lektion7_inline

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1 Matplotlib (Teil 2)

[1]:
```
import numpy as np
import matplotlib.pyplot as plt
#modus für Vorlesung
#%matplotlib qt5
#plt.rcParams['figure.figsize'] = (4., 4.)
#plt.rcParams['lines.linewidth'] = 3
#modus für Export nach pdf
%matplotlib inline
plt.rcParams["figure.figsize"] = (3.0, 2.0) #default figsize für Export nach pdf
```

[ ]:
```
import matplotlib
from matplotlib.backends import backend_registry
```

```
# interactive backends
#backend_registry.list_builtin(matplotlib.backends.BackendFilter.INTERACTIVE)
# noninteractive backends
backend_registry.list_builtin(matplotlib.backends.BackendFilter.NON_INTERACTIVE)
# all backends built into Matplotlib
# backend_registry.list_builtin()
# all registered backends
#backend_registry.list_all()
```

[ ]:
```
#plt.rcParams.keys()
```

https://matplotlib.org/stable/gallery/color/named_colors.html

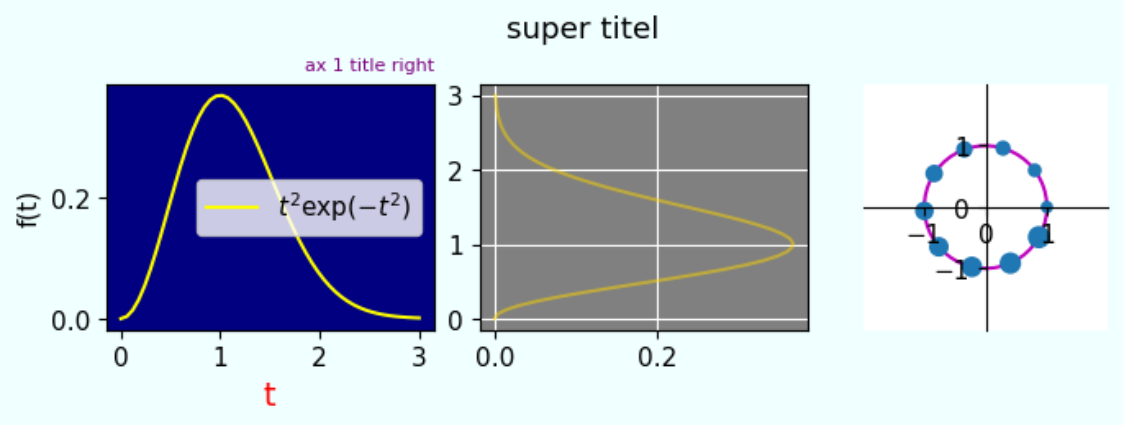
1.1 Wiederholung

1.2 Achsen und Gitterlinien

Hinzufügen von Achsenbezeichnungen. **layout='constrained'** in plt.subplots sorgt dafür, dass alles sichtbar bleibt.

[2]:
```
fig, ax = plt.subplots(1, 3, layout='constrained', figsize=(7, 2.5))
fig.suptitle('super titel')
fig.set_facecolor('azure')

ax[0].set_title('ax 1 title right', loc='right', color='purple', fontsize=8)
ax[0].set_facecolor('navy')

def f(t):
    return t**2 * np.exp(-t**2)

t = np.linspace(0, 3, 51)
y = f(t)

ax[0].plot(t, y, color='yellow', label='$t^2\\exp(-t^2)$')
ax[0].legend();

ax[0].set_xlabel('t', color='red', fontsize=14)
ax[0].set_ylabel('f(t)');

ax[1].set_facecolor('grey')
ax[1].grid(color='white')
ax[1].plot(y, t, color='gold', alpha=.5);

phi = np.linspace(0, 2 * np.pi)
ax[2].plot(np.cos(phi), np.sin(phi), 'm', zorder=1)
ax[2].scatter(np.cos(phi[::5]), np.sin(phi[::5]), s=20 + 10 * phi[::5])
ax[2].set_aspect('equal')
# Setze die bottom und left Achsen (engl. spines) als x und y Achse
```

