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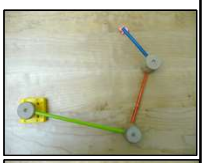
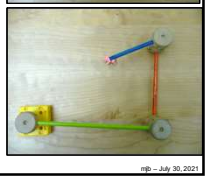
# Inverse Kinematics





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Computer Graphics



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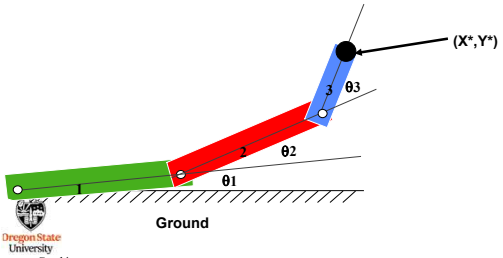
## Inverse Kinematics

**Forward Kinematics** solves the problem "if I know the link transformation parameters, where are the links?".

**Inverse Kinematics *(IK)*** solves the problem "If I know where I want the links to be (X*,Y*), what link transformation parameters will put them there?"

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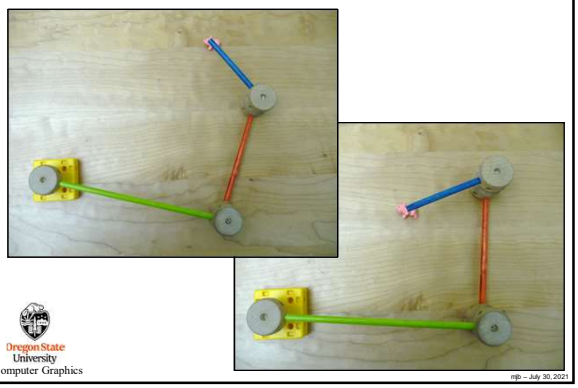
## Inverse Kinematics (IK): Things Need to Move – What Parameters Will Make Them Do That?



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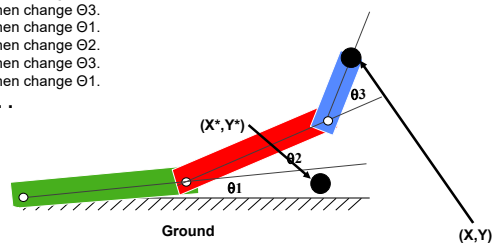
## Cyclic Coordinate Descent (CCD) Method

The idea is to change Θ1 so that (X,Y) are as close to (X*,Y*) as possible.
Then change Θ2.
Then change Θ3.
Then change Θ1.
Then change Θ2.
Then change Θ3.
Then change Θ1.
. . .

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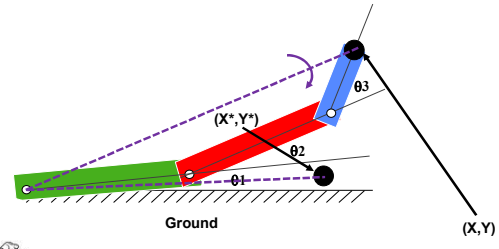
## Changing Θ1

Holding Θ2 and Θ3 constant, rotate Θ1 towards (X*,Y*) so that the dashed purple lines line up.

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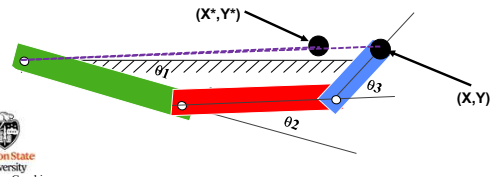
## Changing Θ1

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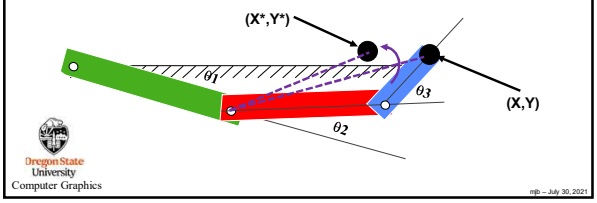
## Changing Θ2

Holding Θ1 and Θ3 constant, rotate Θ2 towards (X*,Y*) so that the dashed purple lines line up.

