Fertility And Development

Written by Mark Lauer, August 30th, 2009

This notebook generates graphics from the data used in the paper:
Mikko Myrskylä, Hans-Peter Kohler & Francesco C. Billari (2009)
"Advances in development reverse fertility declines"
Nature 460, 741-743 (6 August 2009) | doi:10.1038/nature08230
http://www.nature.com/nature/journal/v460/n7256/full/nature08230.html

Import Data

Download and import the data

```
dataurl = "http://www.nature.com/nature/journal/v460/n7256/extref/nature08230-s2.zip";
data = First[Import[dataurl, "*"]];
TableForm[data[[Range[5], Range[10]]]]
```

```
country   HDI.1975 HDI.1976 HDI.1977 HDI.1978 HDI.1979 HDI.1980 HDI.1981 HDI.1982 HDI.1983
Albania                                          0.731273 0.734932 0.737146 0.738452
Algeria   0.565067 0.570966 0.575103 0.581995 0.587976 0.590365 0.593946 0.599331 0.605605
Angola    0.427032 0.427252 0.427463 0.428155 0.428839 0.429516 0.424447 0.422965 0.423151
Argentina 0.796896 0.796294 0.800532 0.798749 0.804949 0.807989 0.805496 0.80343  0.805606
```

Extract and remove the list of countries and column headings, then report the length of each

```
countrylist = Rest[data[[All, 1]]];
headinglist = Rest[data[[1]]];
data = Drop[Transpose[Drop[Transpose[data], 1]], 1];
TableForm[{{"Countries: ", Length[countrylist]}, {"Columns: ", Length[headinglist]}}]
```

```
Countries:  143
Columns:    124
```

A function to parse column headings and define corresponding *Mathematica* functions from the values.
For example, "HDI.1975" leads to defining HDI[countryname, 1975]

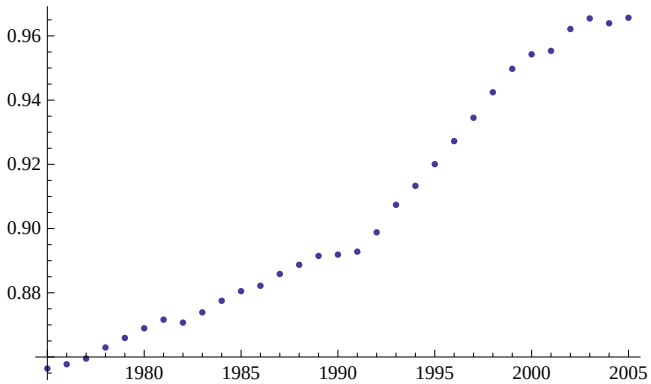
```
Store[value_, {country_Integer, columnname_Integer}] :=
 Module[{type, year},
  {type, year} = StringSplit[headinglist[[columnname]], "."];
  (Symbol[type][countrylist[[country]], ToExpression[year]]) =
   If[NumberQ[value], value, Missing[]]
 ]
```

Apply this across all the data

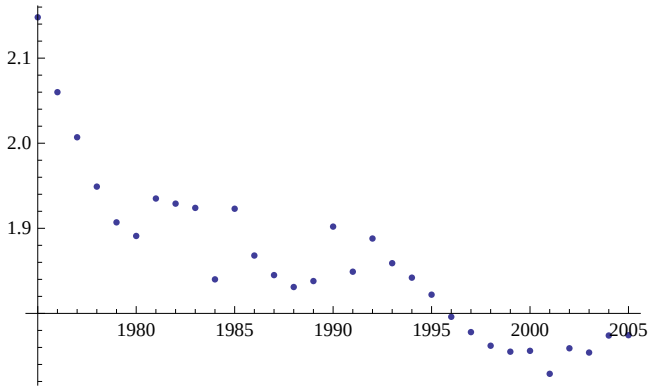
```
MapIndexed[Store, data, {2}];
```

Check this with a couple of plots

```
ListPlot[Table[{y, HDI["Australia", y]}, {y, 1975, 2005}]]
```

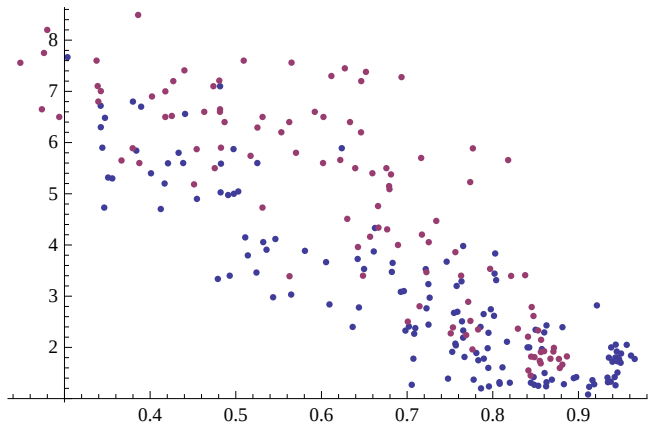



```
ListPlot[Table[{y, TFR["Australia", y]}, {y, 1975, 2005}]]
```



Generate the original plot reported in the paper

```
ListPlot[{
  {HDI[#, 2005], TFR[#, 2005]} & /@ countrylist,
  {HDI[#, 1975], TFR[#, 1975]} & /@ countrylist}
]
```



