

KnApp: The Knee Visualization App

User Guide

Team Knee'd For Speed
Fall Semester 2022

Guide Topics

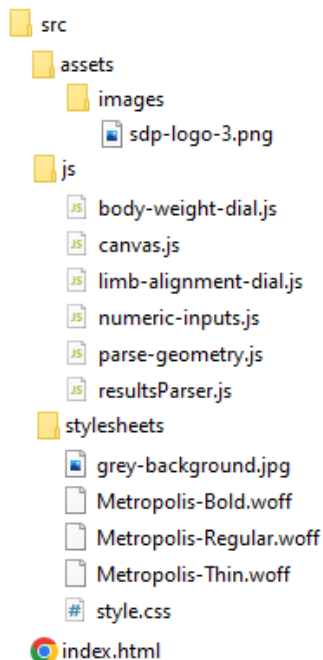
1. [Running the application](#)
2. [File type requirements](#)
3. [How information is displayed](#)
4. [How to use the app](#)
5. [Any known issues in the application](#)


Running the Application

Currently, the app is hosted on the BSU SDP site, located at <https://sdp.boisestate.edu/f22-kneed-for-speed/>, and on GitHub at <https://cs481-ekh.github.io/f22-kneed-for-speed/src/index.html>. It is important to note that the BSU SDP site can only be accessed while on the campus network. You can visit either of these sites to use the app.

To run or host the application elsewhere, you will need to take the following steps:

1. Unzip the provided knapp.zip file
2. Open the 'src' folder
3. Make sure the file structure remains intact



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4. Open index.html on your computer.

This should open the fully functional app in your default browser and run it locally.

Note: The app is designed to run in the Google Chrome web browser. If Chrome is not your default browser, we recommend right-clicking on the index file and opening it with Chrome.

To host the application on your own website, you simply need to deploy the docker image generated from the dockerfile provided in knapp.zip. Detailed instructions on deploying an application to a website using Docker can be found on their documentation site <https://docs.docker.com/>.

File Type Requirements

File format is extremely important for this application to function properly. Both the Geometry and Results files have their own unique formatting specifications.

Geometry Files

Geometry Files must be in .inp format. This means they must have the following features:

- Must have sections with headings containing the keywords 'node', 'element', and if it is a cartilage file, at least one section with the keyword 'side' for side nodes.
- The order of these headings must be 'node', 'element', then 'side'.
- The line following each heading must immediately contain data for that section
- Node and element data must be separated by commas and start a new line for each individual node or element
- A single line for 1 node should contain the node number, the x coordinate, the y coordinate, and the z coordinate for the node.
- A single line for an element should contain the element number, followed by the node numbers for each node in that element.
 - Cartilage elements should have 8 nodes associated with them
 - Bone elements should have 3 nodes associated with them
- Side node data can take any format as long as it is preceded by a heading

Below are picture examples of the correct Geometry .inp file format.

Node section header and data:

```
4 *NODE, NSET=PAT_CART_NODES
5 3990001, 21.081652, 24.661286, 47.058696
6 3990002, 21.006821, 24.931074, 46.669448
7 3990003, 21.039131, 27.290251, 46.527534
8 3990004, 21.035393, 27.092308, 46.908723
9 3990005, 21.041647, 26.894125, 47.289622
10 3990006, 21.037908, 26.696182, 47.670811
```

Element section header and data for a cartilage file:

```
4770 *ELEMENT, TYPE=C3D8R, ELSET=CART-PATELLA
4771 3990001, 3991570, 3991665, 3991780, 3991694, 3991581, 3991675, 3991787, 3991706
4772 3990002, 3991858, 3992067, 3992088, 3991923, 3991870, 3992075, 3992099, 3991933
4773 3990003, 3992283, 3992506, 3992419, 3992259, 3992292, 3992505, 3992431, 3992270
4774 3990004, 3992653, 3992762, 3992636, 3992533, 3992651, 3992766, 3992649, 3992542
4775 3990005, 3991614, 3991775, 3991635, 3991507, 3991622, 3991782, 3991638, 3991515
4776 3990006, 3991964, 3992116, 3992132, 3991974, 3991973, 3992125, 3992142, 3991978
4777 3990007, 3992252, 3992369, 3992422, 3992279, 3992267, 3992380, 3992440, 3992297
```

