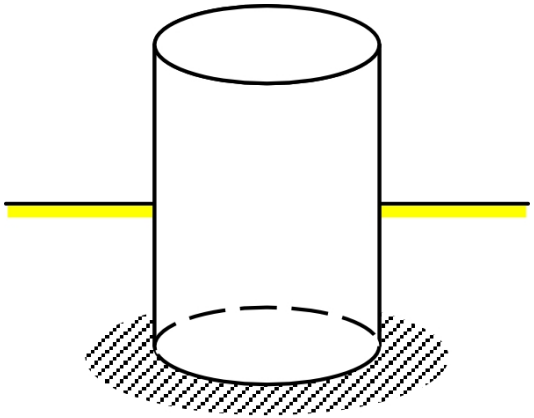
$F_k = 3$ の物理的意味



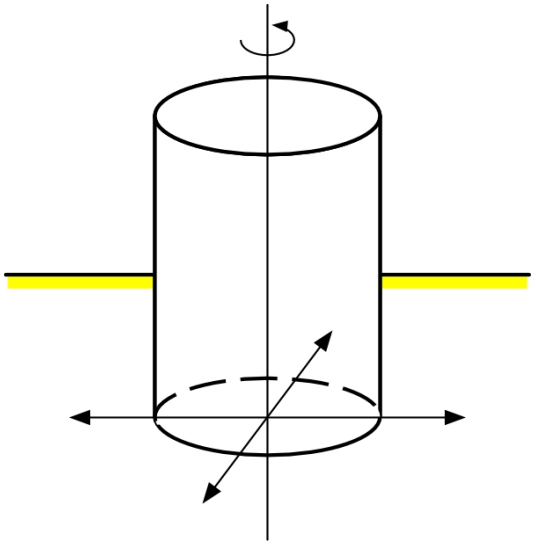
3次元空間に置かれた物体の自由度



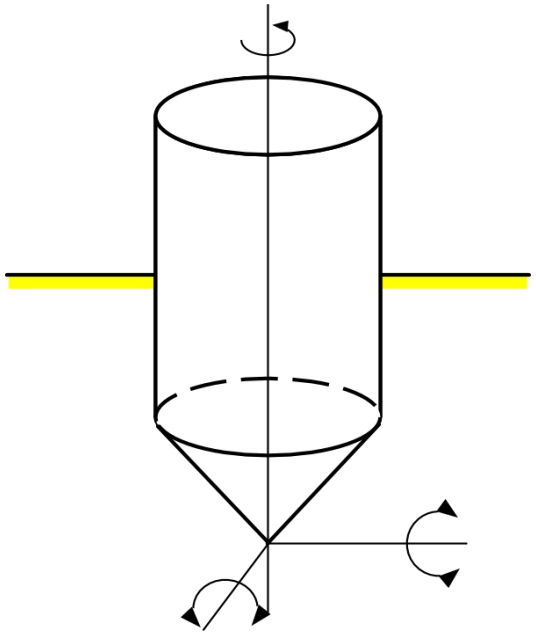
3次元2物体の接触点での自由度



0自由度
6拘束度

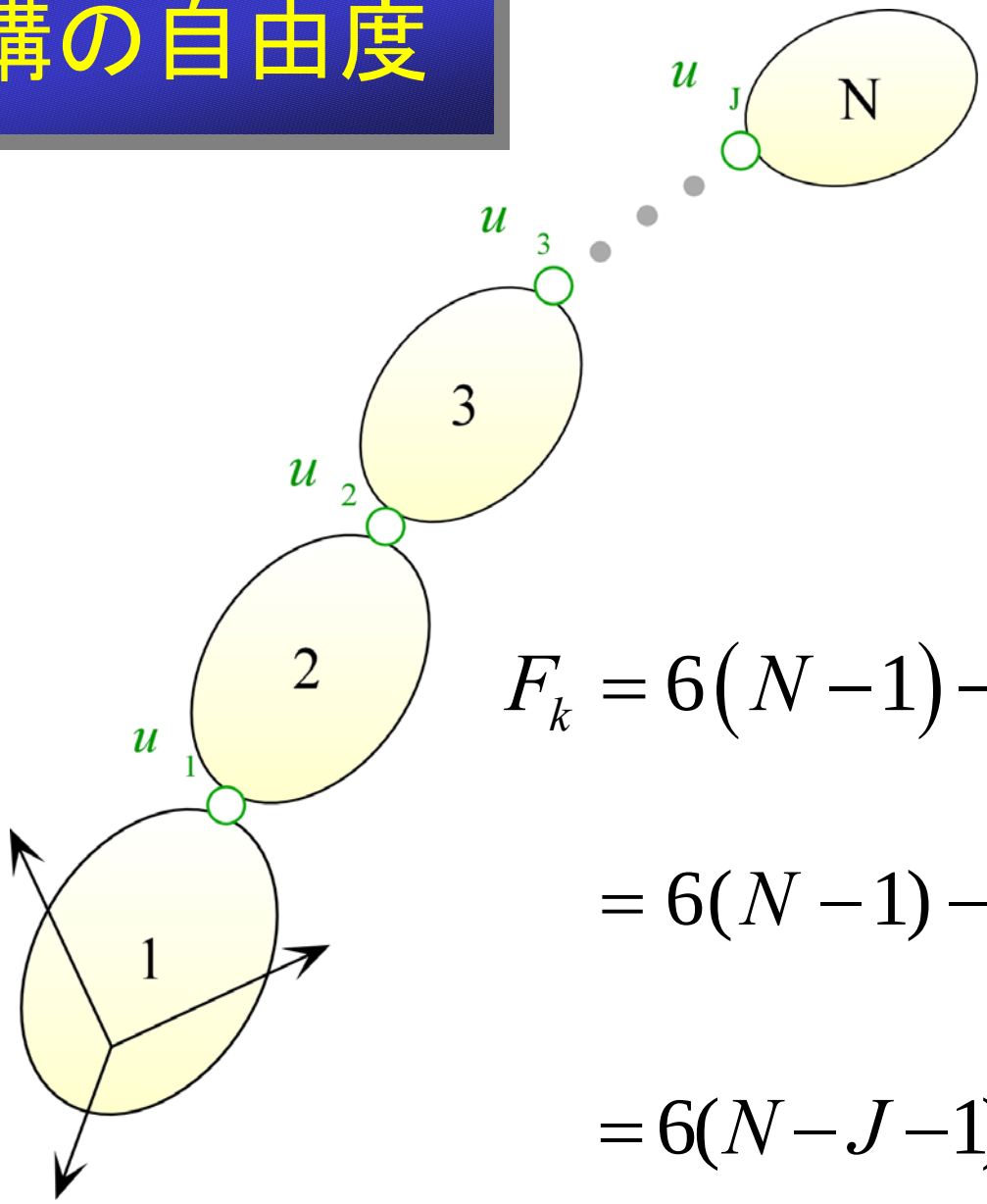


3自由度
3拘束度



3自由度