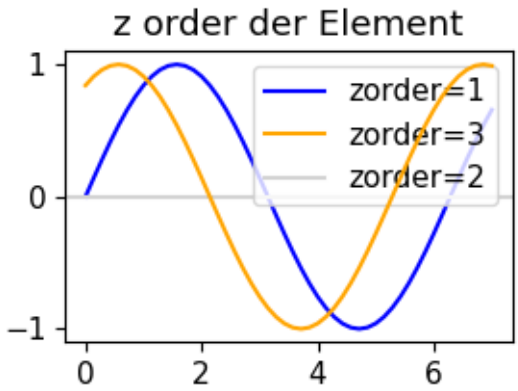
```
ax[2].spines['bottom'].set_position('zero')
ax[2].spines['left'].set_position('zero')
# Entferne top und right spines
ax[2].spines['top'].set_visible(False)
ax[2].spines['right'].set_visible(False)

ax[2].set_xlim((-2, 2))
ax[2].set_ylim((-2, 2))
ax[2].set_xticks([-1, 0, 1])
ax[2].set_yticks([-1, 0, 1]);
```



1.3 Reihenfolge der Elemente festlegen

zorder legt fest, in welcher Reihenfolge die Elemente gezeichnet werden.

[3]:
```
x = np.linspace(0, 7)

plt.figure()
plt.plot(x, np.sin(x), label='zorder=1', color='blue', zorder=1)
plt.plot(x, np.sin(x + 1), label='zorder=3', color='orange', zorder=3)
plt.axhline(0, label='zorder=2', color='lightgrey', zorder=2)

plt.title('z order der Element')
l = plt.legend(loc='upper right')
l.set_zorder(2)
plt.show()
```



Position der Legende

Location String	Location Code
'best'	0
'upper right'	1
'upper left'	2
'lower left'	3
'lower right'	4
'right'	5
'center left'	6
'center right'	7
'lower center'	8
'upper center'	9
'center'	10

1.4 Bilder abspeichern

Bild in einer Datei (pdf, jpeg, ...) speichern:

savefig

[ ]:
```
fig.savefig('bild1.pdf')  # das format wird anhand der Endung geraten
```

[ ]:
```
fig.savefig('bild1.jpg', format='jpg')
```

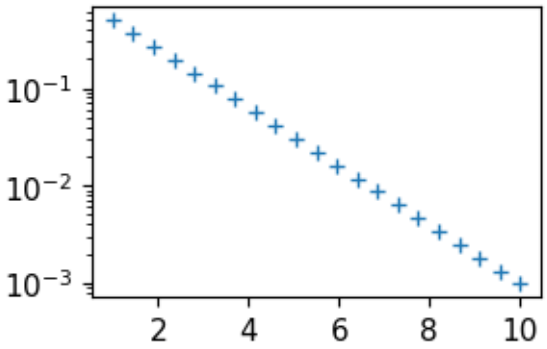
[ ]:
```
fig.canvas.get_supported_filetypes_grouped()
```

1.5 Logarithmische Skalierung der Achsen

Verwendung logarithmischer Achsen:

[4]:
```
x = np.linspace(1, 10, 21)
y = 2**(-x)
```

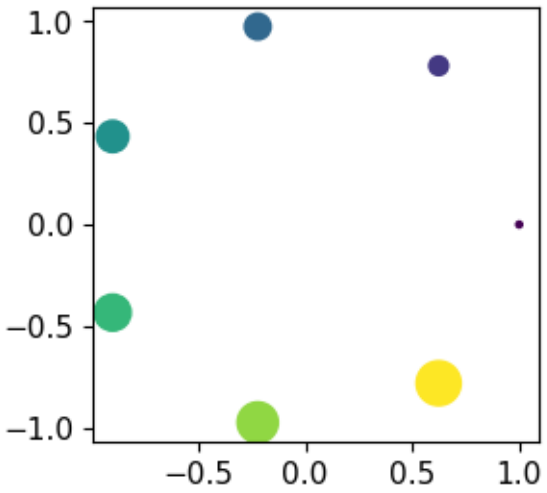
```
fig, ax = plt.subplots(1)
ax.semilogy(x, y, '+');
```



Siehe auch semilogx() und loglog(), wenn die x-Achse bzw. beide Achsen logarithmisch skaliert werden sollen.

