## SECTION C: Resources

### A: Direct personnel costs

One **principal investigator position** for in **total 5 person years at 50%** (30 person months) and one **senior staff scientist position** for in **total 4 person years** (48 person months), and **two postdoctoral positions** for in **total 10 person years** (120 person months) and **three student assistant positions** for in **total 2700 hours** (180 person months at 15 hours/month). This request is based on the following calculation:

FAU Erlangen will employ the PI Dr. Kuhl for (5 years, yr1-5, 50%, 20h/w), one senior scientist (4 years, yr1-4, 40h/w), two postdoctoral researchers (each 5 years, yr1-5, 40h/w), and three student assistants (5 years, yr1-5, 15h/m).

As the PI, Dr. Kuhl will oversee and manage the project, coordinate weekly meetings with the group, mentor the senior staff scientist, the two postdocs, and the three student assistants, and oversee the overall execution and timeline of the project. One postdoc and one student assistant will build the family of constitutive neural networks (WP1.1), train and test the networks on soft matter data from single and multiple loading modes (WP1.2,WP1.3), and discover models and parameters for a wide variety of soft matter systems (WP1.4) in years 1-3, compare their models to the new data (WP2.4) in year 4, and help integrate all knowledge into a single universal subroutine (WP3.4) in year 5. The senior staff scientist and one student assistant will perform a series of multiaxial tests on the heart, arteries, muscle, lung, liver, skin, brain, hydrogels, silicone, artificial meat, foams, and rubber; first starting with man-made soft materials, second turning to natural soft materials from a nearby slaughter house, and third testing freshly harvested human tissue samples (WP2.1) in years 1-3. They will discover the best model and parameters to explain the data (WP2.2), learn the parameters for traditional models (WP2.3), and compare newly discovered and traditional models (WP2.4) in years 2-4, iteratively reperform experiments (WP3.3) in years 3-4, and document and integrate all knowledge (WP3.4) in year 5. One postdoc and one student assistant will help build the family of constitutive neural networks (WP1.1) in year 1, and then embed the networks into a Bayesian analysis (WP3.1) and test and train the networks (WP3.2) in years 2-4. They will iteratively discover better models (WP3.3) in years 3-5 and integrate and document all knowledge (WP3.4) in year 5. Student assistants will be supervised by the postdocs and the senior staff scientist, and all will be supervised and mentored by the PI.

All salaries are determined by the general contract for public servants in science in Germany (Tarifvertrag für den öffentlichen Dienst/TVöD) where the PI is paid at level E15Ü, the senior staff scientist at level E13Ü, the postdoctoral researchers at level 13. Student assistants will be compensated according to the guidelines of the FAU Erlangen-Nürnberg (Vergütungstabelle für studentische Hilfskräfte) at 13€/hr plus 28.29% insurance. This yields **Total Personnel costs of 1,792,717 €.**

### B: Subcontracting cost

none

### C: Purchase costs

#### C.1: Travel and subsistence

For all five years, annual attendance of one major international conference (2,500€) for all four scientists (PI, senior staff scientist, two postdoctoral researchers), for in total 50,000 €.

For the first three years, annual visits of Professor Gerhard Holzapfel (TU Graz, Austria), for two project members (2,500€) to train on the triaxial testing device and establish a collaboration on soft matter testing and analysis (WP2.1-WP2.4), for in total 15,000 €.

This yields a **Travel and subsistence cost of 65,000 €.**

#### C.2: Equipment incl. major equipment

This project relies critically on performing novel high-accuracy multiaxial tests in tension, compression, and shear to generate previously unseen soft matter data to train, test, and validate our automated model discovery platform. We will train our team in Institute of Biomechanics at TU Graz, Austria, on the Zwick/Roell triaxial testing device and then purchase the same equipment for our project at FAU Erlangen, Germany. Because this equipment relies heavily on advanced software and electronics, we apply a depreciation time of five years, such that the requested funding is equal to the acquisition costs.

**Triaxial testing device:** The multiaxial mechanical tests (WP2 and WP3.3) require a triaxial testing device that is capable of performing tension, compression, and shear tests on one and the same sample. While uniaxial tension tests and torsional rheometer shear test are routinely performed at the Chair of Applied Mechanics at FAU Erlangen, these tests require to unmount and remount the samples. Remounting samples into different devices influences the quality of the data, especially when testing ultrasoft materials, liver, brain, hydrogels, silicone, or artificial meat (WP2). It is therefore critical to perform these experiments on a fully triaxial testing device. This system exists and is routinely used at the TU Graz. However, since we will test twelve material systems, heart, arteries, muscle, lung, liver, skin, brain, hydrogels, silicone, artificial meat, foams, and rubber, it is impossible to outsource all the experiments to TU Graz. More importantly, a major outcome of this project is that it will not only discover the best model and parameters, but also the best experiment for each material. We will address this through an iterative discovery of models, parameters, and new experiments (WP3.3). A continuous access to a triaxial testing device is thus mandatory to iteratively perform new tests. Accordingly, **a dedicated triaxial testing device has to be purchased specifically for this project**.

We have received an offer for a suitable triaxial testing system from ZwickRoell Testing Systems GmbH, Fürstenfeld, Austria, at 220,609.34 € including tax. This system is especially designed to probe soft materials. It consists of two main components, an upper platform moving vertically and a lower platform moving horizontally in two perpendicular directions. The system can not only characterize isotropic, but also anisotropic materials. Specimens are attached to the upper and lower platforms using a thin coating of super glue. Forces in three directions are measured simultaneously with a special load cell on the upper platform. The test setup includes a 256x510mm test frame, load cells with nominal forces of 2N in each direction at a maximum velocity of 100mm/min and a resolution of 0.009um. It also includes four sets of specimen holders for multiaxial testing and a temperature-controlled fluid bath. The device is controlled via the software testXpert III with graphic user interface and a work station. Purchasing this triaxial test system amounts to an **Equipment cost of 220,609 €.**

**C.3: Other goods, works and services**

**Consumables incl. fieldwork and animal cost:** For all five years, the project requests 10,000€/year for consumables for experimental testing to train, test, and validate our models on previously unseen data (WP2.1) and iteratively refine the experiments to reduce the credible intervals of the Bayesian analysis (WP3.3). These consumables including lab coats, gloves, scalpels, containers, tubes, disinfectants and other chemicals for the experimental workflow of tension, compression, and shear tests. The costs for these consumables is 10,000€ per year, amounting to 50,000 €. As a one-time purchase in year one, we estimate 10,000 € for additional storage devices including server hard drives. This amounts to a total **Consumable cost of 60,000 €.**

**Publications**: On average five open-access articles per year with on average 3,000 € / publication. This amounts to a **Publication cost of 75,000 €.**

**Other additional direct costs**: The financial audit amounts to **Other additional direct cost of 7,000 €.**

Altogether, this amounts to a **total cost for other goods, work and service of 142,000 €.**