Element section header and data for a bone file:

```
1127 *ELEMENT, TYPE=R3D3, ELSET=BONE-PATELLA
1128 6400000, 6400000, 6400543, 6400788
1129 6400001, 6400000, 6400312, 6400478
1130 6400002, 6400000, 6400138, 6400312
1131 6400003, 6400364, 6400138, 6400000
1132 6400004, 6400788, 6400178, 6400000
1133 6400005, 6400000, 6400178, 6400364
1134 6400006, 6400000, 6400478, 6400543
```

Side node section header and data:








```
8403 *NSET, NSET=PAT_CART_BONE_SIDE_NODES
8404 3991570, 3991665, 3991780, 3991694, 3991858, 3992067, 3992088, 3991923,
8405 3992283, 3992506, 3992419, 3992259, 3992653, 3992762, 3992636, 3992533, 3991614, 3991775,
8406 3992252, 3992369, 3992422, 3992279, 3992911, 3992775, 3990411, 3990601, 3990686, 3990538,
8407 3991285, 3991144, 3991428, 3991543, 3991569, 3991430, 3991828, 3991690, 3991976, 3992147,
8408 3992666, 3992777, 3992781, 3992637, 3992884, 3993071, 3993084, 3992929, 3993238, 3993401,
8409 3993912, 3994101, 3993991, 3993854, 3994210, 3994279, 3994175, 3994089, 3990096, 3990224,
8410 3990631, 3990756, 3990818, 3990683, 3990900, 3991041, 3991084, 3990955, 3991183, 3991318,
8411 3991730, 3991867, 3991897, 3991746, 3992028, 3992180, 3992200, 3992043, 3992335, 3992489,
8412 3992948, 3993096, 3993108, 3992965, 3993249, 3993394, 3993398, 3993261, 3993533, 3993676,
```

They should also follow these conventions for their file names:

- If it is a Bone file, 'bone' must appear in the file name
- If it is a Cartilage file, 'cart' must appear in the file name

Note: These requirements are not case sensitive.

Examples of properly named geometry files:

 BONE2-FEMUR-DU01.inp
 BONE3-TIBIA-DU01.inp
 BONE5-PATELLA-DU01.inp
 FEM_CART_G.inp
 PAT_CART_G.inp
 TIB_CART_LAT_G.inp
 TIB_CART_MED_G.inp

Results Files

Results Files must be in a specific .csv format. This means they must have the following features:

- The file should have **no** header row
- All values in the file should be separated by commas
- The first column should contain the element numbers
- Each column after the first should contain the pressure on each element at specific points in time
- Row length must be the same throughout the file

Below is a picture example of the correct Results .csv file format:









1	3990001,	0.164923966,	0.102849238,	0.104344368,	0.128753245,	0.144220099,	0.137958601,
2	3990002,	0.106993310,	0.038573105,	0.070878349,	0.077289969,	0.120876528,	0.121502385,
3	3990003,	0.167731673,	0.111482248,	0.110375576,	0.148567170,	0.201910555,	0.200200349,
4	3990004,	0.180256590,	0.077891856,	0.053866860,	0.123133272,	0.215372682,	0.222113207,
5	3990005,	0.280470371,	0.061719440,	0.054837197,	0.144018024,	0.264474690,	0.276825041,
6	3990006,	0.175312907,	0.061535120,	0.063404821,	0.092792958,	0.201190531,	0.211526901,
7	3990007,	0.161937296,	0.050189450,	0.051228162,	0.125208378,	0.236920998,	0.250342518,
8	3990008,	0.283551067,	0.058120914,	0.051897988,	0.173304930,	0.305097222,	0.314392298,
9	3990009,	0.475250363,	1.159436941,	1.589010358,	1.341940761,	1.087868094,	1.176681995,
10	3990010,	1.403176308,	1.963101387,	2.020087957,	1.757446289,	1.505095124,	1.498805642,
11	3990011,	0.939915180,	1.425562382,	1.477809906,	0.999076664,	0.802280188,	0.764872968,
12	3990012,	0.324654043,	0.254203171,	0.255007297,	0.077323802,	0.142691463,	0.149346530,
13	3990013,	0.386252761,	0.015531342,	0.021187276,	0.216768160,	0.419994742,	0.447329968,
14	3990014,	0.549425185,	0.028347060,	0.038891796,	0.303172499,	0.586668432,	0.624741018,