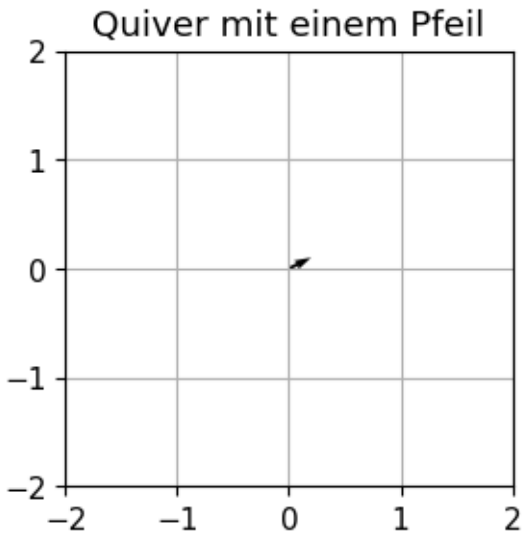
1.6 Scatter Plots

[5]:
```
fig, ax = plt.subplots(figsize=(3, 3))
n = 7
t = np.linspace(0, 2 * np.pi, n, endpoint=False)
x = np.cos(t)
y = np.sin(t)
color = t
# Punkte an Koordinate (x_i, y_i) s: Größe  c: Farbe
ax.scatter(x, y, s=50 * t + 5, c=color);
```

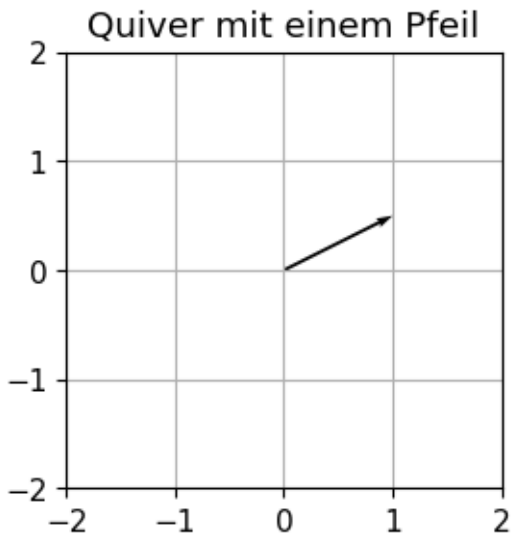


1.7 Vektorpfeile mit quiver

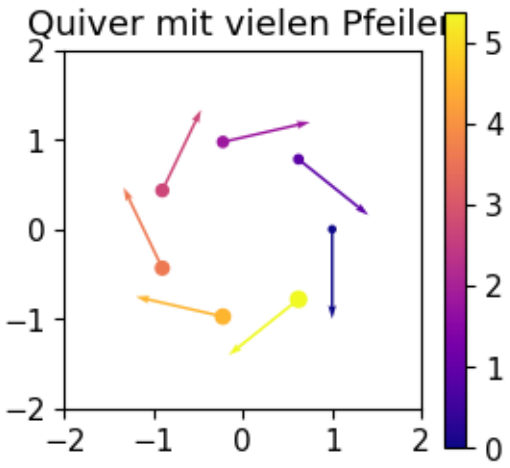
[6]:
```
fig, ax = plt.subplots(figsize=(3, 3))
x, y, u, v = 0, 0, 1, .5

ax.quiver(x, y, u, v)  # (x,y) Fusspunkt (u,v) Richtung
ax.set_title('Quiver mit einem Pfeil')
ax.axis([-2, 2, -2, 2])
ax.grid()
```



[7]:
```
fig, ax = plt.subplots(figsize=(3, 3))
x, y, u, v = 0, 0, 1, .5

ax.quiver(x, y, u, v, angles='xy', scale_units='xy', scale=1)
ax.set_title('Quiver mit einem Pfeil')
ax.axis([-2, 2, -2, 2])
ax.grid()
ax.set_aspect('equal')
```



[9]:
```
fig, ax = plt.subplots(figsize=(3, 3))
n = 7
t = np.linspace(0, 2 * np.pi, n, endpoint=False)
x = np.cos(t)
y = np.sin(t)
u = np.sin(t)
v = -np.cos(t)
color = t
# Punkte an Koordinate (x_i, y_i) s: Größe  c: Farbe
ax.scatter(x, y, s=5 * t + 5, c=color, cmap='plasma');

qv = ax.quiver(x, y, u, v, color, angles='xy', scale_units='xy',
               scale=1, cmap='plasma')
ax.set_title('Quiver mit vielen Pfeilen')
ax.axis([-2, 2, -2, 2])
ax.set_aspect('equal')

fig.colorbar(qv);
```