3拘束度

空間機構の自由度



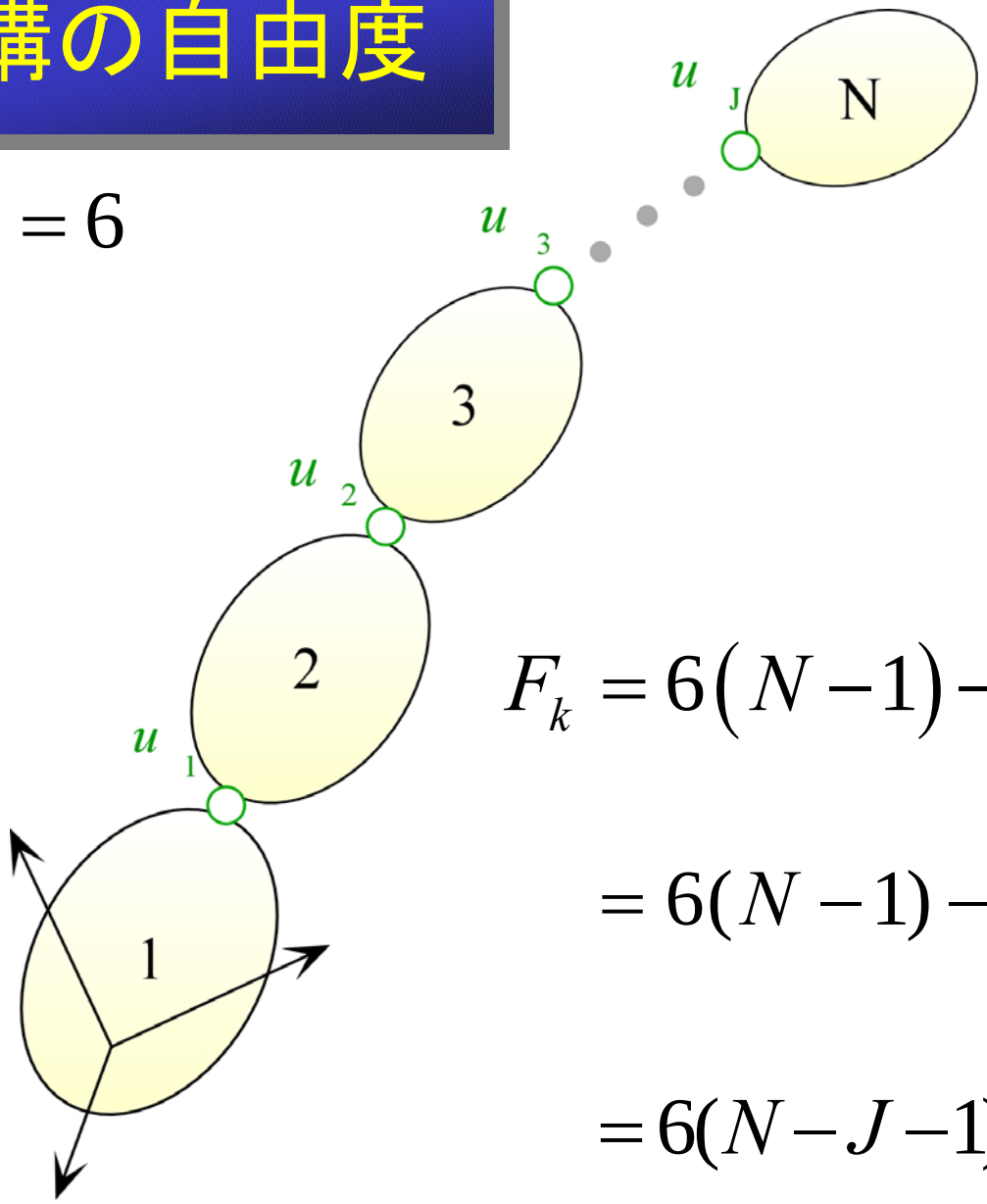
$$F_k = 6(N-1) - \sum_{i=1}^{J} u_i$$

$$= 6(N-1) - \sum_{i=1}^{J} (6 - f_i)$$

$$= 6(N-J-1) + \sum_{i=1}^{J} f_i$$

空間機構の自由度

$$f_i + u_i = 6$$

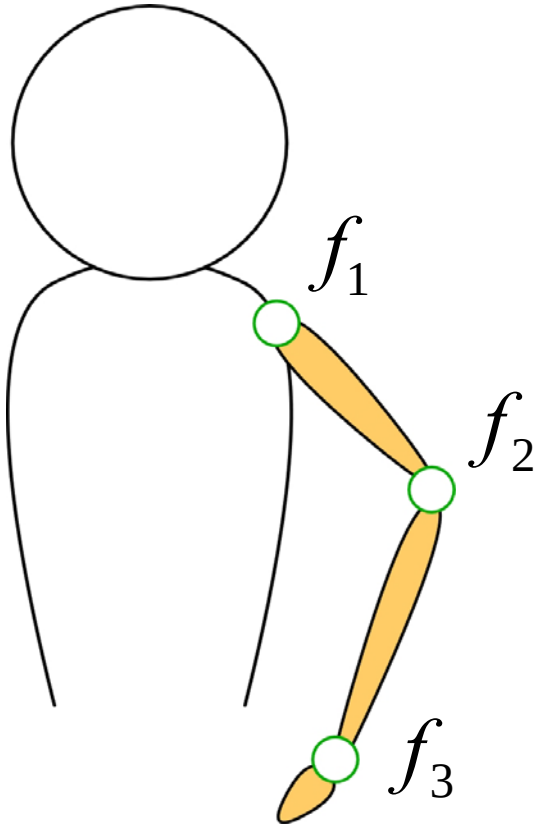


