# Week 7

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# Q1

### Q1.1

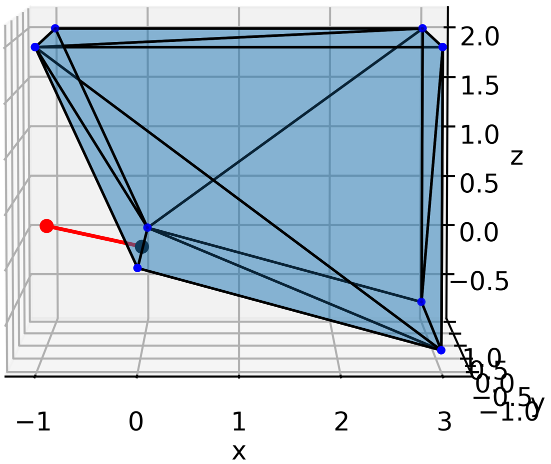
Modifying the script to substitute the given values and include $f_{bias}$ as

```
# Already in local contact coordinats
fbias = Symbol('fbias', real=True)
fbs1 = Matrix((fbias, 0, fbias))
fbs2 = - fbs1

f1 = df1 + fbs1
f2 = df2 + fbs2

pprint(f1)

ksl_v, ksn_v = 500, 100
dbx_v, dbz_v = -2e-3, -2e-3
fbias_v = 0

print("\n----- Q1.1 -----")
print("\n--- f1: ")
pprint(f1.subs([[ksn, ksn_v], [ksl, ksl_v], [
       dbx, dbx_v], [dbz, dbz_v], [fbias, fbias_v]]))
print("\n--- f2: ")
pprint(f2.subs([[ksn, ksn_v], [ksl, ksl_v], [
       dbx, dbx_v], [dbz, dbz_v], [fbias, fbias_v]]))
```

We can then compute the value of the force at each contact, in local coordinates (for now, considering $f_{bias} = 0$), and we find

$$f_i = \begin{pmatrix} -1 \\ 0 \\ 0.2 \end{pmatrix}$$

Which is outside the convex hull

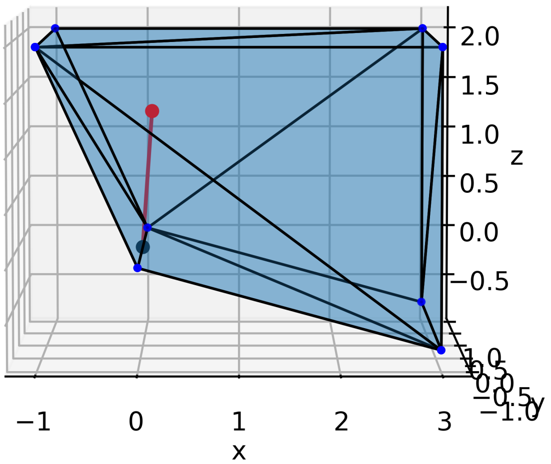



### Q1.2

Considering that, in local contact coordinates, we have

$$f_i = \begin{pmatrix} -1 \\ 0 \\ 0.2 \end{pmatrix} + \begin{pmatrix} f_{bias} \\ 0 \\ f_{bias} \end{pmatrix}$$

we can choose, for example, $f_{bias} = 1.1$ to have a result inside the convex hull




## Q2

For this part I will be referring to the script `Q2.py`, attached to the solution

### Q2.1

We can proceed similarly to Q1.1 to compute how a wrench applied at a point in body coordinate (the origin, in this case), considering the `Jbtran` matrix with the correct value of translation and rotation between the two reference frame.

With this procedure we obtain

$$w_1: \begin{bmatrix} f_x \\ f_y \\ f_z \\ 0.2f_z \\ -0.1f_z \\ -0.2f_x + 0.1f_y \end{bmatrix} \quad w_2: \begin{bmatrix} f_x \\ f_y \\ f_z \\ -0.2f_z \\ -0.1f_z \\ 0.2f_x + 0.1f_y \end{bmatrix} \quad w_3: \begin{bmatrix} f_x \\ f_y \\ f_z \\ -0.2f_z \\ 0.1f_z \\ 0.2f_x - 0.1f_y \end{bmatrix} \quad w_4: \begin{bmatrix} f_x \\ f_y \\ f_z \\ 0.2f_z \\ 0.1f_z \\ -0.2f_x - 0.1f_y \end{bmatrix}$$

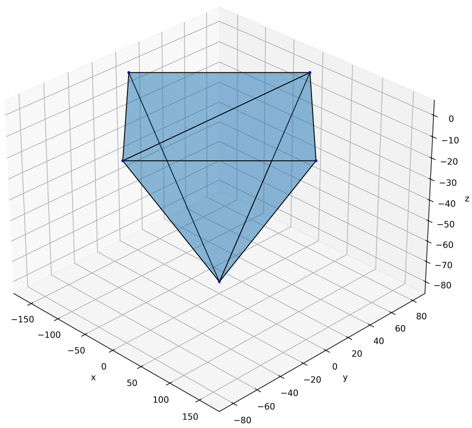
### Q2.2

As we have seen in class, given that:

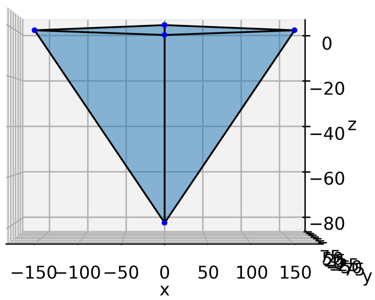
- the load is equally distributed on each unit
- they are all oriented in the same way

the limit surface is a scaled version of the one for a single unit (4x).

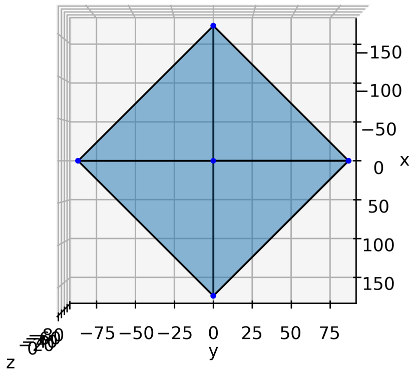
We can plot the surface resuming the methods in `Vector-in-ConvexHull.py`



−150
−100
−50
0
50
100
150
x
−80
−60
−40
−20
0
20
40
60
80
y
0
−10
−20
−30
−40
−50
−60
−70
−80
z

0
−20
−40
−60
−80
z
−150
−100
−50
0
50
100
150
x
y

−150
−100
−50
0
50
100
150
x
−75
−50
−25
0
25
50
75
y
z

### Q2.3

The maximum value of a force directed like $(7, 7, -5)^T$ that the mechanism can hold is given by the intersection of a line in this direction with the limit surface.

Again, resuming the methods of `Vector-in-ConvexHull.py`, we find

$$f_{max} = \begin{bmatrix} 36.19 \\ 36.19 \\ -25.85 \end{bmatrix}$$