Cracking the HDI

Human Development Indexing Exercise

Human Development Report Unit
UNDP Regional Centre for Asia Pacific, Colombo Office

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Preface

This indexing exercise aims to demystify the principles and calculations in indexing, taking up the case of the human development index. It demonstrates that indexing is a simple idea and the actual steps can be mastered by anyone with basic high school mathematics. The document is in three sections. Section one is about measuring human development and, in particular, covers the idea of indexing, its strengths and limitations, principles of calculating an index and actual steps in the calculations. It shows how the HDI is used to represent, very simply, three dimensions of the aggregate human condition of a particular geographic area. Section two contains an exercise based on data for three imaginary countries – Masalabad, Guinea Town and Messifeng. The exercise requires the calculation of the HDI for each and finally comparing the three values to draw conclusions on ranking to help compare the three imaginary countries. The repetition in calculations – repeating the steps three times for the three countries is expected to help in firmer understanding and learning. Section three provides the solutions.

Happy indexing!!

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Acknowledgements

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Section one
Measuring human development

I. The concept

The human development concept brings together observations and experiences from around the world placing human beings at the centre of development concerns, in contrast with the primary pursuit of economic ends. The importance of people has been recognised from as far back as Aristotle, going on to Adam Smith, and even Arthur Lewis, to the extent that he emphasised the importance of economic growth because it expanded choices. This was lost sight of in development writing in the 1960s and 1970s, but revived by Amartya Sen in the 1980s. Today human development is commonly understood as enlarging people's choices to have a meaningful and creative life with human dignity. Human development is multi-disciplinary rather than just economic, focuses on people, not markets and incomes. Incomes, while no doubt important, are treated as the means to a better human condition rather than ends in themselves.

II. Concept to measurement: The Human Development Index

The concept of human development is clearly much broader than the various measures that capture numerically some of its important aspects. The most well known aggregate measure is the Human Development Index (HDI).[1] The concept and the HDI are quite distinct - the two should not be confused. The HDI was developed as an alternative to the gross domestic product (GDP), to monitor the overall status and progress of nations. The GDP aims to present an aggregate picture of the economic status of a nation for a year, while the HDI aims to represent an aggregate picture of the broader human condition. Measuring human development involves using specifically selected variables or indicators and aggregating them to create summary indices. The HDI has become a flagship summary measure to represent human development achievements of a particular geographic area,[2] for a year. It captures three dimensions:

a) a long and healthy life
b) knowledge
c) a decent standard of living

A good question to ask is why go beyond the GDP in measuring progress of nations? GDP limits itself as a measure of aggregate market activity, leaving out non-market sources of value. It is an inadequate mean of income. The limitation of income also as an exclusive

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1 Other commonly used indices are the Gender-related Development Index (GDI), the Gender Empowerment Measure (GEM) and the Human Poverty Index (HPI).
2 Usually a country, but also for sub national units and country clusters or groupings.

measure of development becomes evident as we recognize that many choices do not depend on income. For example, even a rich landlord in a rural area may not have access to reliable electricity or underground sanitation; a female may be considered old enough to marry at 15 years of age in certain communities depriving her of education and other freedoms. Moreover, income is subject to diminishing marginal utility and an exclusive focus on per capita income does not take into account how income is distributed or utilised.

III. Strengths and limitations of the HDI

The strength of composite indices, like the HDI is that being a single number it is simple to present. It can be used as a powerful advocacy tool to catch the attention of policy makers, media and NGOs which can expand the debate to focus on human outcomes. Another strength is that a composite index can offer a multi dimensional view of social and economic phenomena by capturing a broader information set. For example, the HDI attempts to capture the health, education and income related achievements in one single figure. Indices also help monitor progress, facilitate comparisons across time and geographical areas and help in setting measurable targets. The HDI, for instance, can be calculated at sub-national level to convey a more analytical view of the living conditions as depicted by the three dimensions of the index.

Composite indices however do have their limitations. Any index is only a summary – much more limited than the broader concept it sets out to measure. The HDI for example, is far more limited than the concept of human development, just as the GNP is far more limited than the concept of economic prosperity of a nation. The HDI cannot provide a complete picture of human development as many critical aspects of the human condition cannot be quantified. Even for aspects which can be quantified, it is sometimes difficult to obtain consistent and reliable data across time and space.