$$F_k = 6(N-1) - \sum_{i=1}^{J} u_i$$

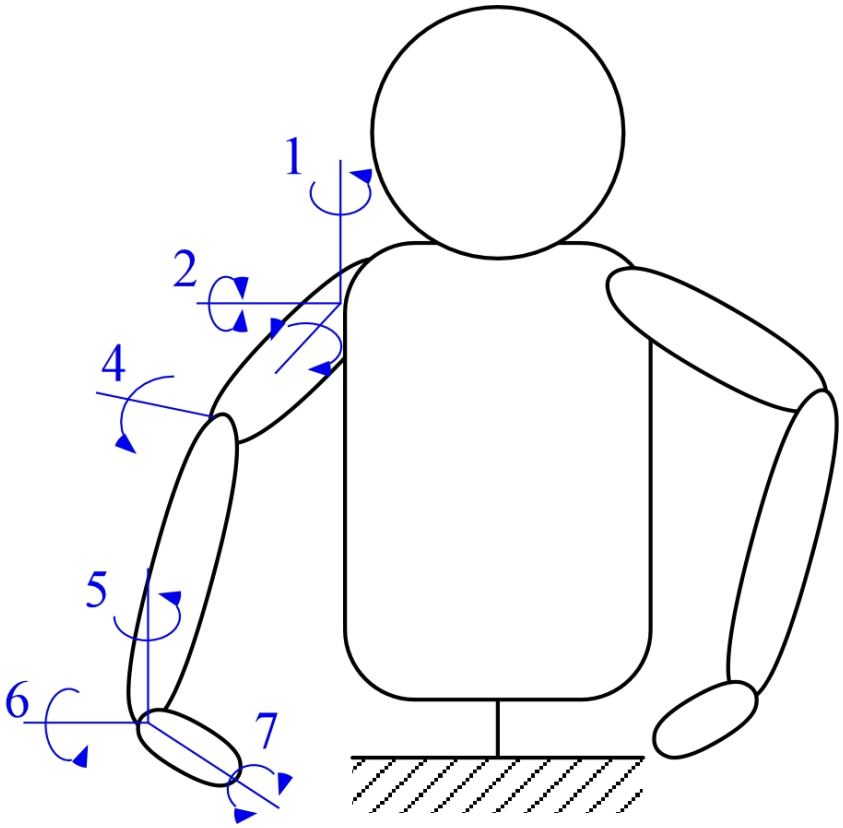
$$= 6(N-1) - \sum_{i=1}^{J} (6 - f_i)$$

$$= 6(N-J-1) + \sum_{i=1}^{J} f_i$$

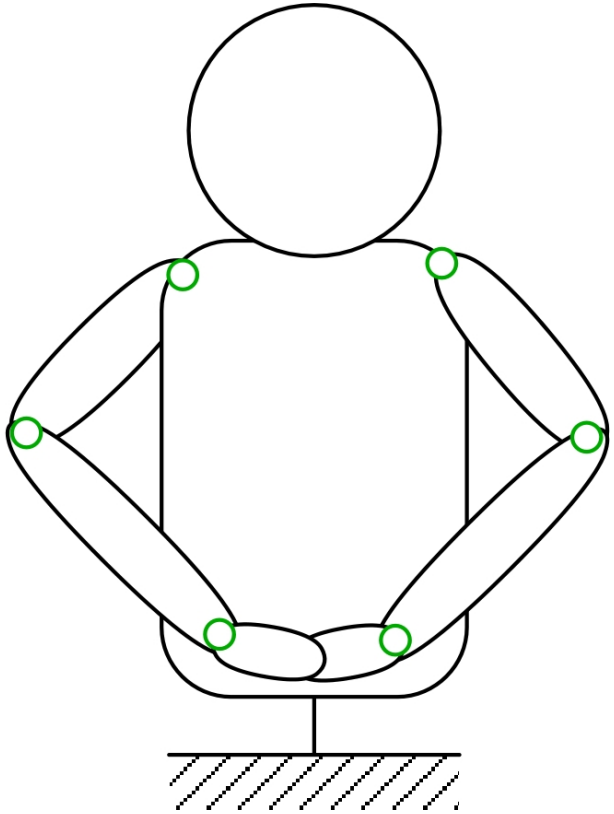
空間機構の自由度（例題１）



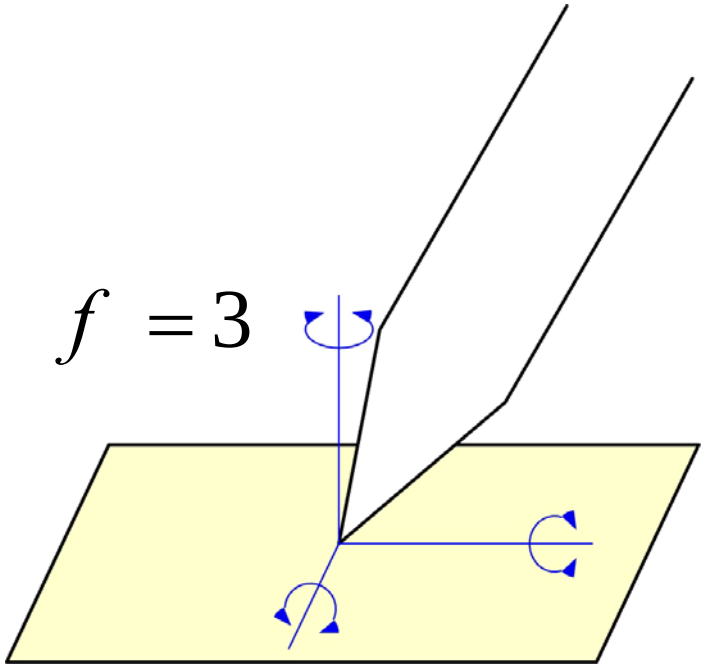
