# HDM Software Users Guide

## Introduction

HDM (Hierarchical Decision Modeling) was developed by **Dundar Kocaoglu** in 1976. It consists of the following steps:

1. Design and verification of the decision hierarchy for strategic management decisions
2. Formation of Expert Panels
3. Quantification of expert judgments by using pairwise comparisons among decision elements by constant sum (CS), direct ratio (DR) or absolute value (AV) methods for data input.
4. Development of Desirability Functions for the characterization of decision alternatives
5. Calculation and reconciliation of decision inconsistencies for each expert
6. Calculation and reconciliation of disagreements among the experts
7. Aggregation of the computations to determine the relative value of each decision alternative in terms of its combined impacts on the top level of the hierarchy
8. Sensitivity analysis to determine the effect of changing priorities and expert opinions
9. Validation of the results by independent experts.

**Liono Setiowijoso** is developing a user-friendly HDM software system for a hierarchy of up to 10 levels and up to 12 decision elements at each level. However, the number of elements can be increased without a limit, using the Chainwise Comparisons method developed in **Jang Ra**'s 1988 PhD dissertation. The software supports steps 1, 3 (with CS and DR inputs), 5, 6 and 7. Steps 4 and 8 are in the process of being incorporated into it.

**Kenny Phan**'s 2013 PhD dissertation are expanded in the software for applications of HDM in strategic management of current and emerging innovative technologies and their impacts on social, technical, economic, environmental, political, legal and ethical (STEEPLE) systems.

HDM Sensitivity Analysis developed in **Hongyi Chen**'s 2007 PhD dissertation is being incorporated into the software system to determine the sensitivity of the strategic decisions on changes in priorities and relative impacts of decision elements on each other.

HDM Inconsistency Analysis developed in **Mustafa Abbas**' 2016 PhD dissertation will soon be included in the software system to determine the level and acceptability of inconsistency in the quantified judgments of each expert.

## Access to the software

- There are 2 types of access:

    1. Researcher's access
    2. Expert's access.

These two access types should not be confused. Sometimes the researcher also wants to be an expert to test or see how the experts will view the model. In that case, the researcher must be clear when he/she is acting as a researcher and when as an expert. When the system is accessed as an expert, the analysis/results are not visible.

- For researcher's access, an account (login and password) is needed. The account can be created at research1.etm.pdx.edu/hdm2

- In researcher's access, one can:
  - Create a model
  - Get the URL to be sent to the experts via email
  - See the results and the analysis after the experts provide their quantified judgements

- No account is needed for expert's access. The expert just provides his/her name so the researcher knows who is responding to the request. The URL for experts is different for each model. The URL is provided when the researcher completes creating a model.

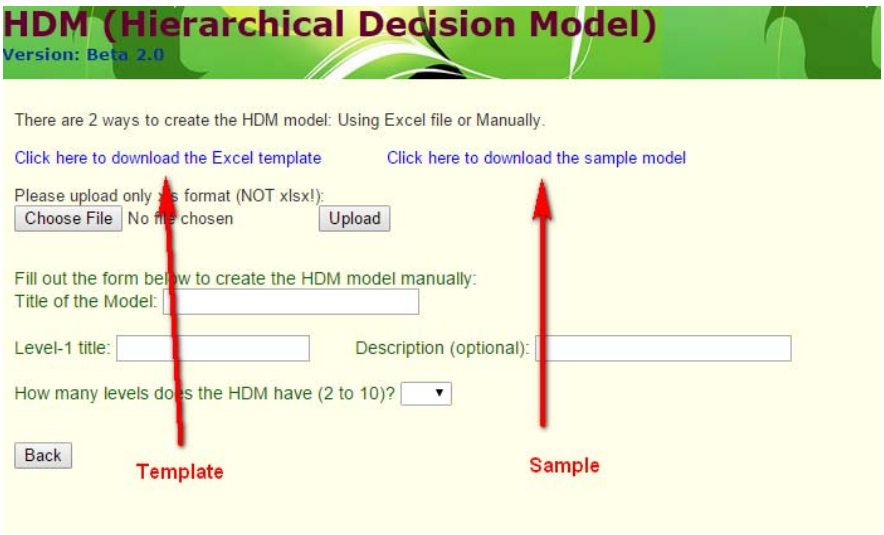
## Creating a model

There are 2 ways to create a model.

1. By using manual data entry on the web
2. By uploading an Excel file.

If the researcher wants to change or modify the model after the model is completed, it is necessary to start from the beginning. So the Excel mode is better, because changes can be made by just modifying the data in the Excel file and uploading it again.

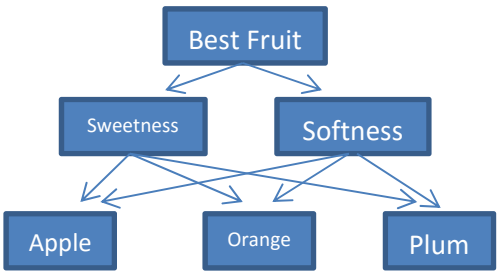
An Excel template and a sample model are provided in HDM software to demonstrate how the data are organized in the Excel file, and how the model is developed.



**An example**

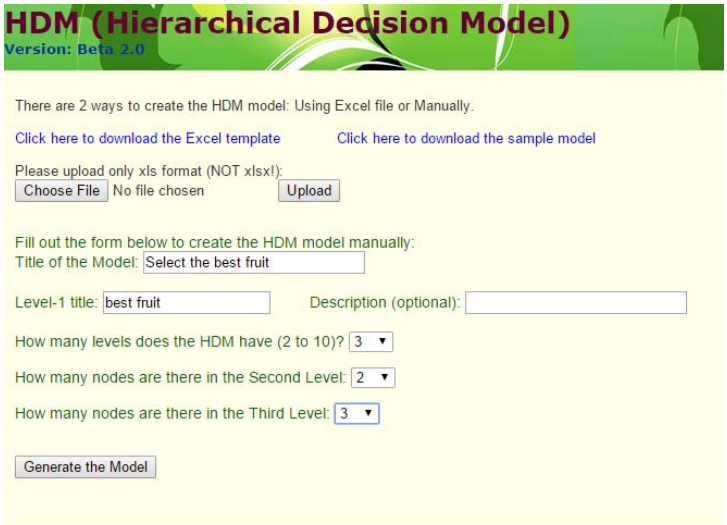
You need to have a clear vision of your final model before creating it using the HDM software. You might want to draw it on a piece of paper before transferring the information to the system.

In this example we want to create the following model:

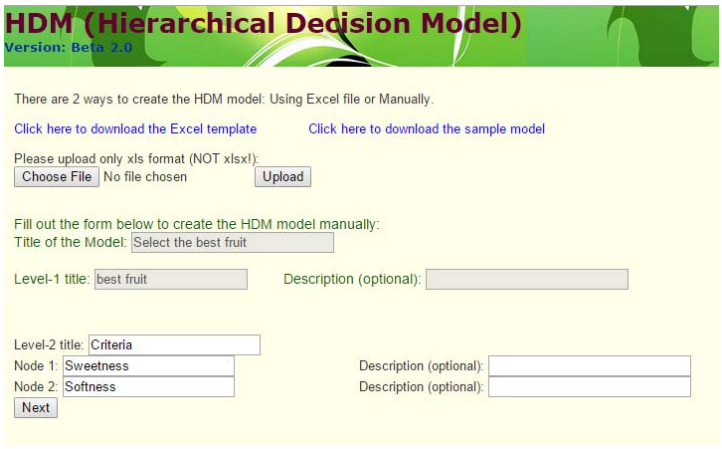



**Using the *manual input* you need to fill out the online form by following the 22 steps below:**

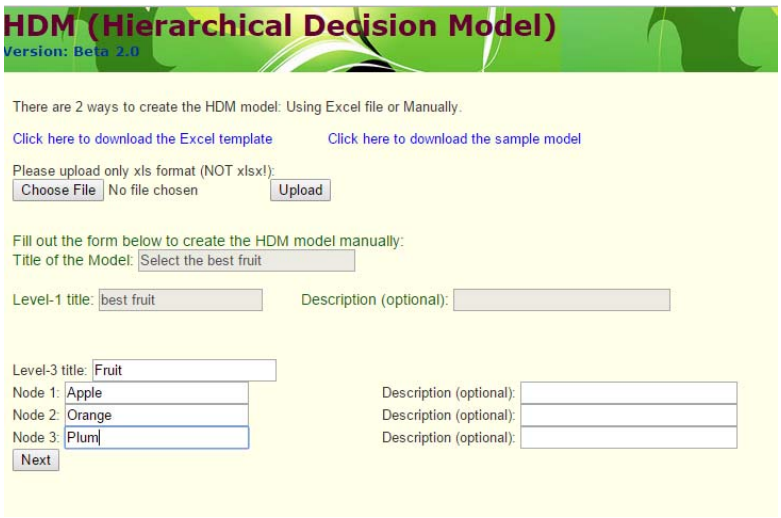
1. Enter the title of the model: *Select the best fruit*
2. Enter title of the top level (level 1): *Best fruit*
3. Select *3* as the number of levels
4. Select *2* nodes for level 2 and *3* nodes for level 3