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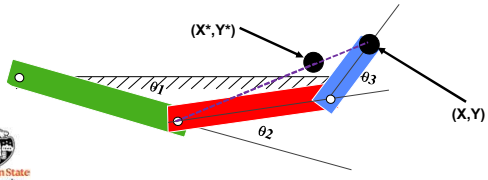
## Changing Θ2

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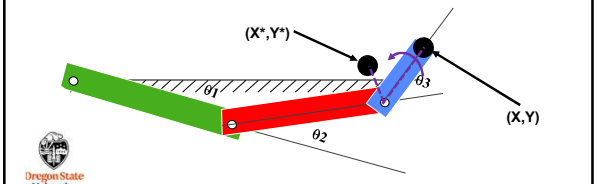
## Changing Θ3

Holding Θ1 and Θ2 constant, rotate Θ3 towards (X*,Y*) so that the dashed purple lines line up.

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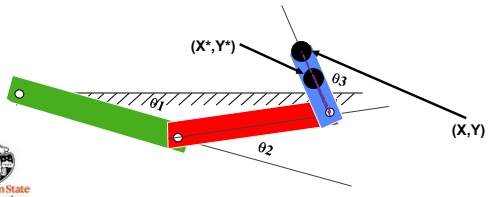
## Changing Θ3

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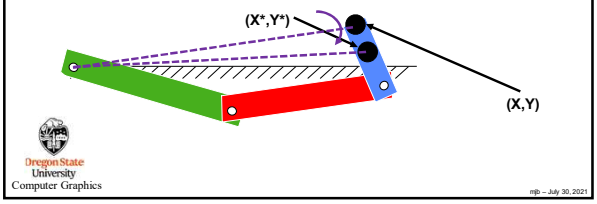
## Now, do it again -- Changing Θ1

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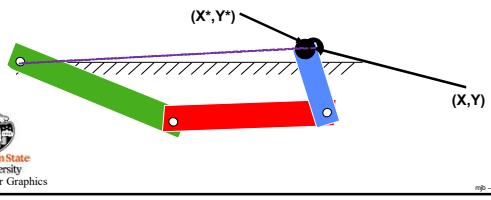
## Now, do it again -- Changing Θ1