空間機構の自由度（例題2）

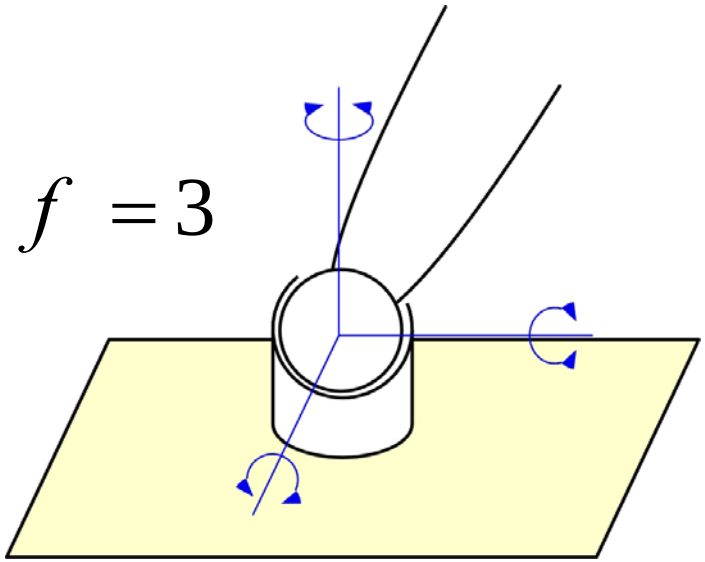


空間機構の自由度（例題3）

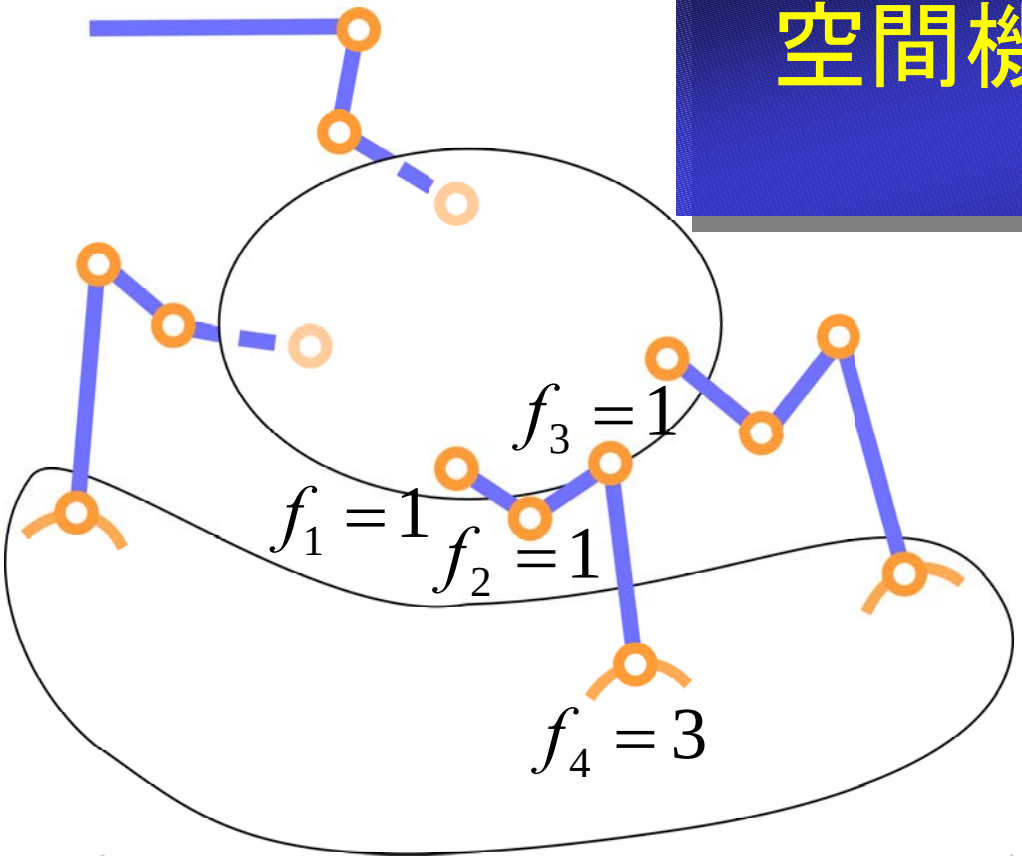


ロボットの足先（指先）と地面との自由度





空間機構の自由度
課題4



９自由度
の意味は？

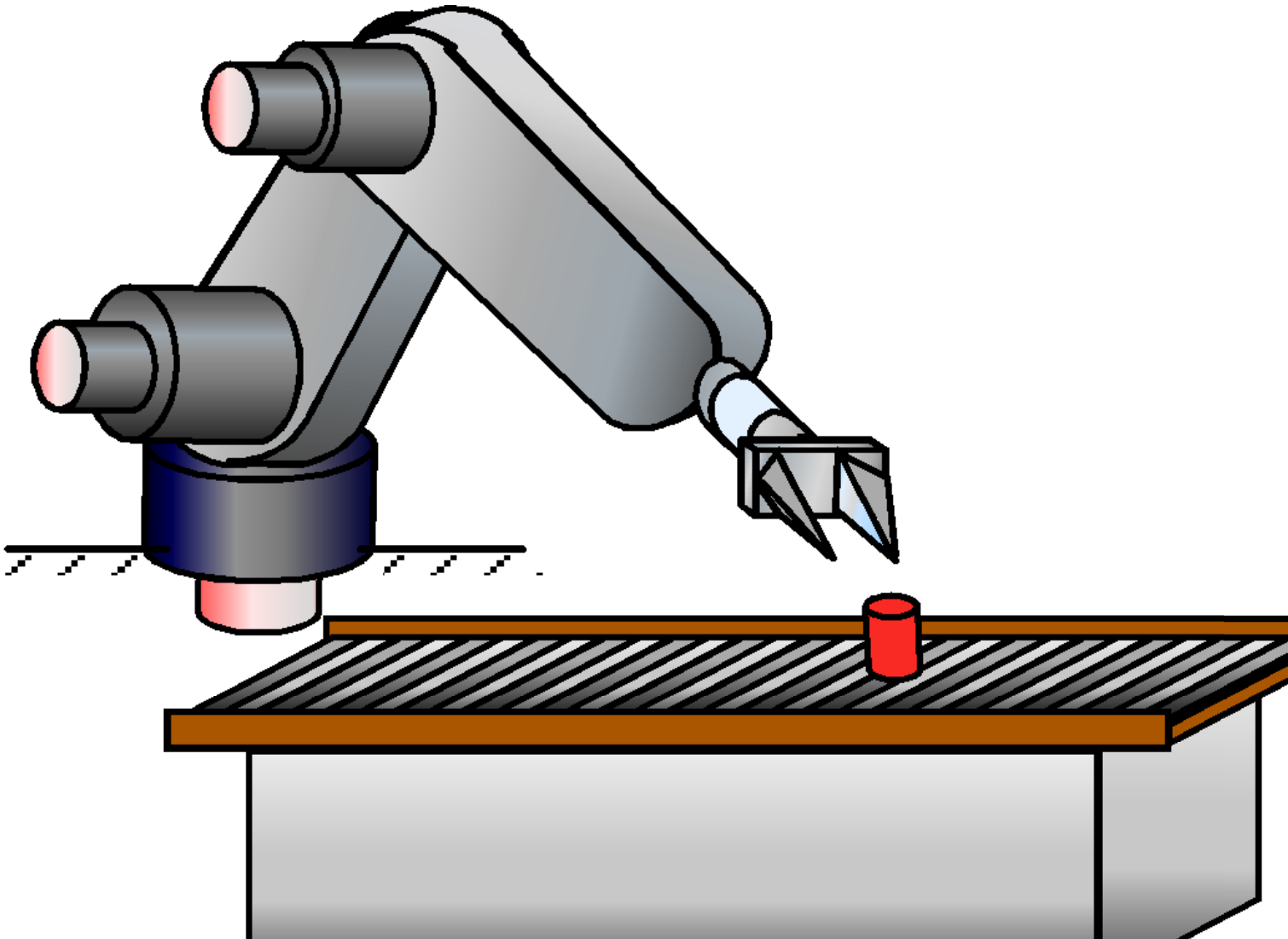
$$N = 14 \quad J = 4 \times 3 + 3 = 15$$

