EECS 367 Lab
KinEval IK Control Flow and Parameters

Administrative

Assignment 5 released

Due Wednesday, November 11 at 11:59pm

Pull stencil update from upstream!

Lab Takeaways

1. Assignment 5 goals
2. KinEval overview
3. KinEval walkthrough

→ How to start Assignment 5

Inverse Kinematics Overview

		Assignment 5: Inverse Kinematics
6	All	Manipulator Jacobian
3	All	Gradient descent with Jacobian transpose*
3	All	Jacobian pseudoinverse
6	Grad	Euler angle conversion

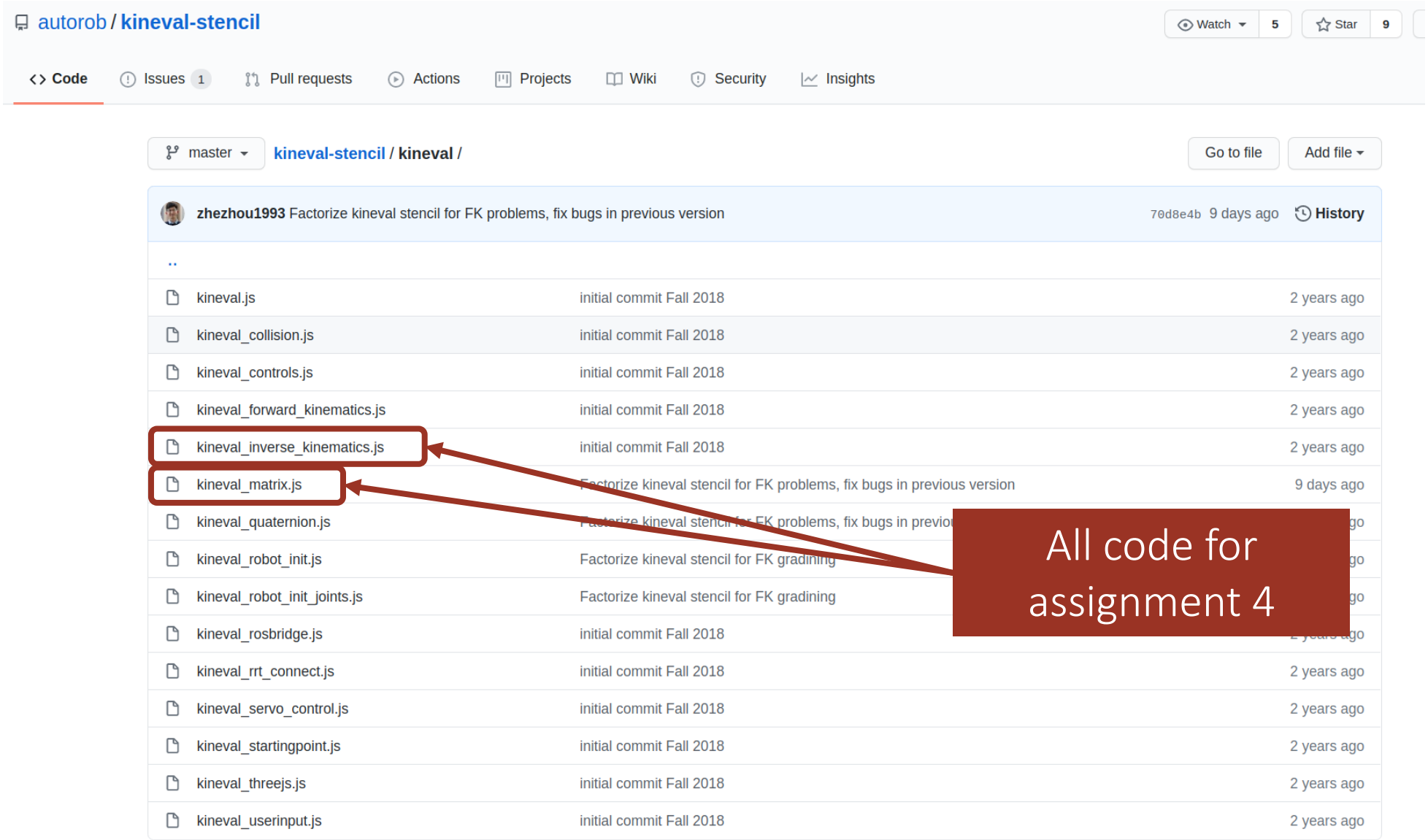
Features assigned to all sections

Feature assigned to grad section only

* Undergrad section will implement gradient descent for **position only**, but grad section will implement gradient descent for **position and orientation**