Nevertheless, the HDI has proved to be a useful shorthand way to map the human conditions, that go beyond material wellbeing. It is wider than Gross Domestic Product /Gross National Product per capita, which represents economic conditions only.

IV. Principles in indexing

Indexing is neither difficult nor a mystery – anybody with high school mathematics can do it once he knows the logic behind it. This exercise is meant to take the reader through the logic and sequential steps involved in the calculations. Once the logic is clear, it can even trigger off ideas to modify and customize the index for other applications.

Typically, indexing is a simple process of aggregating individual variables or indicators to obtain one summary measure. Since individual indicators are expressed in different units of measurement, they cannot be combined together unless they are made scale free. This is the first step. In some cases all

selected indicators do not move in the same direction (e.g. mortality rates cannot be combined with literacy rates because higher mortality is considered bad whereas higher literacy is desirable). All indicators have to be made unidirectional – say by taking reciprocal values for some. Following this, the scale free values are given desired weights (a subjective decision) before completing the aggregation. While these are general principles, in specific cases different formulas are used to combine different indicators.

This exercise will take you through the steps of calculating the HDI based on the formula used in the global Human Development Reports (HDRs). Information is presented on three imaginary countries. The reader will be expected to select appropriate indicators relevant for the HDI, calculate the HDI using the formula, compare the HDIs for the three countries and draw suitable conclusions.

V. Calculating the HDI

Calculating the HDI includes the following steps.

Step 1. Obtain actual data for the relevant indicators
This may be the most time consuming part. As seen above, the HDI captures three dimensions – a long and healthy life, knowledge and a decent standard of living. Indicators for each of the dimensions can be seen in Table 1.1.

Step 2. Convert dimension indicator(s) into unit free values to facilitate aggregation through construction of dimension indices
The indicators used are measured in different units. For example, life expectancy at birth is in number of years, the literacy rate and enrolment are in percentages, and GDP per capita is in US Dollars. They cannot be

Table 1.1: Three dimensions of the HDI, indicators and corresponding goalposts			
Dimension	Indicator	Maximum value	Minimum value
A long and healthy life	Life expectancy at birth	85	25
Knowledge	Adult literacy rate (%)*	100	0
	Combined gross enrolment ratio in education (%)	100	0
A decent standard of living	GDP per capita (PPP US$)	40,000	100

Note: (*)The goalpost for calculating adult literacy implies the maximum literacy rate is 100%. In practice, the HDI is calculated using an upper bound of 99%.
Source: UNDP 2007.

added as they are. For aggregation they have to first be made comparable. In order to do this we first calculate separate, scale free sub indices for each dimension. This can be done in different ways. The HDI uses the method called 'division by own range', the range being the difference between the maximum and minimum values of the respective indicators.[3] The maximum and minimum values are called the goalposts of the indicators.

Identify goalposts for each indicator. This means the maximum and minimum value for each indicator. Theoretically life expectancy, literacy and enrolment as well as incomes can be zero at a minimum. But to be more meaningful, minimums are taken to be lowest values observed historically by going back 30 years. Regarding the maximum values, theoretically income could be infinite – leading to a division by infinity. For life expectancy it is not immediately clear what the maximum should be. Of course for literacy and enrolment 100 percent makes sense as the maxima. For the HDI maximum values are those that can be envisioned in the next thirty years. For example, when looking at GDP, economic growth rates can indicate that maximum income that richest countries are likely to achieve by 2020 is US$ 40,000 (in 1990 US$ PPP).

Calculate dimension indices. These are calculated using the formula:

$$\text{Dimension Index} = \frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

Each difference in indicator value from its minimum is divided by its range (max - min), using fixed values or goal posts in order to get unit free numbers. The value of dimension indices vary between 0 and 1.

Dimension 1: Long and healthy life
The indicator used to measure this dimension is the life expectancy at birth. This is defined as the number of years a newborn would live if prevailing patterns of age-specific mortality rates at the time of birth were to stay the same throughout the individual's life.

Dimension 2: Knowledge
Knowledge is measured by two component indicators – adult literacy rate and combined gross enrolment ratio. Adult literacy rate is defined as the percentage of people ages 15 and above who can, with understanding, both read and write a short, simple statement related to their everyday life. Combined gross enrolment ratio is the number of students enrolled in primary, secondary and tertiary levels of education, regardless of age, as a percentage of the population of official school age for the three levels.