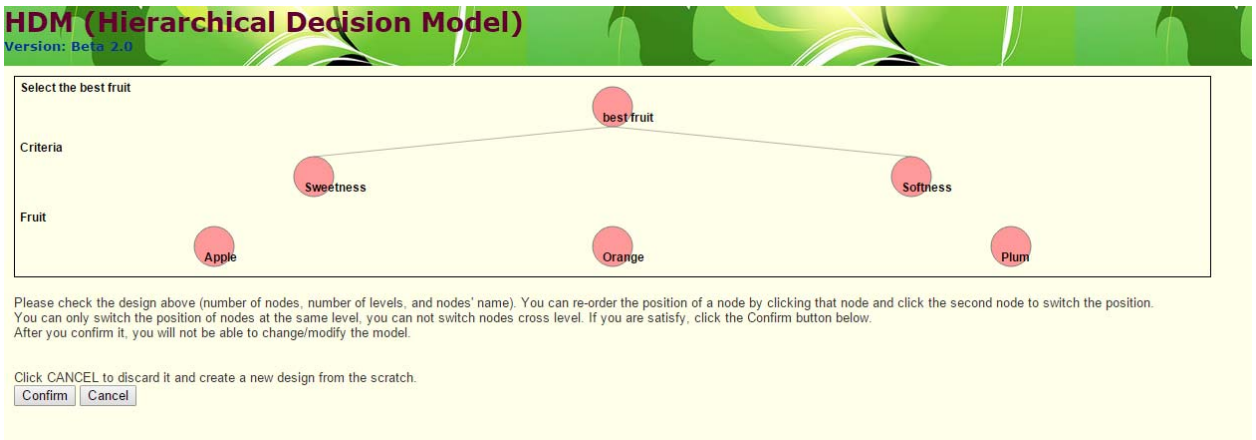

5. Click “Generate the Model”
6. Enter title for level 2: *Criteria*
7. Enter name for node 1: *Sweetness*
8. Enter name for node 2: *Softness*



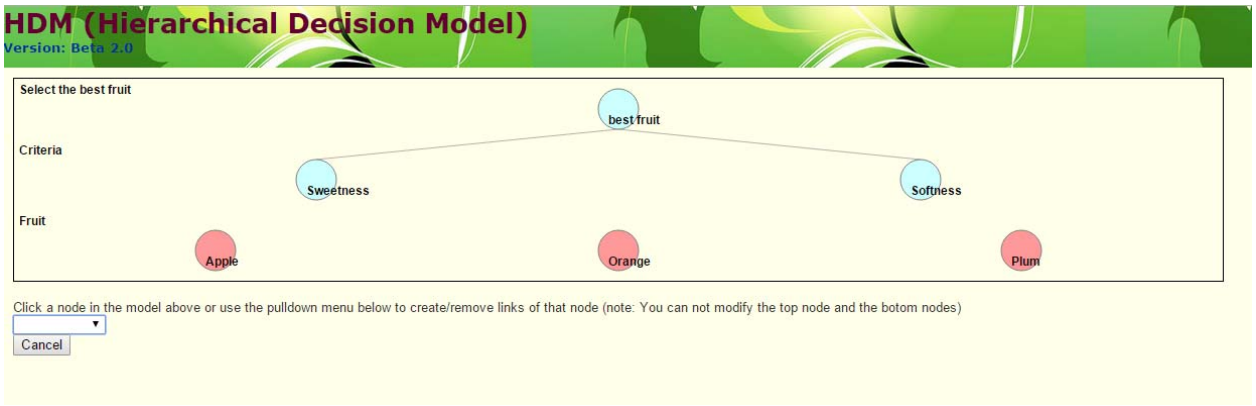

9. Click “Next”
10. Enter title for level 3: *Fruit*
11. Enter name for node 1: *Apple*
12. Enter name for node 2: *Orange*
13. Enter name for node 3: *Plum*



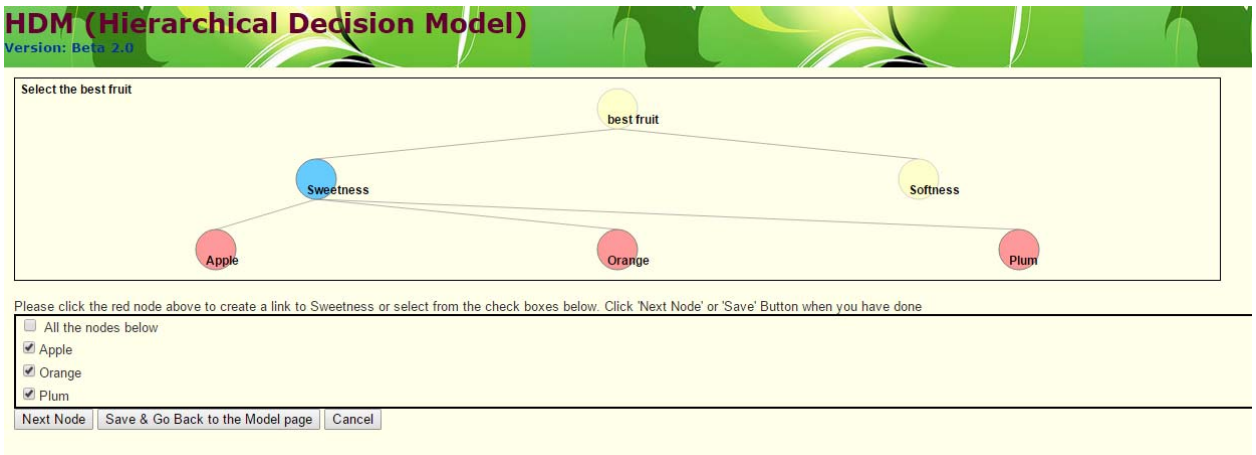

14. Click “Next”



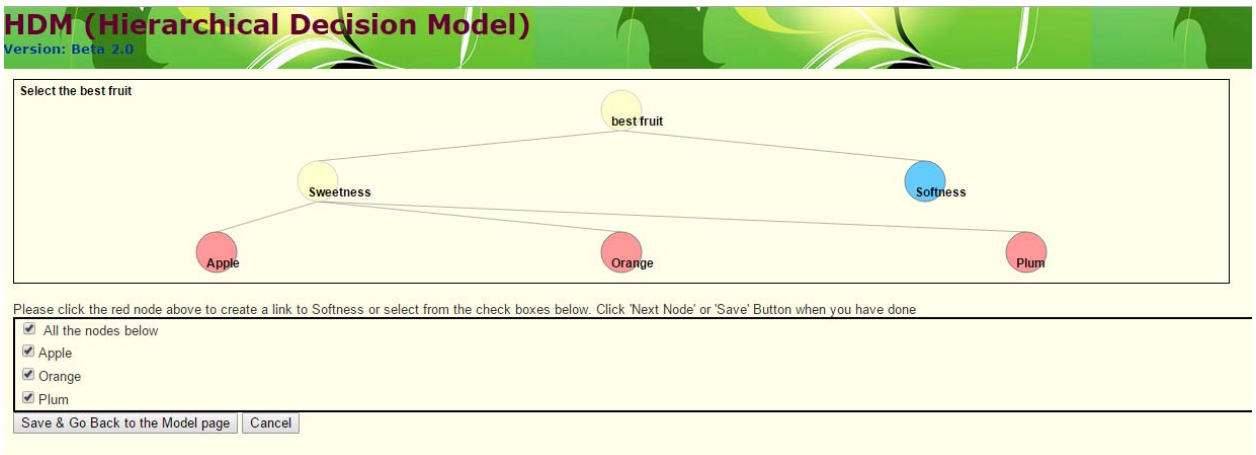
15. At this stage, it is recommended to double check to make sure the model is correct as you want it. Click “Confirm” when you are satisfied with the model.