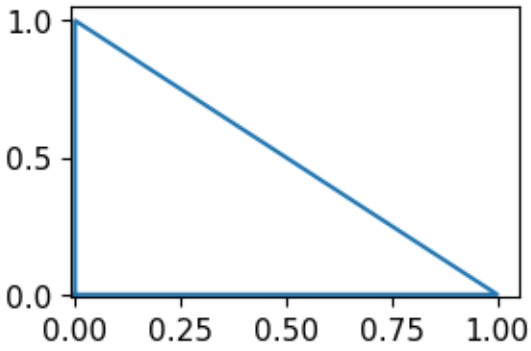


Der Parameter **cmap** wählt die Colormap aus.
Link zu Colormaps (cmap) https://matplotlib.org/stable/tutorials/colors/colormaps.html

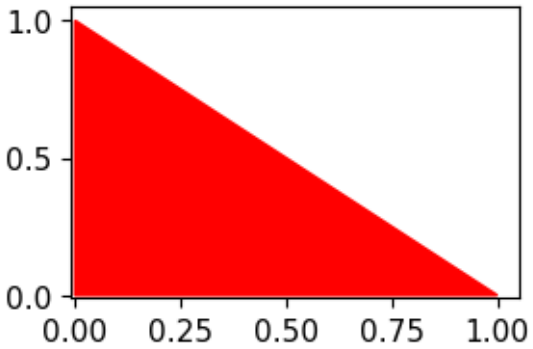
1.8 Flächen füllen

fill

[11]:
```
fig, ax = plt.subplots(1)
ax.plot([0, 1, 0, 0], [0, 0, 1, 0])
ax.axis(xmin=-.01, ymin=-.01);
```

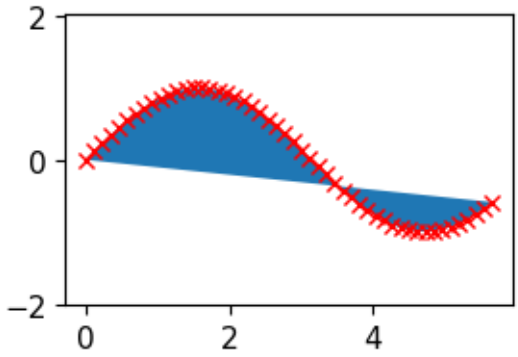


[12]:
```
fig, ax = plt.subplots(1)
ax.fill([0, 1, 0, 0], [0, 0, 1, 0], color='red')
ax.axis(xmin=-.01, ymin=-.01);
```



[13]:
```
x = np.linspace(0, 1.8 * np.pi)
y1 = np.sin(x)
```

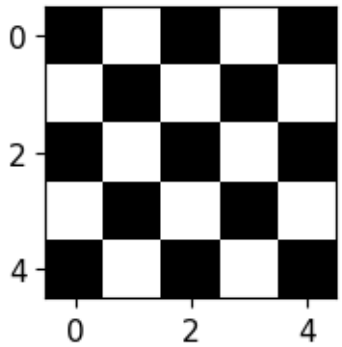
[14]:
```
fig, ax = plt.subplots(1)
ax.fill(x, y1)
ax.plot(x, y1, 'xr')
ax.axis('equal');
```



1.9 Zeichnen von 2d reellwertigen Daten (imshow und contour)

imshow zum darstellen von gepixelten Bildern

[15]:
```
i = np.arange(5)
M = (-1)**(i[:, np.newaxis] + i)
fig, ax = plt.subplots(1)
ax.imshow(M, cmap='Greys');
```



[16]:
```
M
```

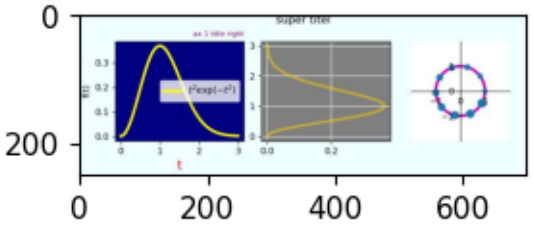
[16]:
```
array([[ 1, -1,  1, -1,  1],
       [-1,  1, -1,  1, -1],
       [ 1, -1,  1, -1,  1],
       [-1,  1, -1,  1, -1],
       [ 1, -1,  1, -1,  1]])
```

[ ]:
```
plt.close('all')
```

[17]:
```
from matplotlib.image import imread

img = imread('bild1.jpg')
img.shape
```