Calculating the knowledge dimension index involves two steps. First, to determine each component index by simply calculating the index for the each of the two component indicators. The second step involves aggregating the individual component indices into the Education Index by giving appropriate weights. In this case adult literacy is considered more important and given a

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[3] One could also divide by the mean values of the dimension indicators.

higher weight of two-thirds and enrolment a weight of one-third.[4] Thus, combining the adult literacy index (with two-thirds weight) and combined gross enrolment index (with one third weight) gives us the Education Index for this dimension.

Education = Index	2/3 (Adult literacy index)	+	1/3 (Gross enrolment index)

Dimension 3: A decent standard of living

The standard of living is measured by using GDP per capita (PPP US$). Per capita income is the total value of the final goods and services produced by a country in a given period of time and divided by the population at mid-year. In order to maintain global comparisons the measurement is made in US$ with purchasing power parity (PPP) – i.e., a measure that equalises the purchasing power of different currencies by converting all to a common currency.

The GDP per capita index is calculated using the same dimension index formula. However there is one difference here. The logarithm of income is used in the formula instead of the actual income figure. The reason for this is that income needs to be discounted since unlimited income is not required to achieve a respectable level of human development. Moreover, income is subject to diminishing marginal utility. Until 1999, income above a cut-off point (world average per capita income) used to be drastically discounted. From 1999, however, a more gradual dis-

counting is done throughout by using the logarithm of income.

Step 3. Final aggregation of the scale free dimension indices to obtain the HDI

Finally the HDI is calculated by calculating the simple average of the three dimension indices i.e. adding the three indices and diving by three.

VI. In sum

The methodology explained in this exercise is the standard one used in the global HDRs. However, each country may come up with their customized indices using the simple principles of indexing explained here - i.e. identification of appropriate indicators, identification of corresponding goalposts or average values, calculation of dimension indices to make the indicators unit free and finally combining them, either by assigning equal or different weights. The global HDI assigns equal weights to each dimension and hence it is a simple average of the three dimension indices.

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[4] One can, of course, choose other weights. Ultimately the decision on relative weights is a subjective one.
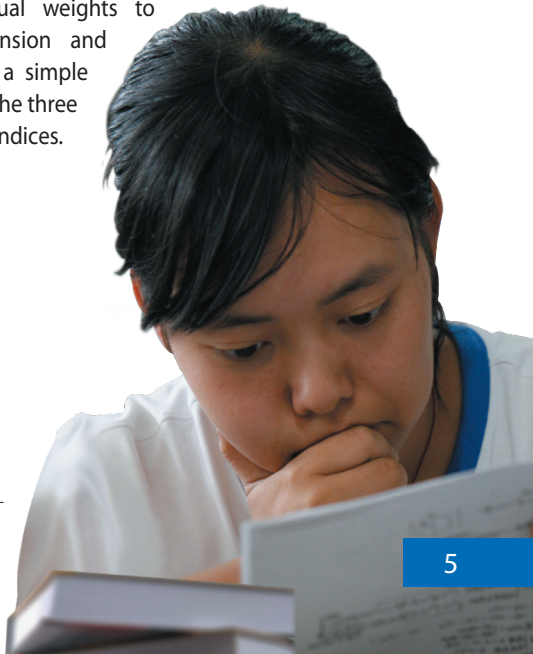
Section two
Human development indexing exercise

Name: _____   Country: _____

I. Instructions

The exercise consists of (i) calculating the HDI for three imaginary countries (Masalabad, Guinea Town and Messifeng); (ii) ranking the countries according to the HDI value obtained; and (iii) based on the HDI index, indicating whether these countries would be among the high, medium, low human development countries.

To facilitate your calculations, indicators for demography, income, education, health and environment are provided for each country at the end of this exercise. Moreover, the maximum and minimum value for certain common indicators are given in Table 2.1 below.

To make the exercise even simpler, here is the log of some numbers. You will need to refer to this table (Table 2.2) for the calculation of the HDI.