$$F_k = 6 \times (14 - 15 - 1) + \sum f_i$$

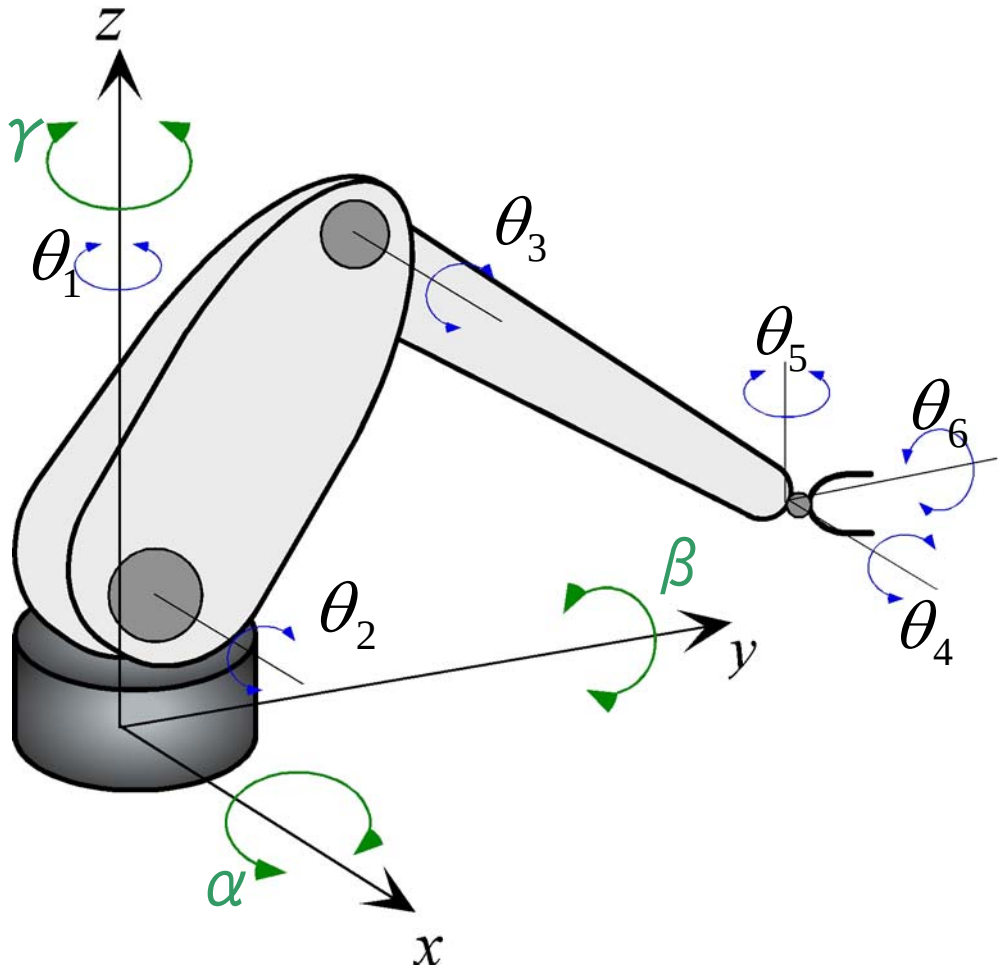
$$= -12 + (6 \times 3 + 3)$$