Demo

KinEval Overview



kineval_inverse_kinematics.js

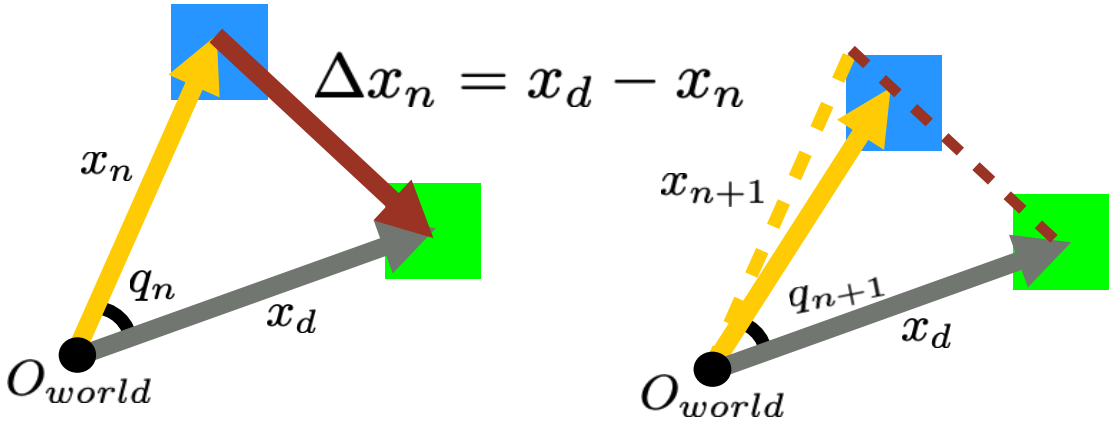
kineval_inverse_kinematics.js

```
19  kineval.robotInverseKinematics = function robot_inverse_kinematics(endeffector_target_world, endeffector_joint, endeffector_position_local) {
20
21      // compute joint angle controls to move location on specified link to Cartesian location
22      if ((kineval.params.update_ik)||(kineval.params.persist_ik)) {
23          // if update requested, call ik iterator and show endeffector and target
24          kineval.iterateIK(endeffector_target_world, endeffector_joint, endeffector_position_local);
25          if (kineval.params.trial_ik_random.execute)
26              kineval.randomizeIKtrial();
27          else // KE: this use of start time assumes IK is invoked before trial
28              kineval.params.trial_ik_random.start = new Date();
29      }
30
31      kineval.params.update_ik = false; // clear IK request for next iteration
32  }
33
34  kineval.randomizeIKtrial = function randomIKtrial () {
35
36      // update time from start of trial
37      cur_time = new Date();
38      kineval.params.trial_ik_random.time = cur_time.getTime()-kineval.params.trial_ik_random.start.getTime();
39
40      // STENCIL: see instructor for random time trial code
41  }
42
43  kineval.iterateIK = function iterate_inverse_kinematics(endeffector_target_world, endeffector_joint, endeffector_position_local) {
44
45      // STENCIL: implement inverse kinematics iteration
46
```

Implement `iterateIK()` such that each joint along the end effector path gets an update to its `.control` term

Translating the IK Update

IK UPDATE PER JOINT



GENERAL IK UPDATE PROCEDURE

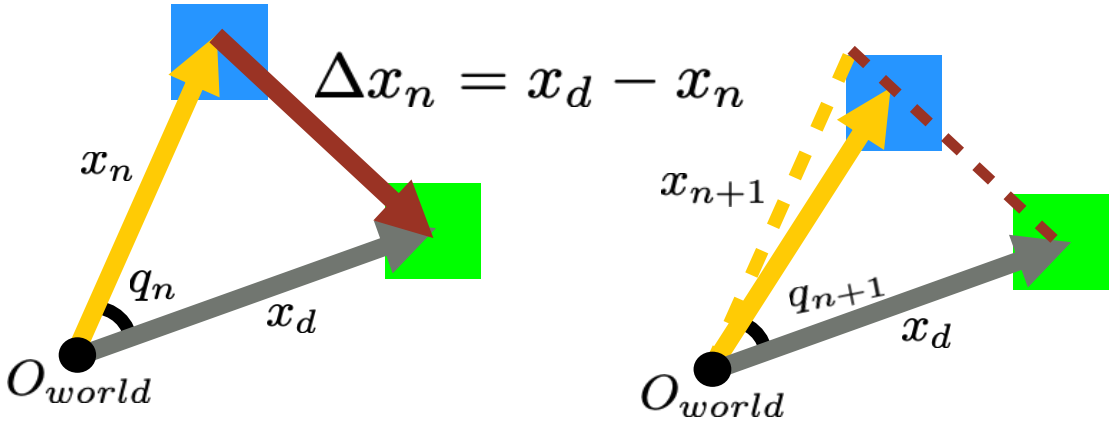
$$\Delta x_n = x_d - x_n$$
$$\Delta q_n = J(q_n)^{-1}\,\Delta x_n$$
$$q_{n+1} = q_n + \gamma \Delta q_n$$

= current end effector position

= desired end effector position

Translating the IK Update

IK UPDATE PER JOINT



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KINEVAL VARIABLES

$x_d \rightarrow$ `endeffector_target_world`

$q_n \rightarrow$ `robot.joints[…].angle`

$p^{x_n} \rightarrow$ `endeffector_position_local`

$x_n \rightarrow T^O_{x_n} p^{x_n}$

$T^O_{x_n} \rightarrow$ a `.xform`, calculated by FK

$\gamma \rightarrow$ `kineval.params.ik_steplength`

$\Delta x_n \rightarrow$ `robot.dx`

$J(q_n) \rightarrow$ `robot.jacobian`

$\Delta q_n \rightarrow$ `robot.dq`

} Necessary for CI grader!

KinEval IK Parameters

Parameters of `iterate_inverse_kinematics` function:

`endeffector_target_world` – target pose of end effector for IK, has `.position` and `.orientation`

`endeffector_joint` – string name of joint connected to end effector

`endeffector_position_local` – position of end effector with respect to local frame

Global parameters that your code needs to check:

`kineval.params.ik_steplength` – size of step to take along configuration gradient when updating control

`kineval.params.ik_pseudoinverse` – Boolean flag denoting which method to use (Jacobian transpose vs pseudoinverse)

Performance Validation

`kineval.randomizeIKTrial()`

- Source code will be provided on assignment 5 channel in MS Team
- Graduate extension points for reaching at least 100 targets in 60 seconds

Inverse kinematics will react in real time

- Turn on `persist_ik` in the GUI menu or hold down ‘p’ key to turn on
- IK will account for manual adjustments to robot base or joint angles
- Also will react to any modification of the end effector target

Keyboard controls