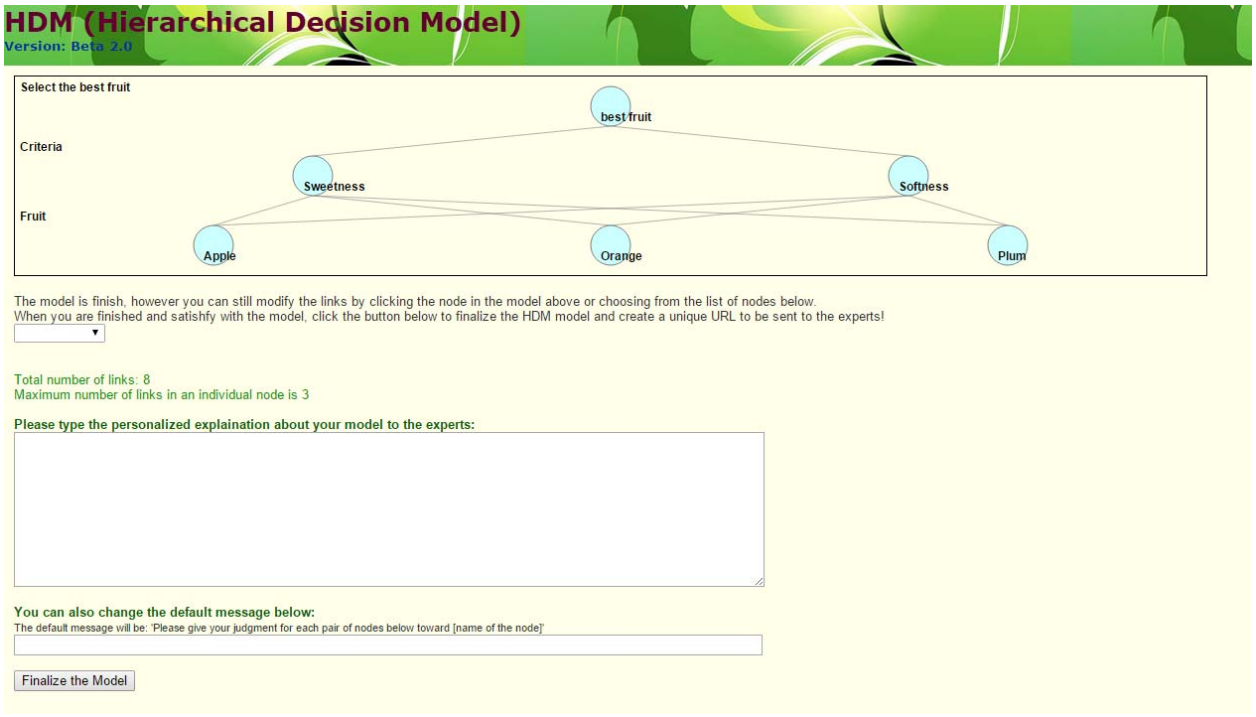

16. Now is the time to finalize the model by creating links from level 2 to level 3.
17. Click “Sweetness” node then click “Apple”, “Orange”, and “Plum”




18. Click “Next Node” and then check “All the nodes below” box




19. Click “Save & Go Back to the Model page”




20. Check the complete model and type instructions for your experts if you wish to do so. Since every model is unique, it helps the experts to see your explanation of what you want to achieve and what they are expected to do. When you are done click “Finalize the Model”


21. After you finalize the model, you will get the URL for this particular model that you can send to your experts. Click “Back” to go back to the researcher main page.
22. If you have created multiple models, the URL for each model is displayed next to that model.

## Using *Excel file* to create the same model

- Download the template file and fill out the information about the model:

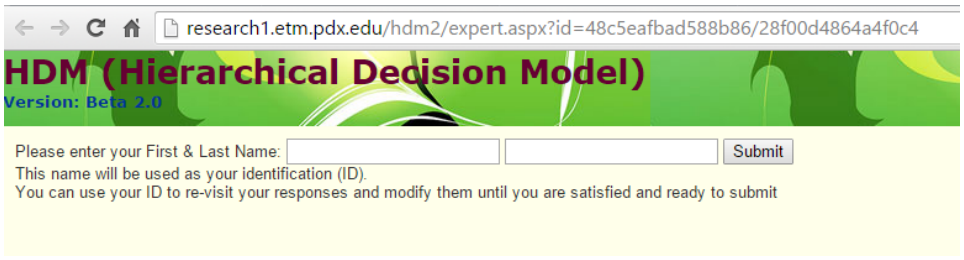
| | A | B | C | D | E | F | |
|---|---|---|---|---|---|---|---|
| 1 | **Model Information** | **Level 1 node name** | **iption of node in Le** | **Level 2 node names** | **otion of node in** | **Level 3 node names** | **Description o** |
| 2 | Select the best fruit | Best fruit | | Sweetness | | Apple | |
| 3 | **Number of Level:** | | | Softness | | Orange | |
| 4 | 3 | | | | | Plum | |
| 5 | **Level 1:** | | | | | | |
| 6 | Best fruit | | | | | | |
| 7 | **Level 2:** | | | | | | |
| 8 | 2 | | | | | | |
| 9 | Criteria | | | | | | |
| 10 | **Level 3:** | | | | | | |
| 11 | 3 | | | | | | |
| 12 | Fruit | | | | | | |
| 13 | **Level 4:** | | | | | | |
| 14 | 0 | | | | | | |
| 15 | | | | | | | |
| 16 | **Level 5:** | | | | | | |
| 17 | 0 | | | | | | |
| 18 | | | | | | | |
| 19 | **Level 6:** | | | | | | |
| 20 | 0 | | | | | | |
| 21 | | | | | | | |
| 22 | **Level 7:** | | | | | | |
| 23 | 0 | | | | | | |
| 24 | | | | | | | |

- Save the Excel file then upload it to the system.
- If you enter the information correctly, you will see the model is displayed as in the step no 15 above.
- Continue with step 16 to step 22 to finalize the model.