$$= 9$$

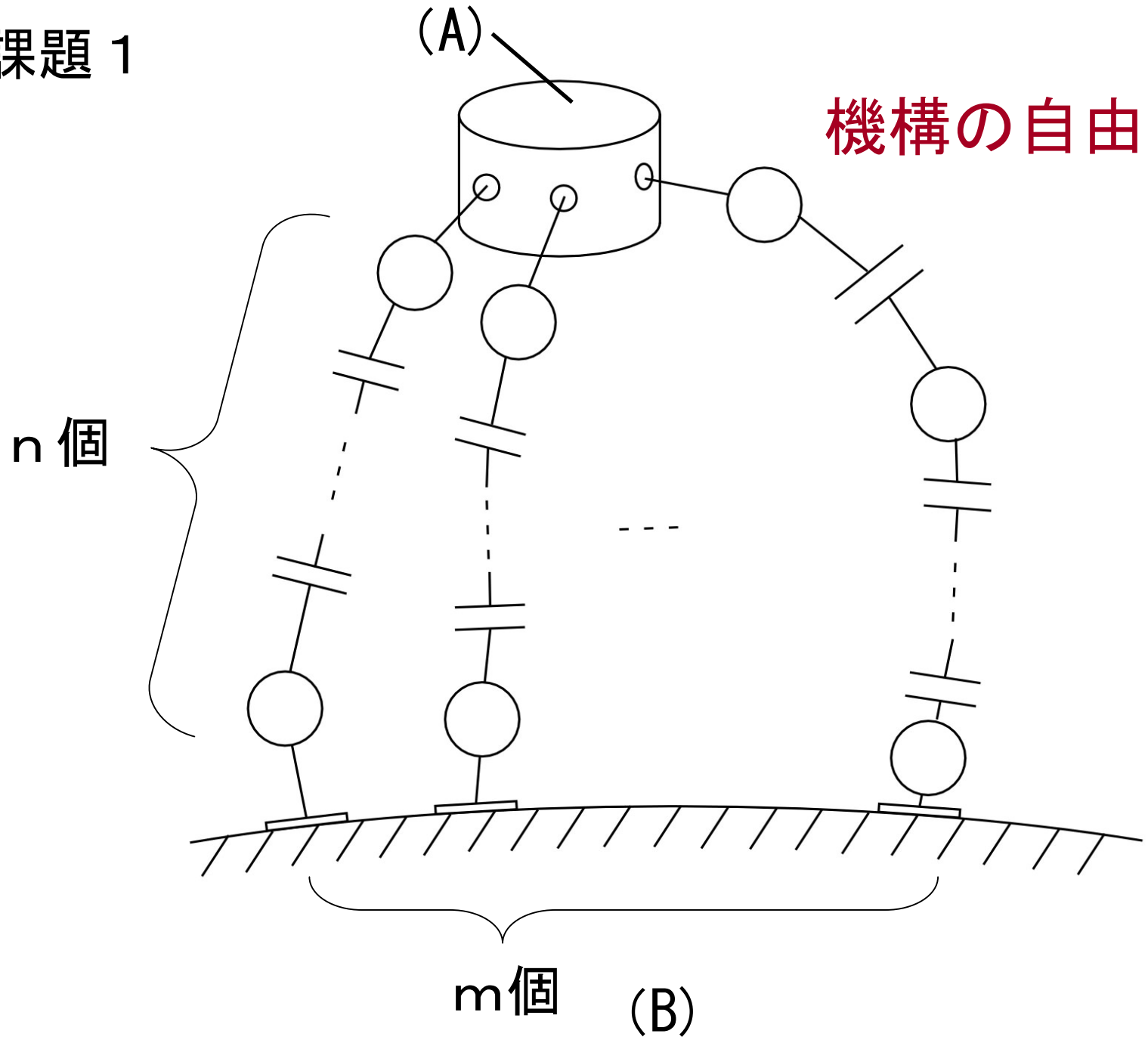
産業用ロボットが任意の位置・姿勢にある対象物がとれる訳



産業用ロボットの自由度

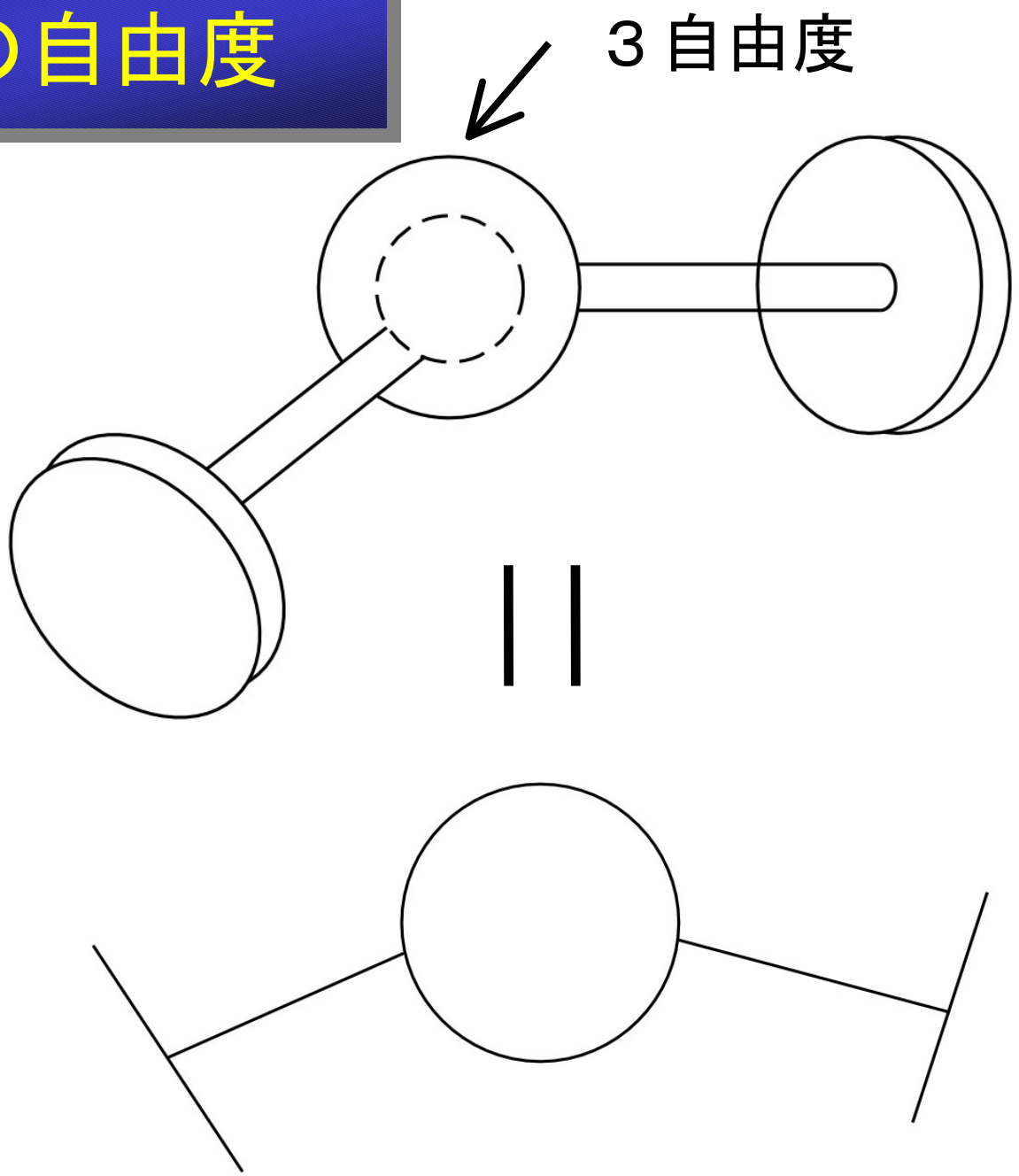