They should also follow these conventions for their file names:

- If it is a stress file, ‘_S’ must appear in the file name
- If it is a strain file, ‘_LE’ must appear in the file name

Note: These requirements are not case sensitive.

Below are some examples of properly named results files:

 CART-FEMUR_LE.csv
 CART-FEMUR_S.csv
 CART-PATELLA_LE.csv
 CART-PATELLA_S.csv
 CART-TIBIA-LAT_LE.csv
 CART-TIBIA-LAT_S.csv
 CART-TIBIA-MED_LE.csv
 CART-TIBIA-MED_S.csv

How Information is Displayed in the App

- The map draws each individual element based only on the x and y values for each of its nodes.
- The largest pressure in the entire results file is found and the pressures on each element at the time in which this maximum pressure occurs are used to color the elements on the heat map.
- The heat map key will display the maximum and minimum force values
- The parameter dials themselves work, but do not currently affect the heat map in any way. The dials can be turned via clicking and dragging, using the '+' and '-' buttons, or typing an exact value into the number input below them, but the map does not change.

How to Use the App

Basic steps:

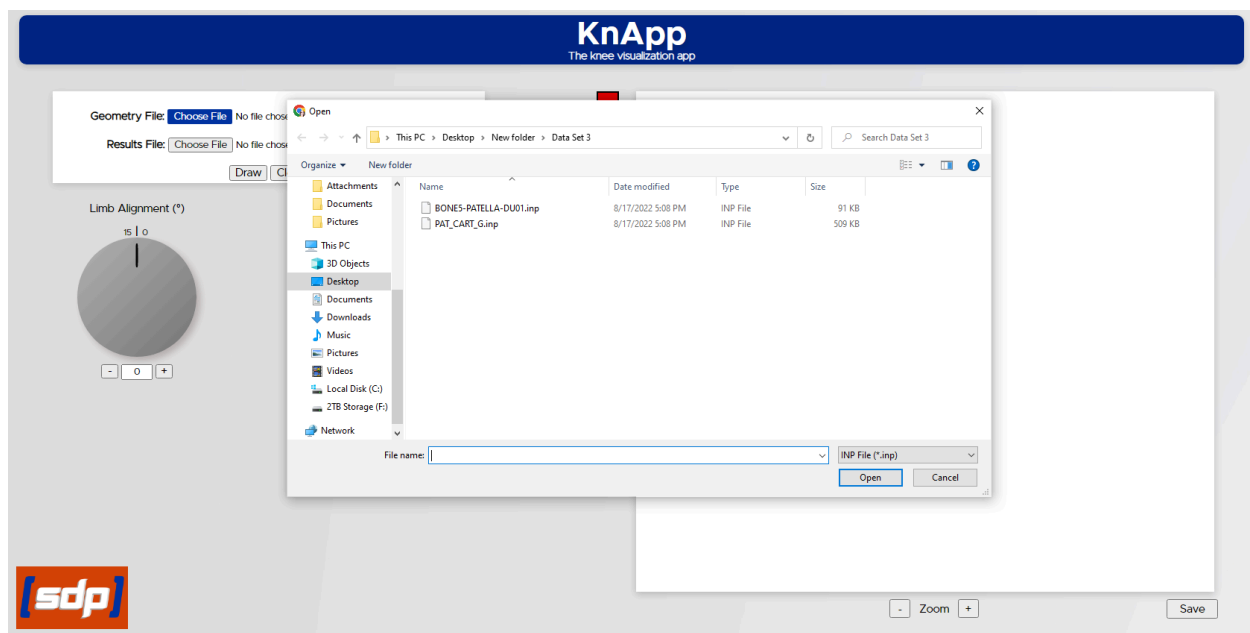
1. Open the app locally or online
2. Select a geometry file
 - a. If it is a bone file, it can be drawn immediately
 - b. If it is a cartilage file, can also be drawn, but will appear as 1 solid color
3. Select a corresponding results file if you are drawing a cartilage geometry
4. Click the Draw button to create the heat map
5. Click and drag the image on the canvas or use Zoom buttons for desired view of the image