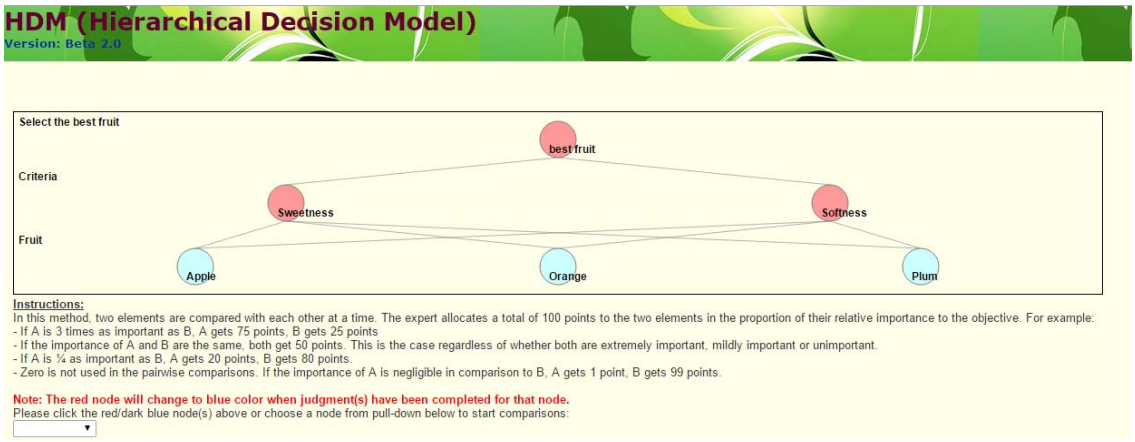
## The expert's access

- When your expert receives the URL and opens it in the web browser, he or she enters his/her name. There are two purposes for entering the name:

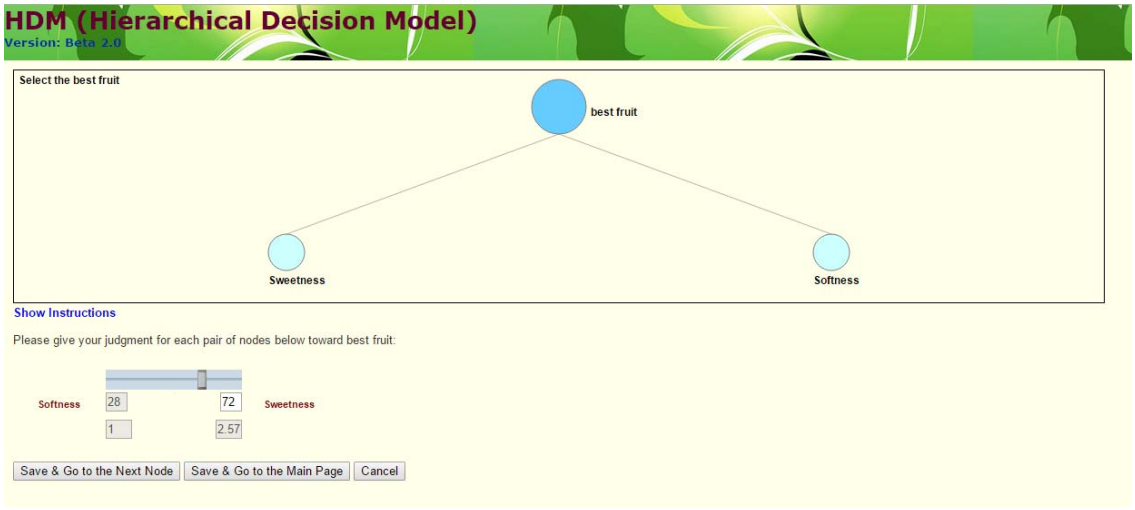
    1. To make sure the researcher can identify who the respondent is
    2. To stop and continue later if the expert does not finish completing data entry at the first attempt. For a big model, there will be a large number of nodes, and the expert might want to stop in the middle and come back later to continue. The expert will not be able to submit the answer until he/she completes all of the nodes.



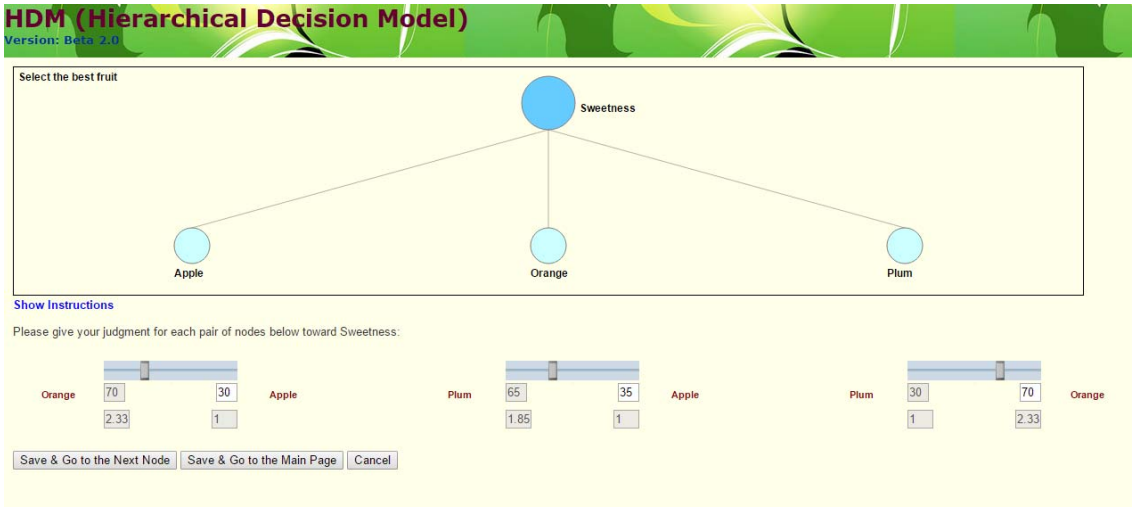

- Click "Submit" and your model will be displayed.

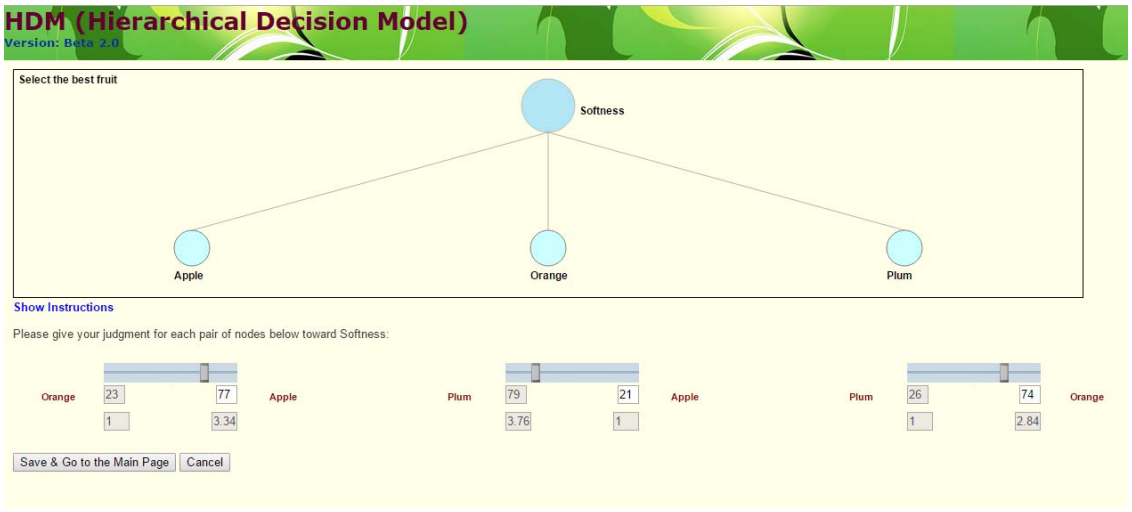



- The expert can click any red node to do the judgement quantification.

