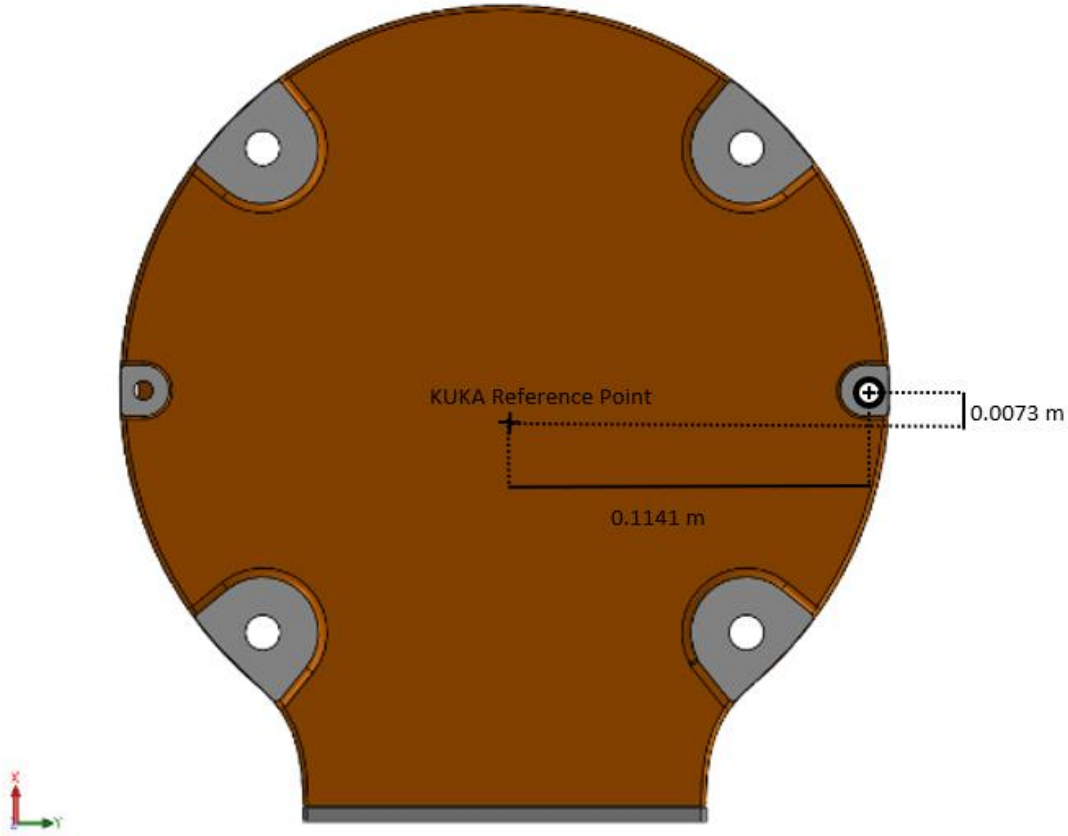
The database file Kuka_LBR_iiwa_Database.sql is an exported MySQL database. To use the database, this file should be imported into MySQL. This can be done from the shell or by using the MySQL Workbench graphical user interface.

Each row of the table `poses' in the database contains the following information for a unique manipulator configuration.

Data Column Name	Description
RowID	Unique row identifier
CART_INDEX	Index of row indicating end-effector Cartesian XYZ position
EFF_X	X Co-ordinate of end-effector position
EFF_Y	Y Co-ordinate of end-effector position
EFF_Z	Z Co-ordinate of end-effector position
EFF_alp	α end-effector orientation
EFF_bet	β end-effector orientation
EFF_gam	γ end-effector orientation
J1	Angle of Joint 1
J2	Angle of Joint 2
J3	Angle of Joint 3
J4	Angle of Joint 4
J5	Angle of Joint 5
J6	Angle of Joint 6
J7	Angle of Joint 7
J1X	X Co-ordinate of joint 1 Cartesian position
J1Y	Y Co-ordinate of joint 1 Cartesian position
J1Z	Z Co-ordinate of joint 1 Cartesian position
J2X	X Co-ordinate of joint 2 Cartesian position
J2Y	Y Co-ordinate of joint 2 Cartesian position
J2Z	Z Co-ordinate of joint 2 Cartesian position
J3X	X Co-ordinate of joint 3 Cartesian position
J3Y	Y Co-ordinate of joint 3 Cartesian position
J3Z	Z Co-ordinate of joint 3 Cartesian position
J4X	X Co-ordinate of joint 4 Cartesian position
J4Y	Y Co-ordinate of joint 4 Cartesian position
J4Z	Z Co-ordinate of joint 4 Cartesian position
J5X	X Co-ordinate of joint 5 Cartesian position
J5Y	Y Co-ordinate of joint 5 Cartesian position
J5Z	Z Co-ordinate of joint 5 Cartesian position
J6X	X Co-ordinate of joint 6 Cartesian position
J6Y	Y Co-ordinate of joint 6 Cartesian position
J6Z	Z Co-ordinate of joint 6 Cartesian position
J7X	X Co-ordinate of joint 7 Cartesian position
J7Y	Y Co-ordinate of joint 7 Cartesian position
J7Z	Z Co-ordinate of joint 7 Cartesian position

Once imported, the database can be queried to return manipulator configurations which satisfy requested criteria for any column.

The KUKA LBR iiwa 14 configuration database contains 1,055,493,847 systematically sampled unique manipulator configurations. Each configuration contains the Cartesian (XYZ) position and Tait-Bryan (αβγ) orientation of the end-effector, the corresponding 7 joint angles and the Cartesian (XYZ) positions of each of the joints. All positions are recorded relative to the base point of the KUKA, shown in the figure below.