6. Click the Save button for a .png file of your image
7. Click the Clear button to reset the page or simply choose new files if you wish to draw another image

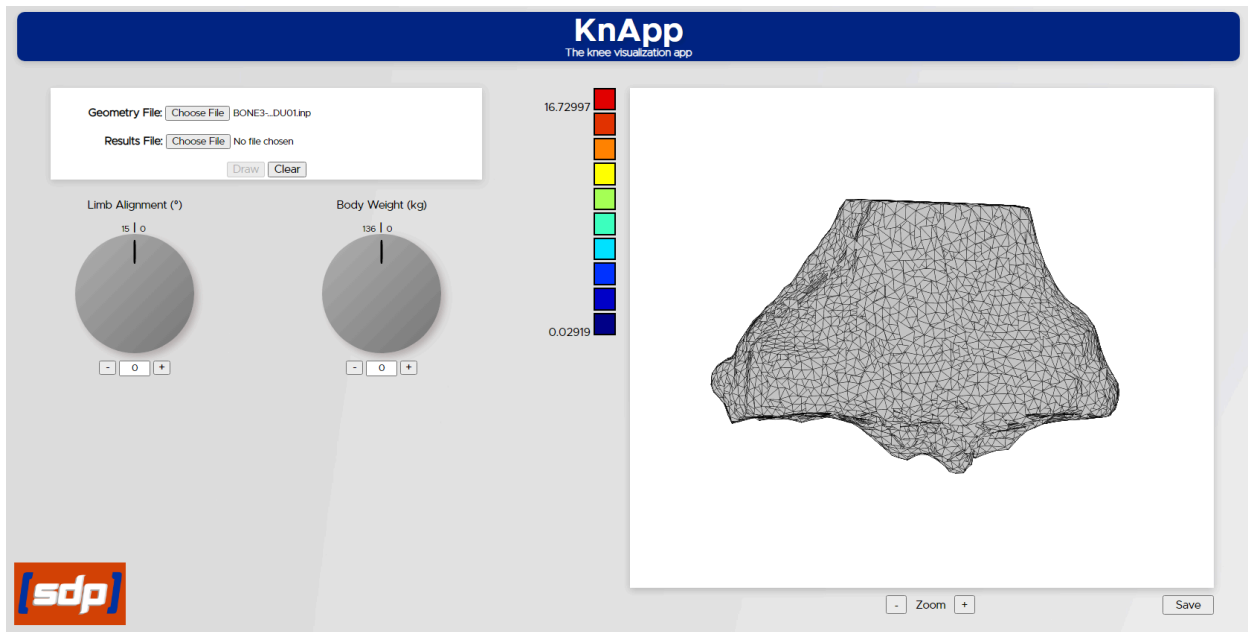
Note: The parameter dials on the left side of the page do not affect the image yet, but they should still be able to be interacted with by clicking, dragging, using their associated '+' and '-' buttons, or by having their number input manually changed in the box below them.