[17]:
```
(250, 700, 3)
```

[19]:
```
plt.figure()
plt.imshow(img);
```



contour berechnet und zeichnet Höhenlinien auf einem kartesichen Gitter

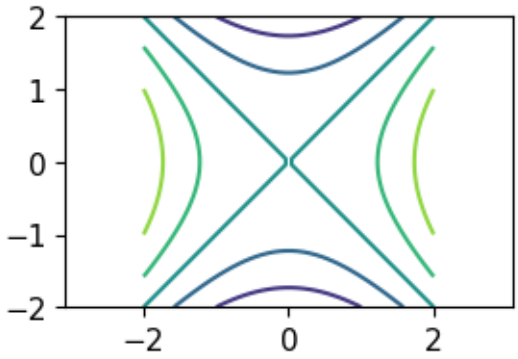
```
contour(x, y, z, levels)
```

x, y : Arrays mit den Koordinaten für den Wert z

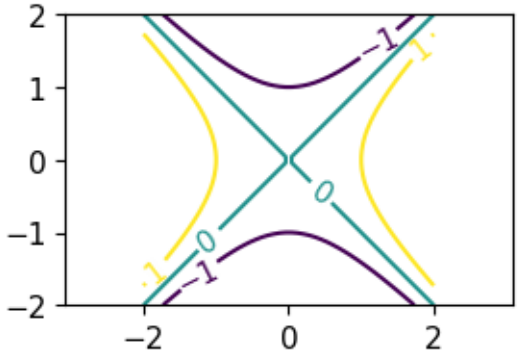
levels : Anzahl der Höhenlinine oder Werte für die Höhenlinien

[20]:
```
x = np.linspace(-2, 2)
y = np.linspace(-2, 2)
xx, yy = np.meshgrid(x, y)
zz = xx**2 - yy**2
```

[21]:
```
fig, ax = plt.subplots(1)
cs = ax.contour(x, y, zz, 5) # 5 Höhenlinien ausgewählt von matplotlib
#cs.clabel()
ax.axis('equal');
```



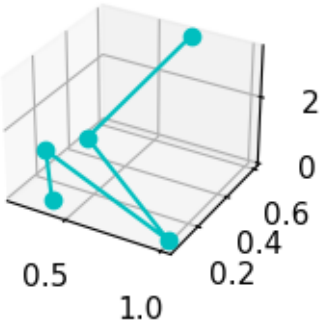
[23]:
```
fig, ax = plt.subplots(1)
cs = ax.contour(x, y, zz, [-1, 0, 1]) # 3 Höhenlinien zu Werten -1, 0 und 1
cs.clabel()
ax.axis('equal');
```



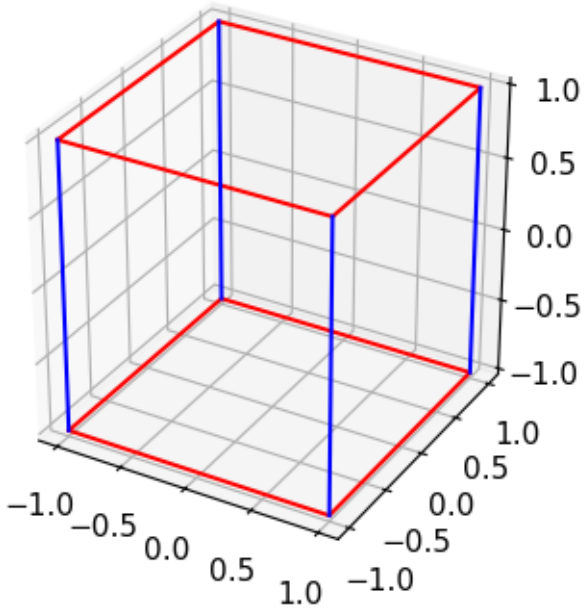
2 3D Plots

2.1 Polygonzug in 3D

[24]:
```
# erzeugen ein 3D Koordinatensystem
ax = plt.figure().add_subplot(projection='3d')

x = np.random.rand(5)
y = np.random.rand(5)
z = np.random.randn(5)

ax.plot(x, y, z, 'co-');
```