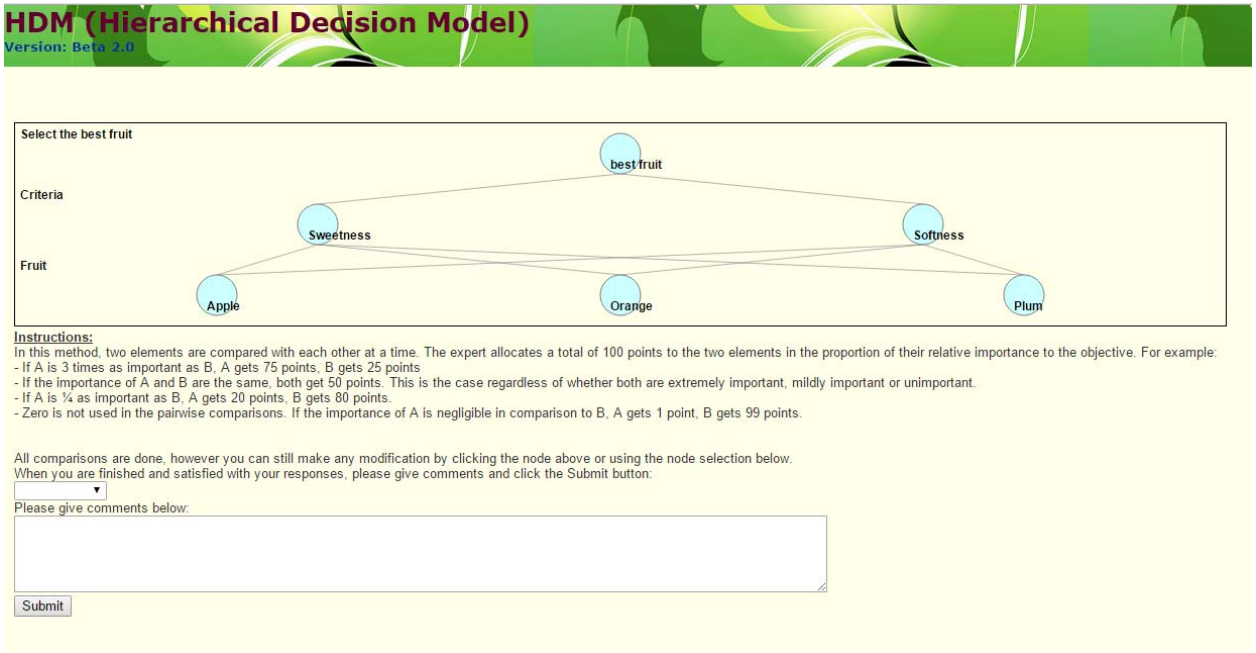



- Click “Save & Go to the Next Node” to continue the process until finish





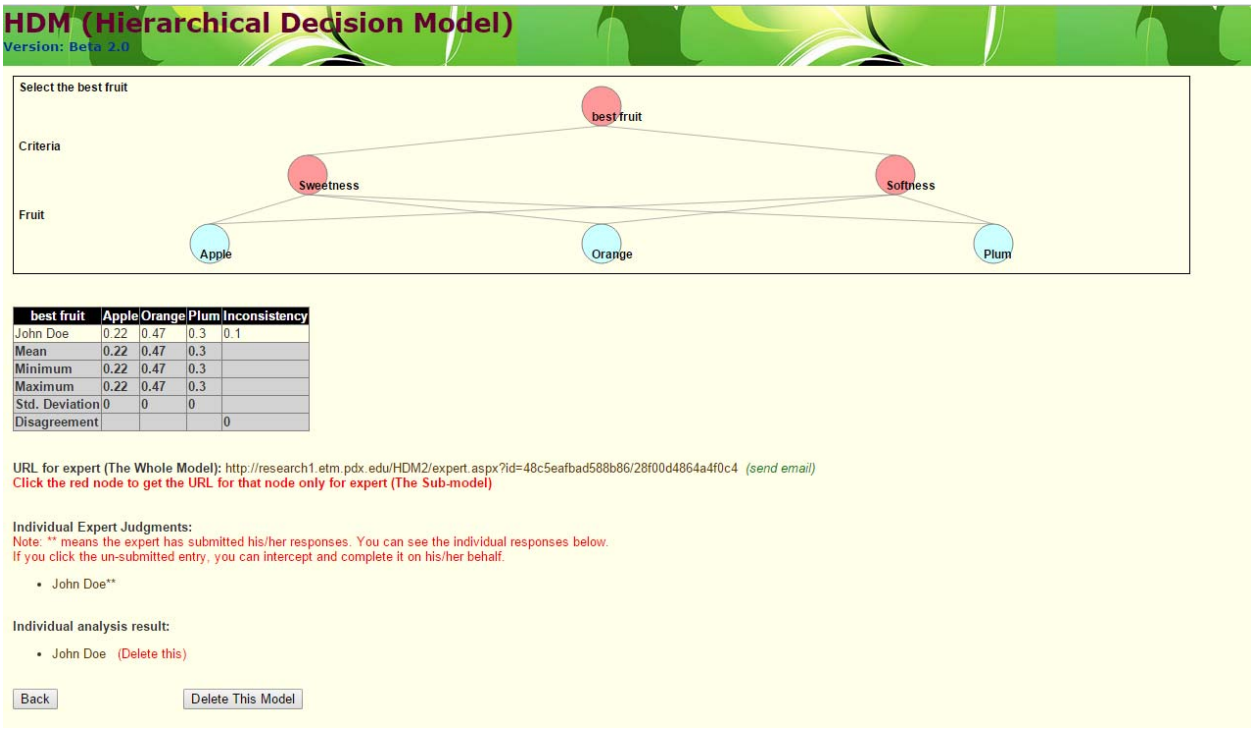

- After the last node, click “Save & Go to the Main Page”



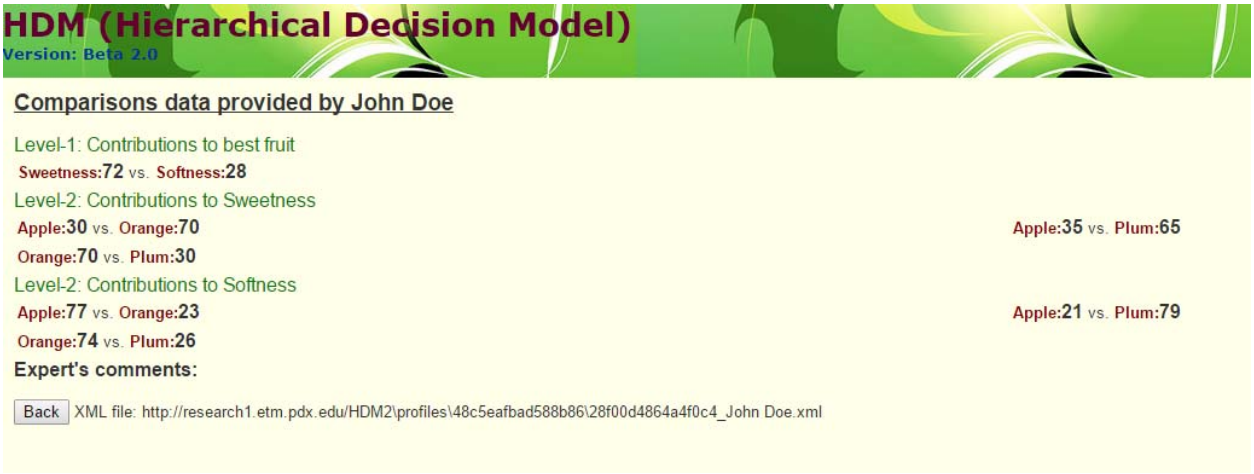

- You see that the red nodes become light blue now. It means that the data entry process for quantified judgments has been completed. The expert is ready to submit his/her responses at that point. However, if any red nodes remain, the expert cannot submit the responses.

## Checking the responses and results

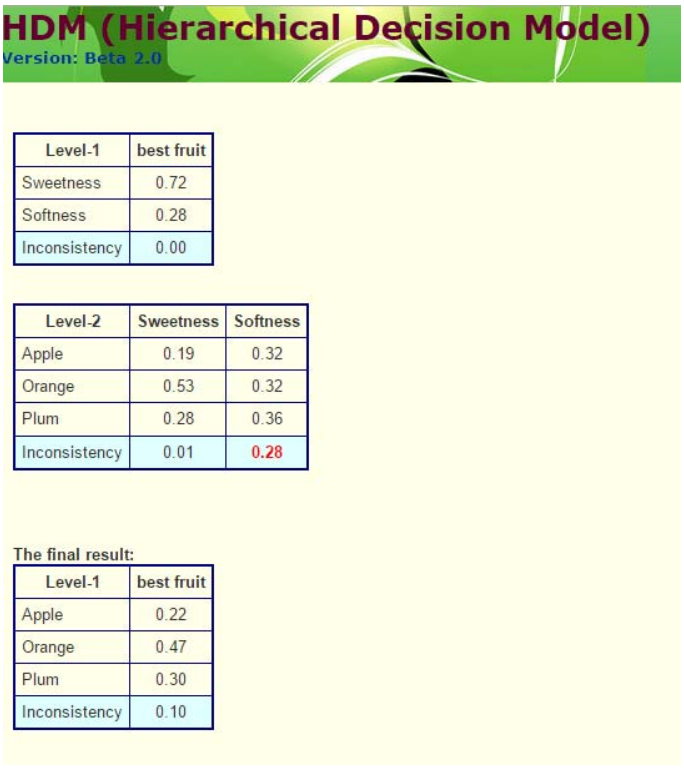
Whenever the researcher logs in to the system and there is a response from an expert, the researcher can see the results.