More detail:

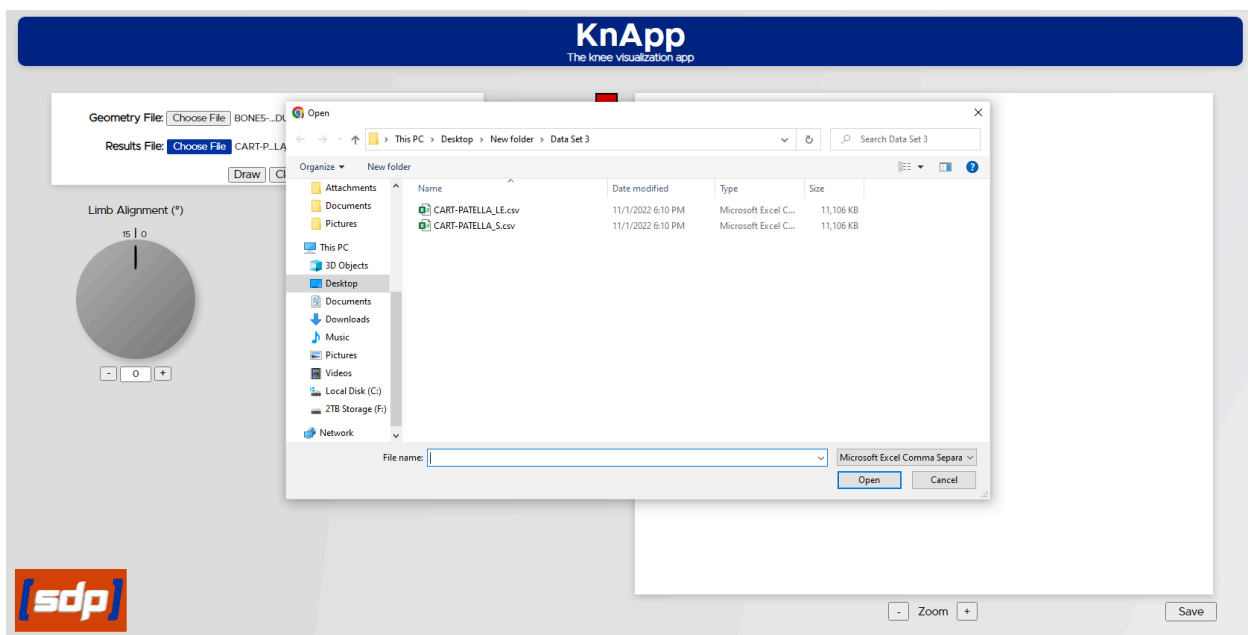
To use this web application, a user must first click on the “Choose File” button in the upper left of the web page following the “Geometry File” label and select a Geometry data file from their local drive. Files must be in .inp format and the file name must include the tissue type it will produce- ‘bone’ for bone files and ‘cart’ for cartilage files.



If the file is a bone file, the user can draw it accurately without a corresponding result file, as the app is only designed to generate pressure maps for cartilage. Bones are drawn entirely in grey, such as the tibia geometry below.