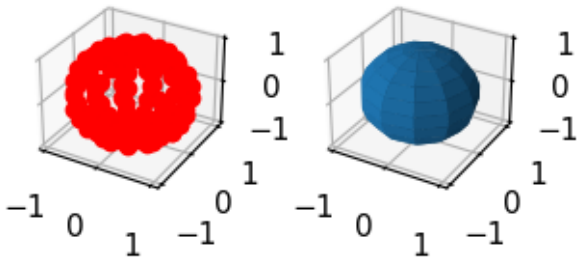
[25]:
```
fig = plt.figure(figsize=(4, 4))
ax = fig.add_subplot(projection='3d')

x, y = [-1, 1, 1, -1, -1], [-1, -1, 1, 1, -1]
for z in (-1, 1):                          # Zwei Quadrate
    ax.plot(x, y, [z] * 5, color="r")
for a, b in zip(x[:4], y[:4]):             # verbinde die vier Ecken der Quadrate
    ax.plot([a, a], [b, b], [-1, 1], color="b")

ax.set_box_aspect((1, 1, 1))
```



2.2 Fläche in 3d mit plot_surface

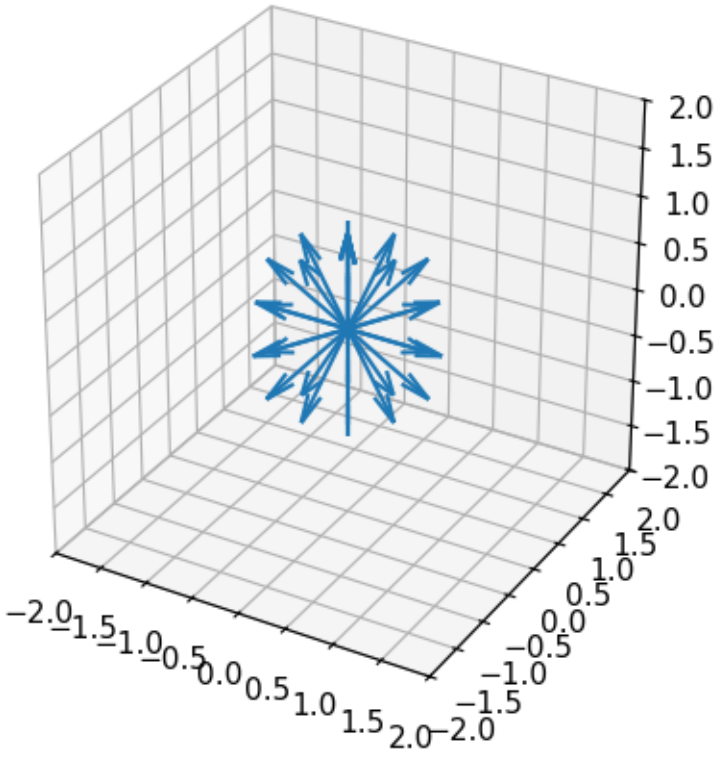
[26]:
```
fig, ax = plt.subplots(1,
                       2,
                       layout='constrained',
                       subplot_kw={'projection': '3d'})

phi = np.linspace(0, 2 * np.pi, 12).reshape(-1, 1)
theta = np.linspace(0, np.pi, 12).reshape(1, -1)
theta = np.append(theta, np.nan) #nan Trick um ungewünschte Linien zu entfernen

# Parametrisierung der Kugelfläche siehe https://de.wikipedia.org/wiki/Kugel
x = np.cos(phi) * np.sin(theta)  # durch broadcasting sind x, y, z hier 2Darrays
y = np.sin(phi) * np.sin(theta)
z = (phi * 0 + 1) * np.cos(theta)

ax[0].plot(x.flatten(), y.flatten(), z.flatten(), 'ro-', linewidth=1)
ax[1].plot_surface(x, y, z)
```

[26]:
```
<mpl_toolkits.mplot3d.art3d.Poly3DCollection at 0x7a529e241eb0>
```



2.3 Vektorpfeile in 3d mit quiver

[28]:
```
fig = plt.figure(figsize=(5, 5))
ax = fig.add_subplot(projection='3d')

phi = np.linspace(0, 2 * np.pi, 6, endpoint=False).reshape(-1, 1)
theta = np.linspace(0, np.pi, 6, endpoint=False).reshape(1, -1)

# durch broadcasting sind u, v, w hier 2D arrays
u = np.cos(phi) * np.sin(theta)
v = np.sin(phi) * np.sin(theta)
w = np.ones_like(phi) * np.cos(theta)

ax.quiver(0, 0, 0, u, v, w)
ax.set_box_aspect((1, 1, 1))

ax.set_xlim(-2, 2)
ax.set_ylim(-2, 2)
ax.set_zlim(-2, 2);
```



[ ]:
```
plt.close('all')
```