課題１

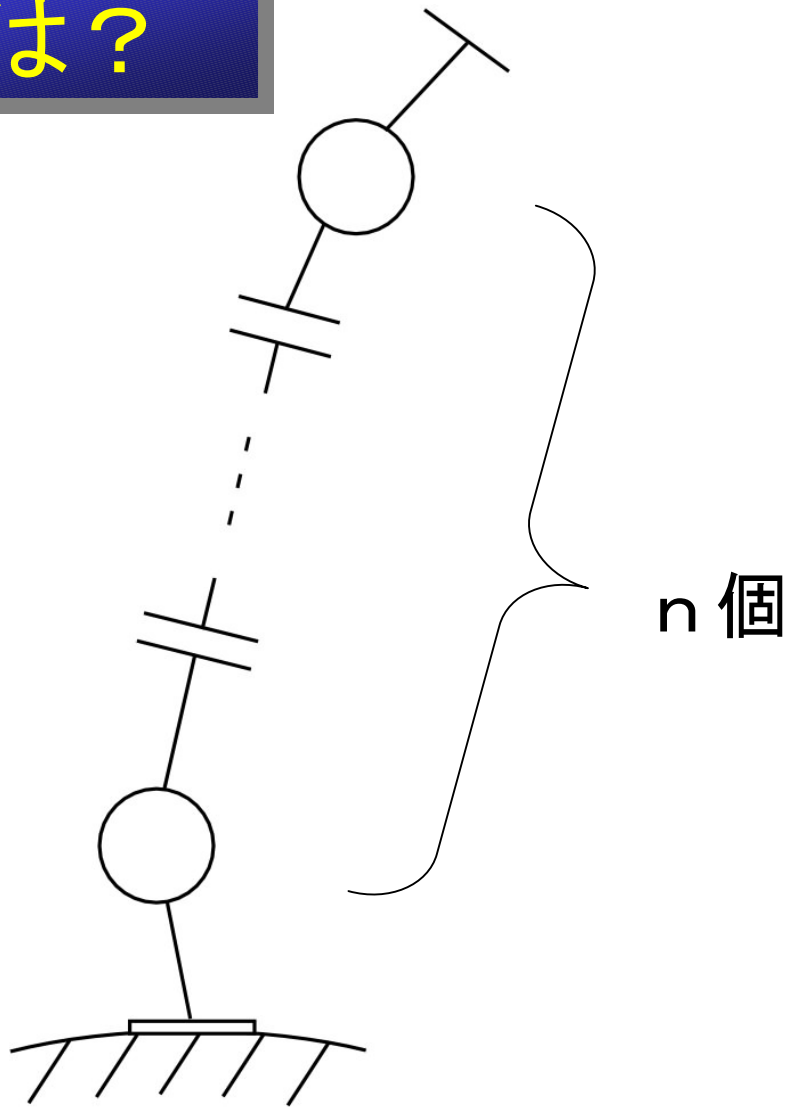


機構の自由度は？

球関節の自由度

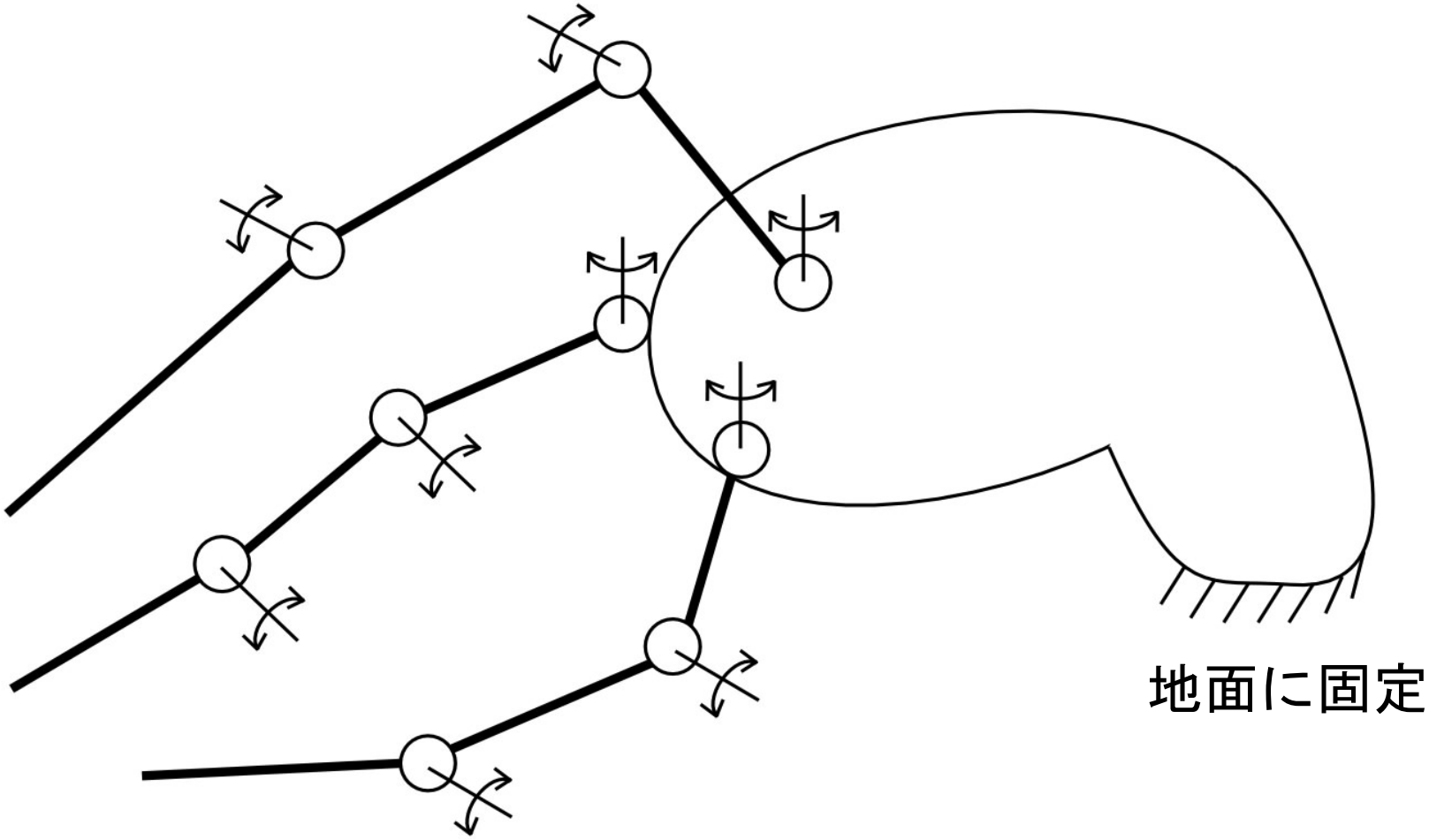