The end-effector reference point is based on a Robotiq 2F-85 gripper. The positions of the joints when the arm is in the zero position, are given relative to the KUKA reference point in the table below.

Position relative to KUKA reference point [m]	X	Y	Z
Joint 1	7.3000E-03	5.4000E-05	1.5250E-01
Joint 2	7.3000E-03	5.4000E-05	3.6000E-01
Joint 3	7.3000E-03	5.4000E-05	5.8100E-01
Joint 4	7.3000E-03	5.4000E-05	7.8000E-01
Joint 5	7.3000E-03	5.4000E-05	9.5950E-01
Joint 6	7.3000E-03	-6.5600E-02	1.1800E+00
Joint 7	7.3000E-03	5.4000E-05	1.2561E+00
End-Effector	7.3000E-03	1.5000E-05	1.4040E+00

The Cartesian workspace of the KUKA has been sampled to 5cm increments within the bounds shown relative to the KUKA base in the table below.

	X	Y	Z
Min (m)	-0.305	-0.505	0.695
Max (m)	0.505	0.505	1.205

The database can be indexed according to any data column contained within. The existing index has been created by Cartesian position (XYZ) of the end-effector. To prevent a table wide lookup, the index should be used first in finding a suitable manipulator configuration. Results of this index search can then be filtered by preference, e.g. end-effector orientation. The index key is shown in the index table below and an example of use is shown in the python file get_manipulator_configuration.py

An example of the MySQL query format for this database is:

SELECT * FROM kukalbriiwa14_robotiq2f_database.poses WHERE CART_INDEX=017013029

In this query, all column data is returned for rows in the `poses' table of the `kukalbriiwa14_robotiq2f_database' schema which satisfy the criteria that the CART_INDEX column contains 017013029. From the index table below, this query would return all information for all configurations in the database where the end-effector is located at [-0.30, -0.5, 0.7]. Further criteria can be applied by appending AND to the query. Some examples are shown below.

Criteria to append to the query	Description
AND EFF_alp=0 AND EFF_bet=0 AND EFF_gam=0	Further filters results by end-effector orientation
AND J4X > 0	Further filters results by X co-ordinate of the robot's elbow joint in Cartesian space.

As well as filtering by data saved in the table, the results can also be filtered by numerical calculation performed on the data in each row. An example is shown below:

SELECT J1, J2, J3, J4, J5, J6, J7, abs(J1-*known current J1 angle*) as J1_diff_calc FROM kukalbriiwa14_robotiq2f_database.poses WHERE CART_INDEX=017013029 ORDER BY J1_diff_calc

In this query, all columns listed after SELECT including a new column defined as J1_diff_calc which is a calculation on the difference between the J1 value stored in the row and a known value, the angle of joint 1 at the robots present position. This query returns all configurations where the end-effector is located at [-0.30, -0.5, 0.7]. Results are ordered by the minimum difference between the returned configuration's J1 angle and the J1 angle of the robots present position. So the first configuration returned in the list would be as near as possible to the robots present position in terms of Joint 1.

CART_INDEX = 017013029

Index X Index Y Index Z

End-effector X Co-ordinate	Index X	End-effector Y Co-ordinate	Index Y	End-effector Z Co-ordinate	Index Z
-1.10	001	-1.1	001	-0.7	001
-1.05	002	-1.05	002	-0.65	002
-1.00	003	-1	003	-0.6	003
-0.95	004	-0.95	004	-0.55	004
-0.90	005	-0.9	005	-0.5	005
-0.85	006	-0.85	006	-0.45	006
-0.80	007	-0.8	007	-0.4	007
-0.75	008	-0.75	008	-0.35	008
-0.70	009	-0.7	009	-0.3	009
-0.65	010	-0.65	010	-0.25	010
-0.60	011	-0.6	011	-0.2	011
-0.55	012	-0.55	012	-0.15	012
-0.50	013	-0.5	013	-0.1	013
-0.45	014	-0.45	014	-0.05	014
-0.40	015	-0.4	015	0	015
-0.35	016	-0.35	016	0.05	016
-0.30	017	-0.3	017	0.1	017
-0.25	018	-0.25	018	0.15	018
-0.20	019	-0.2	019	0.2	019
-0.15	020	-0.15	020	0.25	020
-0.10	021	-0.1	021	0.3	021
-0.05	022	-0.05	022	0.35	022
0.00	023	0	023	0.4	023
0.05	024	0.05	024	0.45	024
0.10	025	0.1	025	0.5	025
0.15	026	0.15	026	0.55	026
0.20	027	0.2	027	0.6	027
0.25	028	0.25	028	0.65	028
0.30	029	0.3	029	0.7	029
0.35	030	0.35	030	0.75	030
0.40	031	0.4	031	0.8	031
0.45	032	0.45	032	0.85	032
0.50	033	0.5	033	0.9	033
0.55	034	0.55	034	0.95	034
0.60	035	0.6	035	1	035
0.65	036	0.65	036	1.05	036
0.70	037	0.7	037	1.1	037
0.75	038	0.75	038	1.15	038
0.80	039	0.8	039	1.2	039
0.85	040	0.85	040	1.25	040
0.90	041	0.9	041	1.3	041
0.95	042	0.95	042	1.35	042
1.00	043	1	043	1.4	043
1.05	044	1.05	044	1.45	044
1.10	045	1.1	045		