To assist you even further, here's the formula for dimension index (the indicator for which you are interested to calculate an index):

$$\text{Dimension Index} = \frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

Table 2.1: Goalposts for common indicators		
Indicator	**Maximum value**	**Minimum value**
Life expectancy at birth (years)	85	25
Adult literacy rate (%)*	100	0
Combined gross enrolment ratio (%)	100	0
GDP per capita (PPP US$)	40,000	100
Note: (*)The goalpost for calculating adult literacy implies the maximum literacy rate is 100%. In practice, the HDI is calculated using an upper bound of 99%. Source: UNDP 2007.		

Table 2.2: Log of numbers			
Number	Log	Number	Log
100	2	1,890	3.276462
250	2.39794	2,039	3.309417
790	2.897627	4,595	3.662286
1,310	3.117271	10,882	4.036709
1,680	3.225309	40,000	4.602060

Note that the minimum and maximum values (the goalposts) for the purposes of this exercise are given in Table 2.1 above.

Using Table 2.3, countries can be ranked as high, medium and low development according to their HDI value.

Final tips: we have inserted some images to help you in following the steps required.

Table 2.3: Ranking the countries	
High/Medium/Low HD	HDI Value
High	1-0.800
Medium	0.500 – 0.799
Low	0-0.499

Lets start now ….. and …..

Good Luck

II. Exercise sheet for Masalabad

Exercise sheet for Masalabad	

HDI for Masalabad = weight (Dimension index 1) + weight (Dimension index 2) + weight(Dimension index 3)
In the HDI equal weights are assigned hence each weight = 1/3. In other words, just calculate the simple arithmetic mean of the three dimension indices.

III. Exercise sheet for Guinea Town

Exercise sheet for Guinea Town	

HDI for Guinea Town = weight (Dimension index 1) + weight (Dimension index 2) + weight (Dimension index 3)
In the HDI equal weights are assigned hence each weight = 1/3. In other words, just calculate the simple arithmetic mean of the three dimension indices.

IV. Exercise sheet for Messifeng

Exercise sheet for Messifeng	

HDI for Messifeng = weight (Dimension index 1) + weight (Dimension index 2) + weight (Dimension index 3)
In the HDI equal weights are assigned hence each weight = 1/3. In other words, just calculate the simple arithmetic mean of the three dimension indices.

V. Ranking the countries

The ranking of the countries is the following:

Country	Value	Rank	High/Medium/Low HD

Right or wrong... Congratulations for completing the exercise ...

VI. HD indicators for Masalabad

	HD indicators for Masalabad	
	Demography	Value
1	Total population (millions), 2005	25.7
2	Urban population (as % of the total), 2005	67.3
3	Population under age 15 (as % of the total), 2005	31.4
4	Total fertility rate, 1970–75	5.2
5	Total fertility rate, 2000–05	2.9
	Income	Value
6	GDP per capita (PPP US$), 2005	10882.0
7	Female estimated earned income (PPP US$), 2005	5751.0
8	Male estimated earned income (PPP US$), 2005	15861.0
9	Youth unemployment (% of labour force aged 15–24), 2006	NA
10	Percentage of population below poverty line (US$ 1 a day), 1990–2005	<2
11	Percentage of population below poverty line (national poverty line),1990–2004	15.5
	Education	Value
12	Adult literacy rate (% age 15 and above), 1995-2005	88.7
13	Female literacy rate, 1995-2005 (%)	85.4
14	Male literacy rate, 1995-2005 (%)	92.0
15	Female gross enrolment ratio combined primary, secondary, tertiary, 2005	77.0
16	Male gross enrolment ratio combined primary, secondary, tertiary, 2005	72.0
17	Combined primary, secondary, tertiary gross enrolment ratio (%), 2005	74.3
18	Public expenditure on education (as % of GDP), 2002-2005	6.2
19	Public expenditure on pre-primary & primary education (as % of all levels), 2002-2005	30.0
20	Public expenditure on secondary and post secondary non-tertiary education (as % of all levels), 2002-2005	35.0

Contd....

Contd....