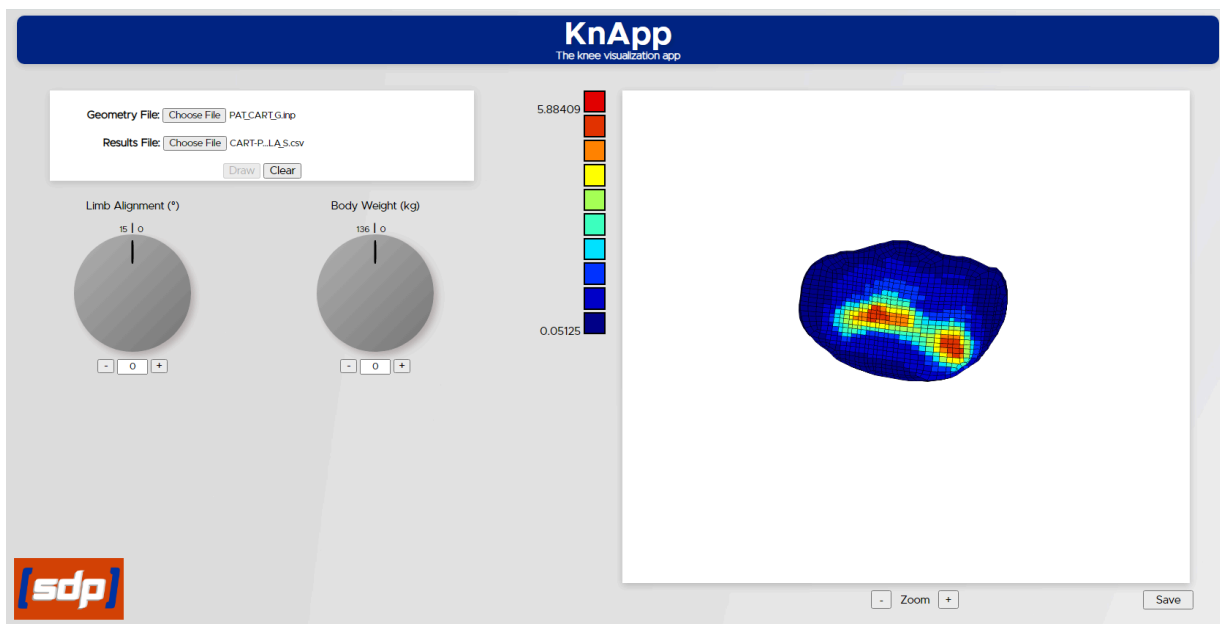


If they are working with a cartilage file, users must then click on the “Choose File” button following the “Results File” label and select a Results data file from their local drive. Results files must be in .csv format and the file name must include the pressure type it will display- ‘_S’ for stress files and ‘_LE’ for strain files. If they do not select a results file, the cartilage will be drawn in one single color rather than with a heat map applied.