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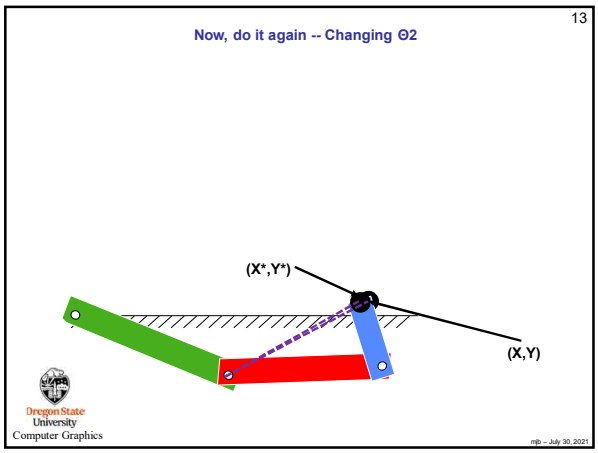
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Now, do it again -- Changing Θ2
(X*,Y*)
(X,Y)
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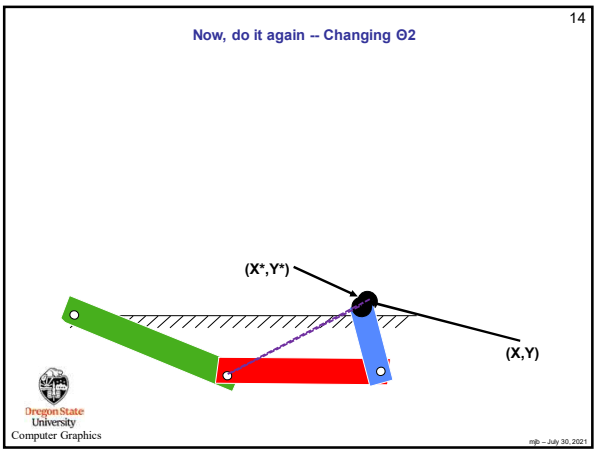
14
Now, do it again -- Changing Θ2
(X*,Y*)
(X,Y)
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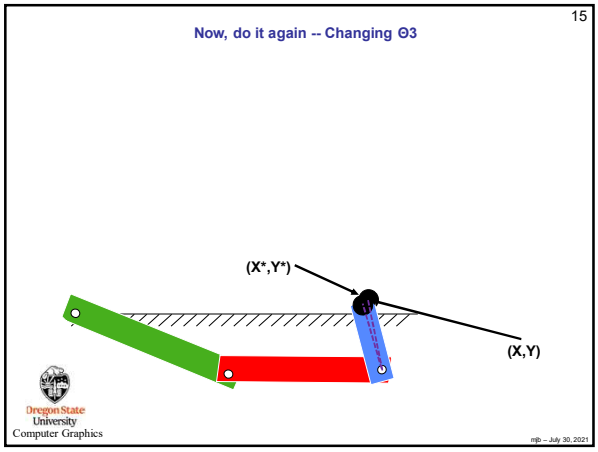
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Now, do it again -- Changing Θ3
(X*,Y*)
(X,Y)
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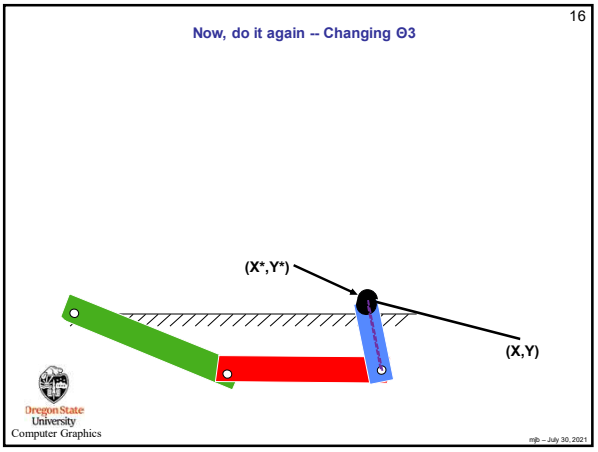
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Now, do it again -- Changing Θ3
(X*,Y*)
(X,Y)
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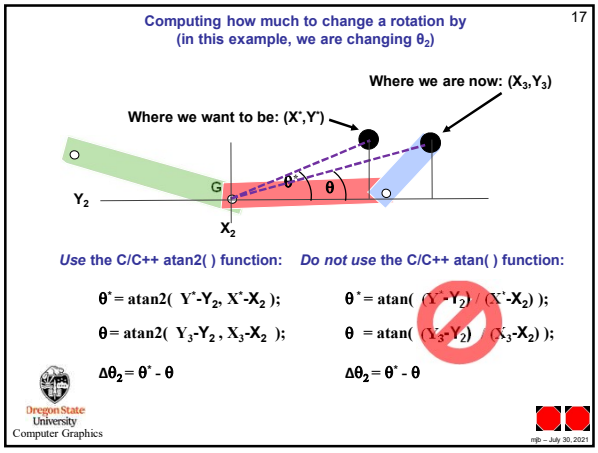
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Computing how much to change a rotation by
(in this example, we are changing θ2)
Where we are now: (X3,Y3)
Where we want to be: (X*,Y*)
G
θ*
θ
Y2
X2
Use the C/C++ atan2( ) function:
Do not use the C/C++ atan( ) function:
θ* = atan2( Y*-Y2, X*-X2 );
θ = atan2( Y3-Y2 , X3-X2 );
Δθ2 = θ* - θ
θ* = atan( (Y*-Y2) / (X*-X2) );
θ = atan( (Y3-Y2) / (X3-X2) );
Δθ2 = θ* - θ
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