Under “Individual Expert Judgments:”, when you click the expert’s name, you can see the quantified judgments provided by that expert.




When you click the expert name under “Individual analysis result:”, you get the complete analysis for the particular expert.

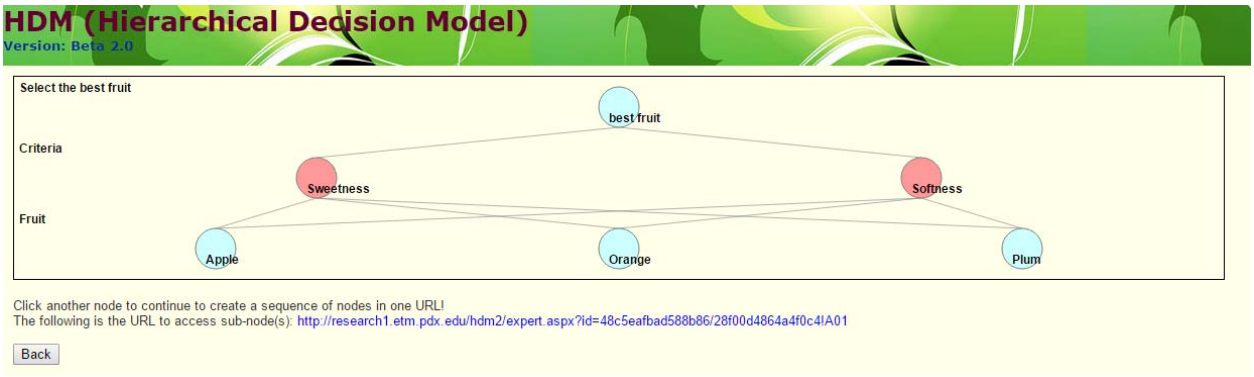



After the expert submits the quantified judgments, he or she cannot see or modify his/her responses anymore. In some cases, the expert informs the researcher that he/she made a mistake and wants to redo the judgement quantifications again. In order to allow the expert to redo this, the researcher needs to delete that expert's earlier response by clicking "Delete this" next to the expert's name under both "Individual Expert Judgments:" and "Individual analysis result:".

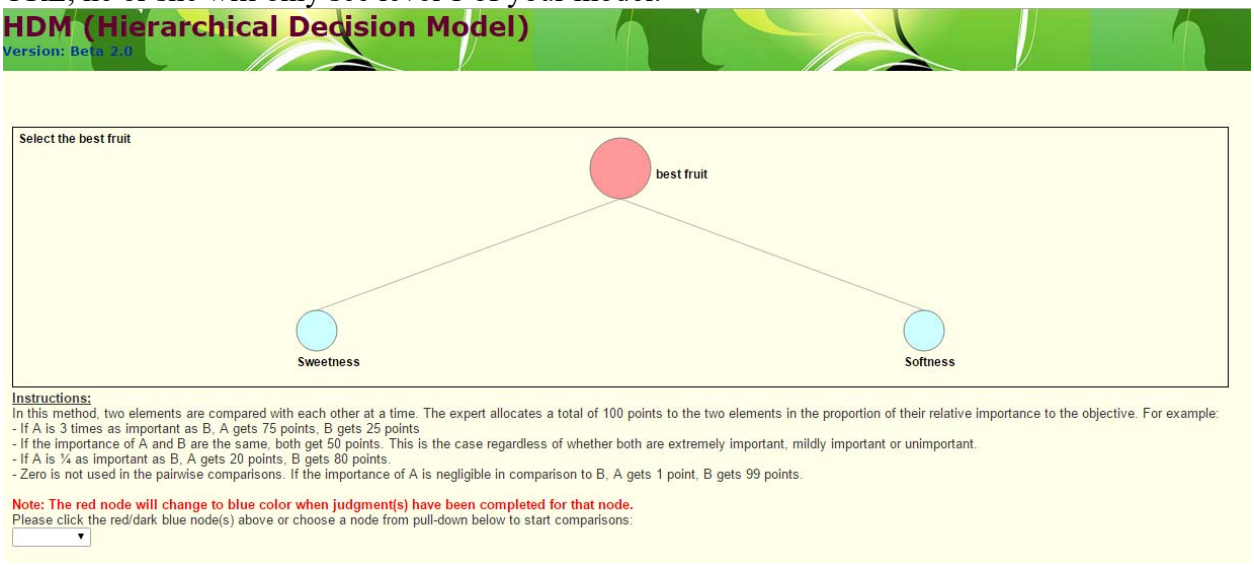
## Advanced Topic

In very complex model with multiple levels; there is a big possibility that you have multiple groups of experts to evaluate the model. Certain group of experts will only evaluate sub-part of your model and the other part will be evaluated by other experts. So how do we do this in this system?

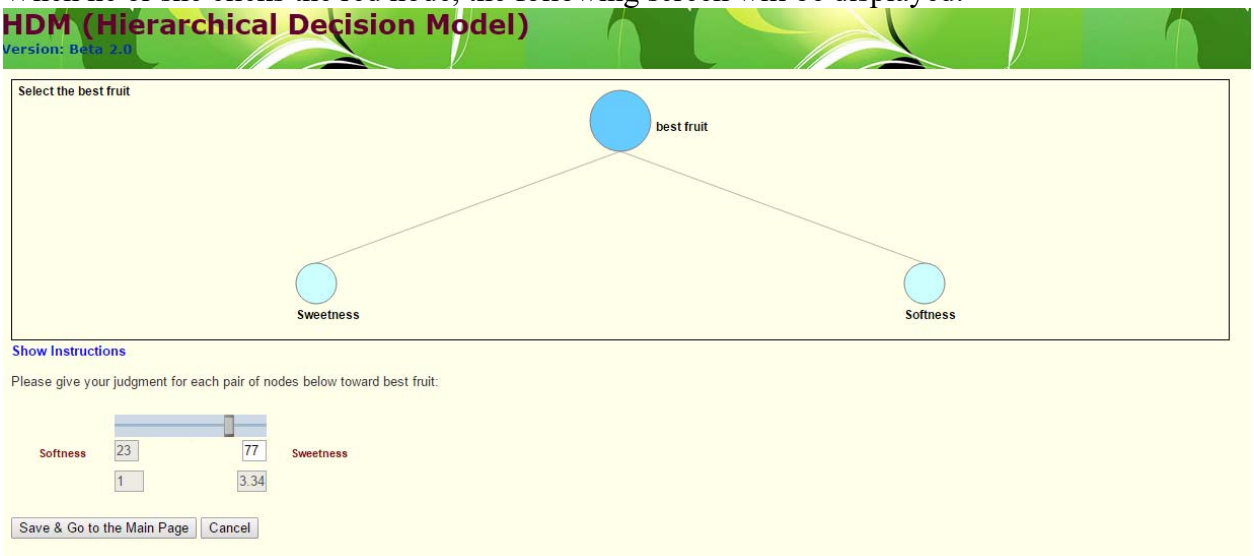
Let us go back to the previous sample. Imagine that you have 2 groups of experts. The first group will evaluate the top level only and the second group will evaluate the second level.
From the model main page click "Best fruit" node and the system will give you a unique URL for that node only.