21	Public expenditure on tertiary education (as % of all levels), 2002-2005	35.0
	Health	**Value**
22	Life expectancy at birth (yrs), 2005	73.7
23	Life expectancy at birth (female), 2005 (yrs)	76.1
24	Life expectancy at birth (male), 2005 (yrs)	71.4
25	Infant mortality rate (per 1,000 live births), 2005	10.0
26	Under 5 mortality rate (per 1,000 live births), 2005	12.0
27	Maternal mortality ratio reported (per 100,000 live births), 2005	62.0
28	Percentage of children underweight for age (% under age 5), 1996–2005	11.0
29	Population with access to improved sanitation (%), 2004	94.0
30	Population with access to improved sanitation (%), urban, 2005	NA
31	Population with access to improved water source (%), 2004	99.0
32	Population with access to improved water source (%), urban, 2005	NA
33	Population with access to improved water source (%), rural, 2005	NA
	Environment	**Value**
34	Percentage of land area covered by forests, 2005	63.6
35	Ratio of protected area to surface area, 2003	NA
36	Per capita carbon dioxide emissions (metric tons), 2004	7.5

VII. HD indicators for Guinea Town

	HD indicators for Guinea Town	
	Demography	Value
1	Total population (millions), 2005	19.1
2	Urban population (as % of the total), 2005	15.1
3	Population under age 15 (as % of the total), 2005	24.2
4	Total fertility rate, 1970–75	4.1
5	Total fertility rate, 2000–05	2.0
	Income	Value
6	GDP per capita (PPP US$), 2005	4595.0
7	Female estimated earned income (PPP US$), 2005	2647.0
8	Male estimated earned income (PPP US$), 2005	6479.0
9	Youth unemployment (% of labour force aged 15–24), 2006	NA
10	Percentage of population below poverty line (US$ 1 a day), 1990–2005	5.6
11	Percentage of population below poverty line (national poverty line), 1990–2004	25.0
	Education	Value
12	Adult literacy rate (% age 15 and above), 1995-2005	90.7
13	Female literacy rate, 1995-2005 (%)	89.1
14	Male literacy rate, 1995-2005 (%)	92.3
15	Female gross enrolment ratio combined primary, secondary, tertiary, 2005	64.0
16	Male gross enrolment ratio combined primary, secondary, tertiary, 2005	63.0
17	Combined primary, secondary, tertiary gross enrolment ratio (%), 2005	62.7
18	Public expenditure on education (as % of GDP), 2002-2005	NA
19	Public expenditure on pre-primary & primary education (as % of all levels), 2002-2005	NA
20	Public expenditure on secondary and post secondary non-tertiary education (as % of all levels), 2002-2005	NA

Contd....

Contd....

21	Public expenditure on tertiary education (as % of all levels), 2002-2005	NA
	Health	**Value**
22	Life expectancy at birth (yrs), 2005	71.6
23	Life expectancy at birth (female), 2005 (yrs)	75.6
24	Life expectancy at birth (male), 2005 (yrs)	67.9
25	Infant mortality rate (per 1,000 live births), 2005	12.0
26	Under 5 mortality rate (per 1,000 live births), 2005	14.0
27	Maternal mortality ratio reported (per 100,000 live births), 2005	58.0
28	Percentage of children underweight for age (% under age 5), 1996–2005	29.0
29	Population with access to improved sanitation (%), 2004	91.0
30	Population with access to improved sanitation (%), urban, 2005	NA
31	Population with access to improved water source (%), 2004	79.0
32	Population with access to improved water source (%), urban, 2005	NA
33	Population with access to improved water source (%), rural, 2005	NA
	Environment	**Value**
34	Percentage of land area covered by forests, 2005	29.9
35	Ratio of protected area to surface area, 2003	NA
36	Per capita carbon dioxide emissions (metric tons), 2004	0.6