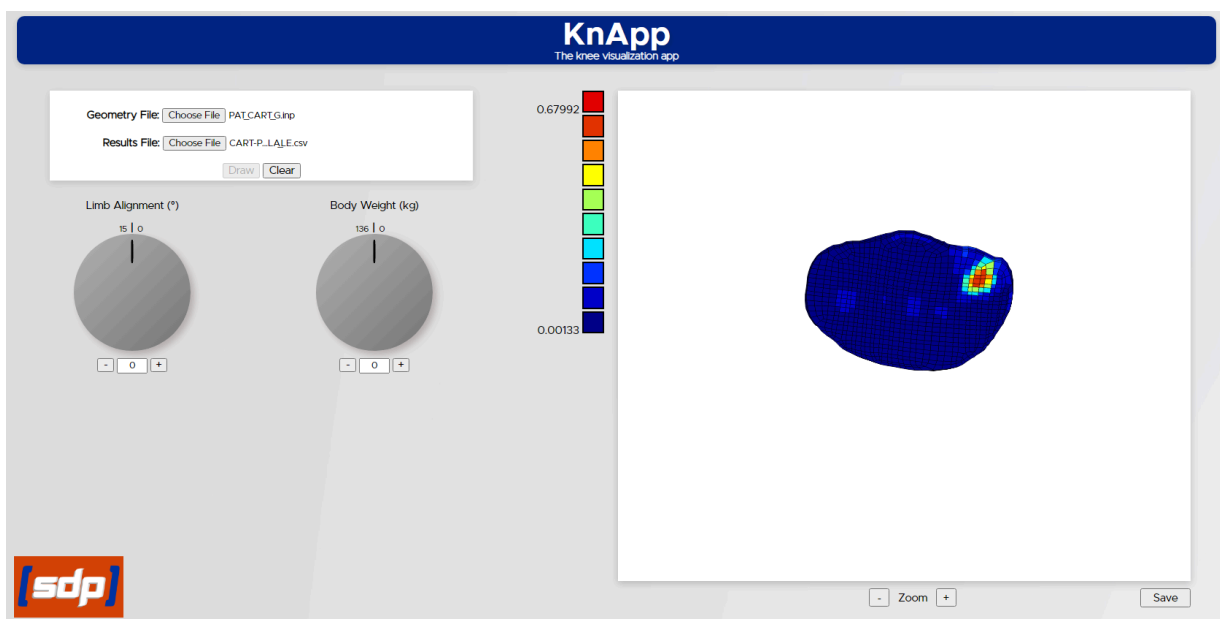


Once their file(s) are chosen, the user must click on the “Draw” button to generate their image. The image will appear in the canvas element on the right side of the web page.

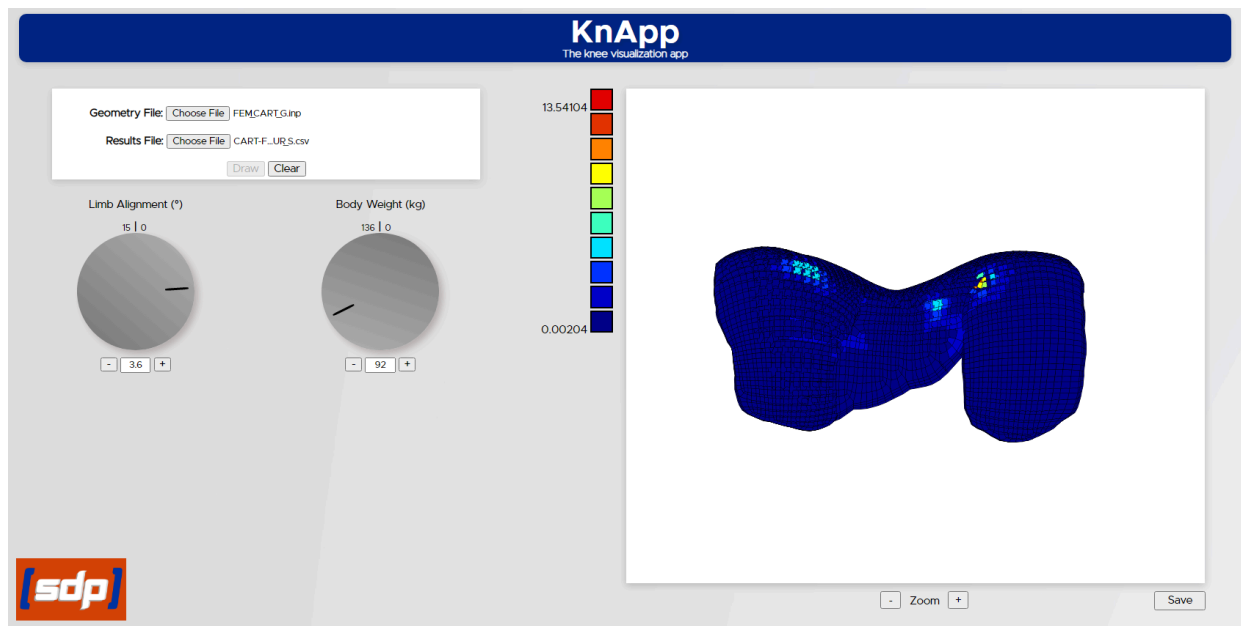
The following image shows the map of a stress results file on a patella cartilage geometry file:



The following image shows the map of a strain results file on the same patella cartilage geometry file as above:

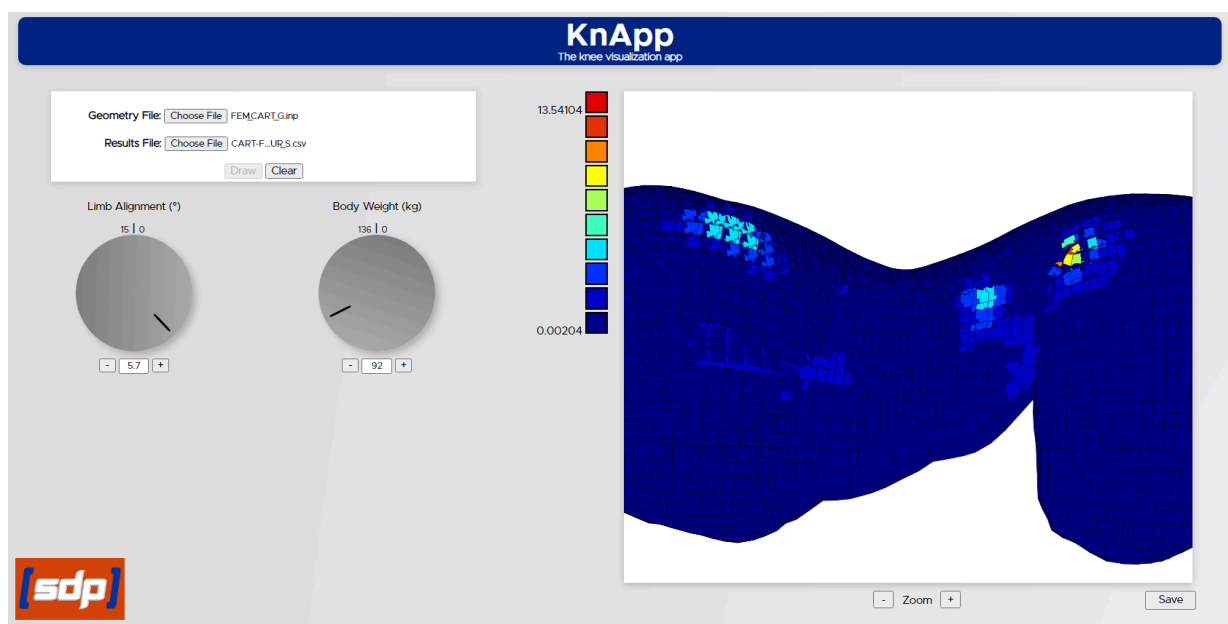



This next image shows the map of a stress results file on a femur cartilage geometry file:



Note: When drawing femur cartilage in particular, the app can run very slowly due to the sheer size and number of unique nodes and elements. You may need to wait a moment for the page to respond.

Users can then Zoom in or out on the image they have created and are also able to save a .png file of the image using the buttons located below the canvas.





To draw another image, users can click on the 'Clear' button located next to the 'Draw' button to reset the page completely, or they can simply choose a new geometry or results file from either or both of the file selection buttons and click 'Draw' again.

Currently, the parameter dials on the left side of the page do not affect the generated heat map. They can be turned by clicking and dragging to rotate them, by clicking or holding the '+' and '-' buttons below them, or by manually entering a value in their indicated range in the number input area below them. Future work on the project could allow these values to update the heat map in real-time for the user to show them how changes to these parameters could change where or how much pressure is being applied to different parts of the knee.

Known Issues

The application in its current state suffers from three known issues:

1. It can run slowly when drawing, moving, or zooming in/out of the heat map image, especially on larger files like femur cartilage. The user may need to wait a moment for the page to respond.
2. Due to their x and y values, some items are drawn out of the initial canvas field of view and must be dragged into view or found by zooming out.
3. Due to the way the maximum force on the knee is found and displayed, if that force is an extremely high outlier, it will cause the heat map drawing to be mostly dark blue, signifying potentially false low pressure across the map. Also due to this current calculation, if all forces are between 0 and 1, the entire element will appear to be drawn in red, signifying potentially false high pressure across the entire map.

One aspect of the application also remains incomplete at this time:

1. The parameter dials do not affect the generated heat map. A future team or project contributor could possibly implement this feature by having the code listen for any changes to the parameter dial values, taking these new values and applying the proper equation based on the results file type (stress or strain) to figure out how the new value would change the current result file data, and then applying the new results data to the heat map and re-drawing it.