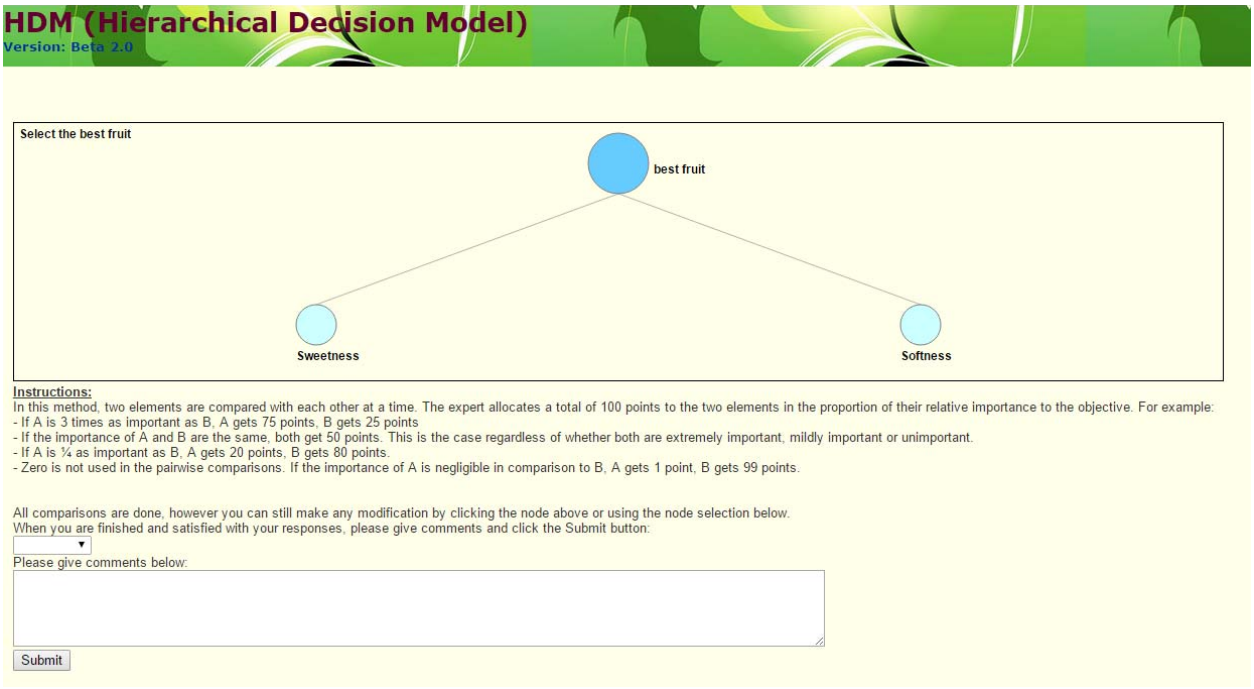

So this is the URL that you should send to your first group of expert. When the expert opens this URL, he or she will only see level 1 of your model.




When he or she clicks the red node, the following screen will be displayed:




When finish this there is nothing else to compare, so the only option is to save and go back to main page.

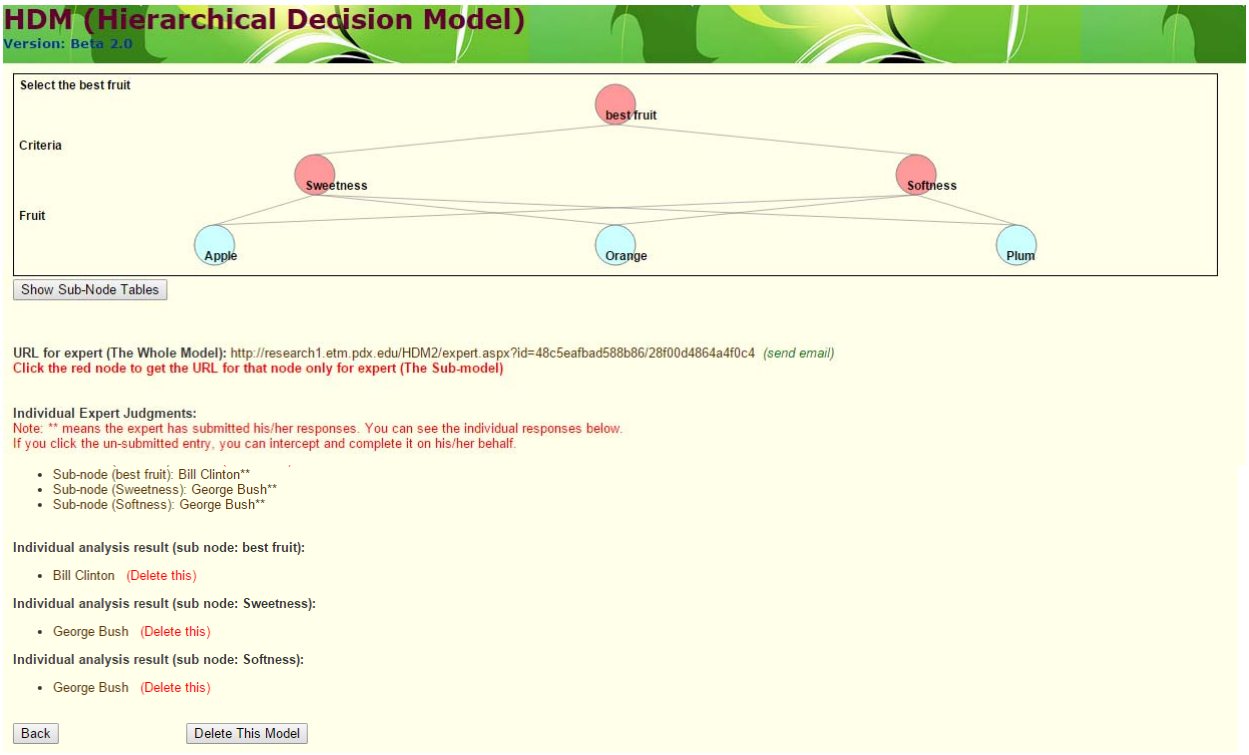



Since he or she has complete all of the judgment quantification, the submission page is available so he or she can write comment and submit the result.

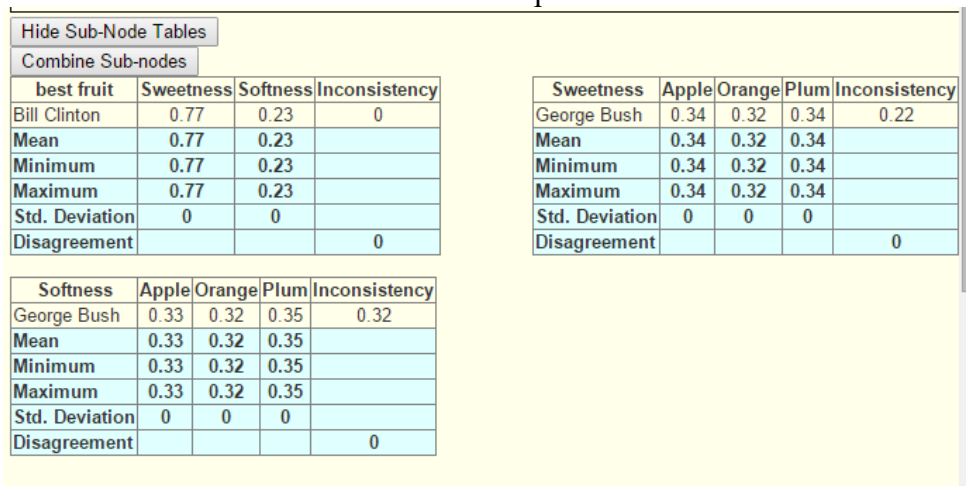
Similarly the URL for the second group, click “Sweetness” node from the model main page then when you get the URL do not stop here because we still need the “Softness” node also. Click “Softness” node so you will get URL for both nodes in level 2. This is the URL that you should send to your second group of experts.

When your expert finishes one node and submit it, he or she will be given the link to continue to the second node and so on.

The following screen shot shows what the researcher will see if there are responses from either group of experts:




You will see that each response will be grouped based on which node that sub-models is started. Here you can also see the evaluation value from each expert and also see the analysis for each sub-model by clicking the expert name. But where is the final result? See the new button "Show Sub-Node Tables"? Click that button to open the sub-node results.