VIII.   HD indicators for Messifeng

	HD indicators for Messifeng	
	Demography	Value
1	Total population (millions), 2005	5.7
2	Urban population (as % of the total), 2005	20.6
3	Population under age 15 (as % of the total), 2005	39.8
4	Total fertility rate, 1970–75	6.4
5	Total fertility rate, 2000–05	3.6
	Income	Value
6	GDP per capita (PPP US$), 2005	2039.0
7	Female estimated earned income (PPP US$), 2005	1385.0
8	Male estimated earned income (PPP US$), 2005	2692.0
9	Youth unemployment (% of labour force aged 15–24), 2006	NA
10	Percentage of population below poverty line (US$ 1 a day), 1990–2005	27.0
11	Percentage of population below poverty line (national poverty line), 1990–2004	38.6
	Education	Value
12	Adult literacy rate (% age 15 and above), 1995-2005	68.7
13	Female literacy rate, 1995-2005 (%)	60.9
14	Male literacy rate, 1995-2005 (%)	77.0
15	Female gross enrolment ratio combined primary, secondary, tertiary, 2005	56.0
16	Male gross enrolment ratio combined primary, secondary, tertiary, 2005	67.0
17	Combined primary, secondary, tertiary gross enrolment ratio (%), 2005	61.5
18	Public expenditure on education (as % of GDP), 2002-2005	2.3
19	Public expenditure on pre-primary & primary education (as % of all levels), 2002-2005	49.0
20	Public expenditure on secondary and post secondary non-tertiary education (as % of all levels), 2002-2005	35.0

Contd....

Contd....

21	Public expenditure on tertiary education (as % of all levels), 2002-2005	15.0
	Health	**Value**
22	Life expectancy at birth (yrs), 2005	63.2
23	Life expectancy at birth (female), 2005 (yrs)	64.5
24	Life expectancy at birth (male), 2005 (yrs)	61.9
25	Infant mortality rate (per 1,000 live births), 2005	62.0
26	Under 5 mortality rate (per 1,000 live births), 2005	79.0
27	Maternal mortality ratio reported (per 100,000 live births), 2005	660.0
28	Percentage of children underweight for age (% under age 5), 1996–2005	40.0
29	Population with access to improved sanitation (%), 2004	30.0
30	Population with access to improved sanitation (%), urban, 2005	NA
31	Population with access to improved water source (%), 2004	51.0
32	Population with access to improved water source (%), urban, 2005	NA
33	Population with access to improved water source (%), rural, 2005	NA
	Environment	**Value**
34	Percentage of land area covered by forests, 2005	69.9
35	Ratio of protected area to surface area, 2003	NA
36	Per capita carbon dioxide emissions (metric tons), 2004	0.2

Section three
Solutions - right or wrong?

I. Solutions for Masalabad

Solutions for Masalabad	
	Life Expectancy Index = (73.7- 25) / (85 - 25) = 0.81167 = **0.812**
	Adult Literacy Index = (88.7 - 0) / (100 - 0) = 0.887 **Gross Enrolment Index** = (74.3 -0) / (100 - 0) = 0.743 **Education Index** = 2/3 (0.887) + 1/3 (0.743) = **0.839**
	GDP Index = [log (10882) – log (100)] / [log (40,000) - log (100)] = **0.783**
HDI for Masalabad = 1/3 (0.812) + 1/3 (0.839) + 1/3 (0.783) = **0.811**	

II. Solutions for Guinea Town

Solutions for Guinea Town	
	Life Expectancy Index = (71.6 -25) / (85 - 25) = 0.77667 = **0.777**
	Adult Literacy Index = (90.7 - 0) / (100 - 0) = 0.907 **Gross Enrolment Index** = (62.7 -0) / (100 - 0)= 0.627 **Education Index** = 2/3 (0.907) + 1/3 (0.627) = **0.814**
	GDP Index = [log (4595) – log (100)] / [log (40,000) - log (100)] = **0.639**
HDI for Guinea Town = 1/3 (0.777) + 1/3 (0.814) + 1/3 (0.639) = **0.743**	

III.Solutions for Messifeng

Solutions for Messifeng	
	Life Expectancy Index = (63.2 -25) / (85 -25) = 0.63667 = **0.637**
	Adult Literacy Index = (68.7 - 0) / (100 - 0) = 0.687 **Gross Enrolment Index** = (61.5 - 0) / (100 - 0) = 0.615 **Education Index** = 2/3 (0.687) + 1/3 (0.615) = **0.663**
	GDP Index = [log (2039) – log (100)] / [log (40,000) - log (100)] = **0.503**
HDI for Messifeng = 1/3 (0.637) + 1/3 (0.663) + 1/3 (0.503) = **0.601**	

IV.Ranking of the countries

Country	Value	Rank	High/Medium/Low HD
Masalabad	0.811	1	High HD
Guinea Town	0.743	2	Medium HD
Messifeng	0.601	3	Medium HD

Congratulations for completing the exercise ...

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