課題1：球関節がn個連なったらFkは？



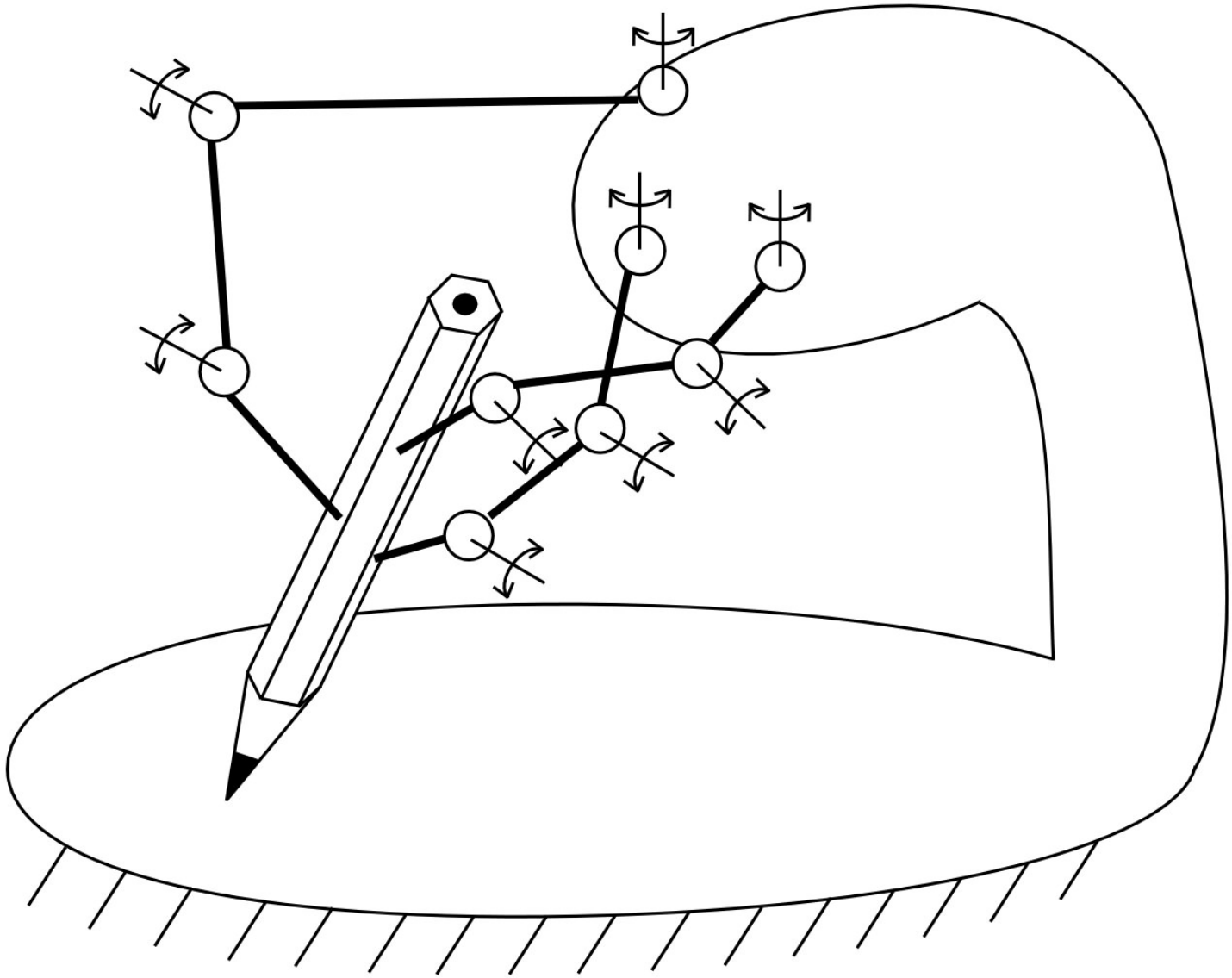
課題２

機構の自由度は？



課題３

機構の自由度は？



地面に固定