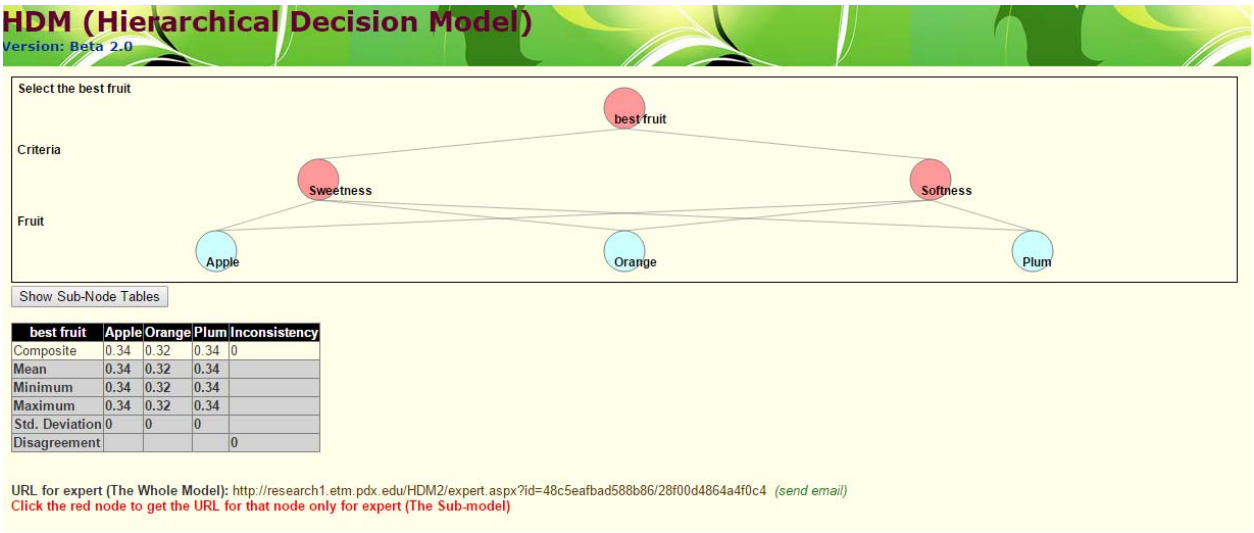

| best fruit | Sweetness | Softness | Inconsistency |
|---|---|---|---|
| Bill Clinton | 0.77 | 0.23 | 0 |
| Mean | 0.77 | 0.23 | |
| Minimum | 0.77 | 0.23 | |
| Maximum | 0.77 | 0.23 | |
| Std. Deviation | 0 | 0 | |
| Disagreement | | | 0 |

| Sweetness | Apple | Orange | Plum | Inconsistency |
|---|---|---|---|---|
| George Bush | 0.34 | 0.32 | 0.34 | 0.22 |
| Mean | 0.34 | 0.32 | 0.34 | |
| Minimum | 0.34 | 0.32 | 0.34 | |
| Maximum | 0.34 | 0.32 | 0.34 | |
| Std. Deviation | 0 | 0 | 0 | |
| Disagreement | | | | 0 |

| Softness | Apple | Orange | Plum | Inconsistency |
|---|---|---|---|---|
| George Bush | 0.33 | 0.32 | 0.35 | 0.32 |
| Mean | 0.33 | 0.32 | 0.35 | |
| Minimum | 0.33 | 0.32 | 0.35 | |
| Maximum | 0.33 | 0.32 | 0.35 | |
| Std. Deviation | 0 | 0 | 0 | |
| Disagreement | | | | 0 |

Here you can see the results but not the final result yet because we need to combine all of these sub-models to get the result for the whole model. Please note that you need to get at least one response from each groups of experts otherwise there will be some part of your model with no result. Before you combine these sub-models, it is a good time to analyze the result for each sub-model. If you need to remove some of outliers that you do not want to include, you can do so.

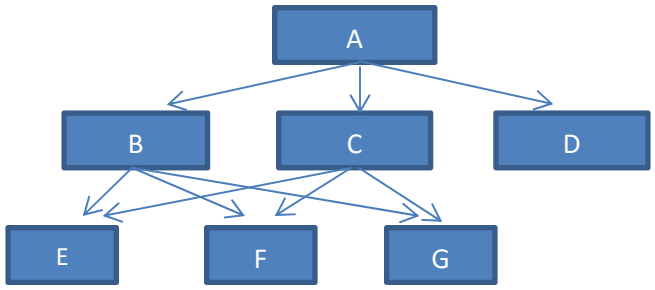
Click "Combine Sub-nodes" to get the final result of your model.



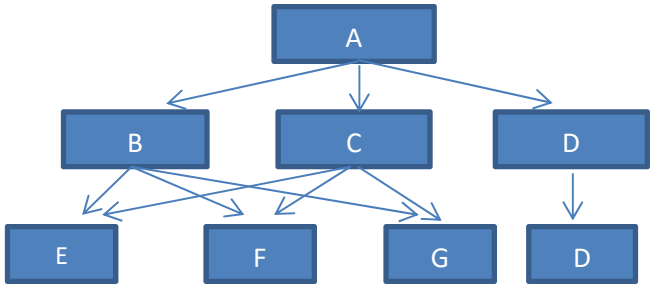

And you will get the final result from top to bottom.

## Complex models (Still under contruction)

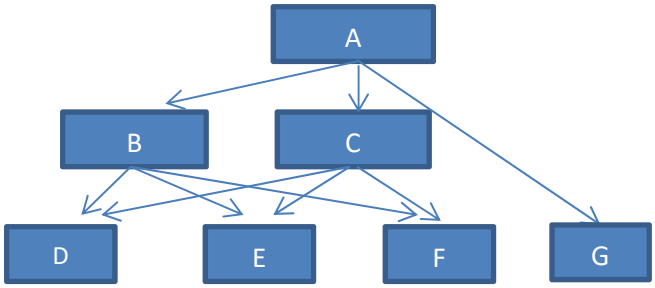
Some models in the real world can be very complex. However we need to have a model that has balance nodes in every level. In another word, we cannot skip node in any level. See the following illustrations.



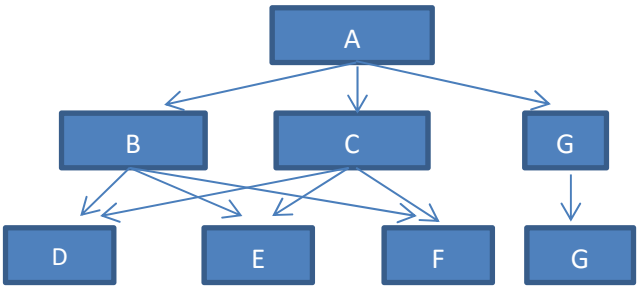

In this case, we need to create a dummy node D in level 3 so that in calculation we can have a value for D toward the top level A.



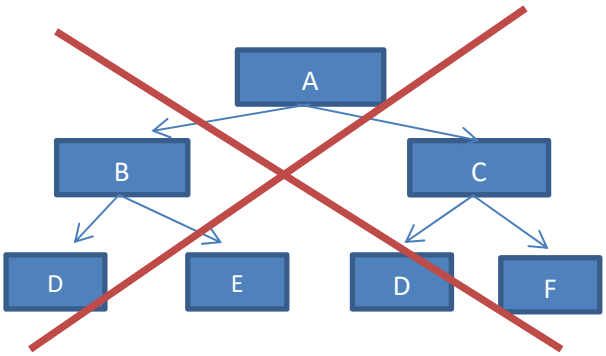

Another possibility of a complex model as follow:



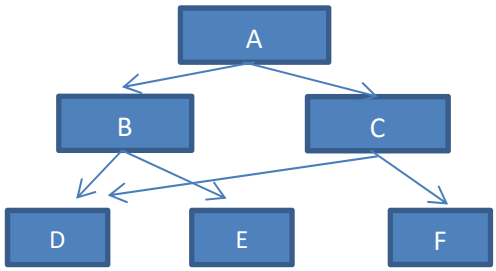

In this case, we need to add dummy node G in level 2.




Also remember that you cannot have more than 1 node with the same name in any level.




WRONG




CORRECT