Match Countries To *Mathematica* Country Data

Define an equivalent list of countries using *Mathematica* names by expanding some abbreviations and removing spaces

```
canonicallist =
  (countrylist /. {"USA" → "UnitedStates", "Congo, Dem. Rep." → "DemocraticRepublicCongo",
     "Congo, Rep." → "RepublicCongo", "Cote d'Ivoire" → "IvoryCoast",
     "Kyrgyz Republic" → "Kyrgyzstan", "NL" → "Netherlands", "S. Korea" → "SouthKorea",
     "Slovak Republic" → "Slovakia", "Trinidad and Tobago" → "TrinidadTobago",
     "Lao" → "Laos", x_String :> StringReplace[x, {" " → ""}]});
```

Check that every country in the data matches one in *Mathematica*

```
Complement[canonicallist, CountryData["Countries"]] == {}
```

```
True
```

Key Functions

Define (self-cacheing) function to map countries to the *Mathematica* names using the list

```
CanonicalName[country_String] :=
 (CanonicalName[country] = canonicallist[[First[First[Position[countrylist, country]]]]])
```

Check this for three countries

```
CanonicalName /@ {"USA", "New Zealand", "United Kingdom"}
```

```
{UnitedStates, NewZealand, UnitedKingdom}
```

Get list of continents for countries

```
continentslist = Union[CountryData[CanonicalName[#], "Continent"] & /@ countrylist]
```

```
{Africa, Asia, Europe, NorthAmerica, Oceania, SouthAmerica}
```

Define (self-cacheing) function to map countries to continents

```
ContinentOf[country_String] :=
 (ContinentOf[country] = CountryData[CanonicalName[country], "Continent"])
```

Check this for four countries

```
ContinentOf /@ {"USA", "China", "Israel", "Australia"}
```

```
{NorthAmerica, Asia, Asia, Oceania}
```

Define ColourOf[] function from continents to colours by splitting the (reversed) DarkRainbow spectrum, then display all values

```
MapThread[Set, {ColourOf /@ Reverse[continentslist],
   ColorData["DarkRainbow"] /@ (Range[Length[continentslist]] / Length[continentslist])}];
Style[#, FontColor → ColourOf[#]] & /@ continentslist
```

```
{Africa, Asia, Europe, NorthAmerica, Oceania, SouthAmerica}
```

Define (self-cacheing) function to map countries to their populations according to *Mathematica*

```
PopulationOf[country_String] :=
 (PopulationOf[country] = CountryData[CanonicalName[country], "Population"])
```

Check this for four countries

```
PopulationOf /@ {"USA", "China", "Israel", "Australia"}
```

$$\left\{3.02841\times10^{8},\ 1.29801\times10^{9},\ 6.80999\times10^{6},\ 2.05304\times10^{7}\right\}$$

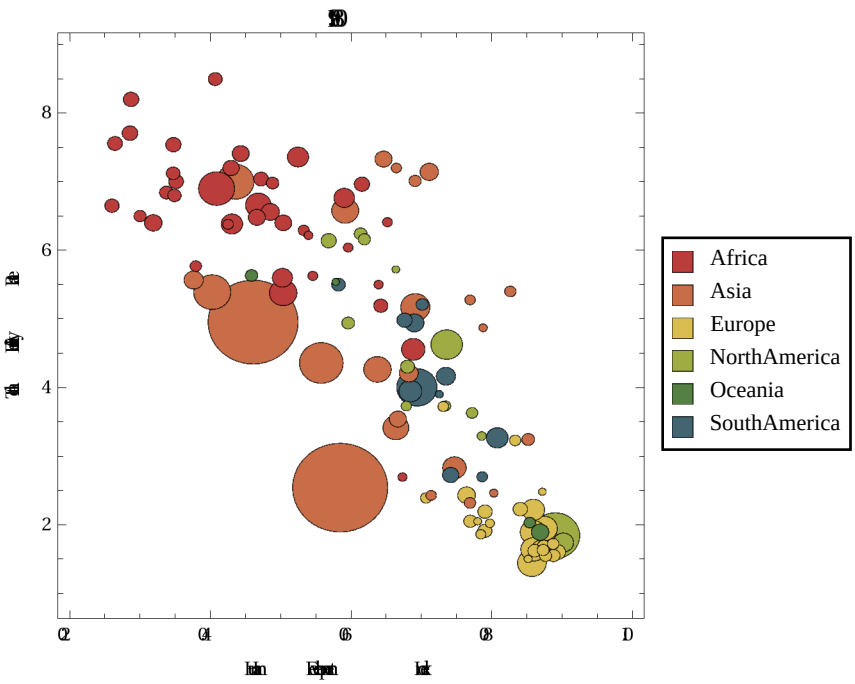
Charts

Define function to plot a bubble chart of Total Fertility Rate against Human Development Index for a given year. Bubble sizes are determined by population, colours by continent.

```
MyChart[year_Integer] :=
 BubbleChart[{
   (* Ensure legend appears in fixed order by "plotting" continents *)
   Legended[Style[{0, 0, 1}, ColourOf[#]], #] & /@ continentslist,
   (* Add bubble for each country *)
   Legended[
      Style[
       (* On mouse-over, display country names *)
       Tooltip[
        {HDI[#, year], TFR[#, year], PopulationOf[#]},
        #],
       ColourOf[ContinentOf[#]]
      ],
      ContinentOf[#]] & /@ countrylist},
  BubbleSizes → {0.01, 0.15}, PlotRange → {{0.2, 1.0}, {0.8, 9}}, FrameLabel →
   {"Human Development Index", "Total Fertility Rate"}, PlotLabel → ToString[year]
 ]
```

Check this for one year

```
MyChart[1980]
```



Generate an animated GIF of all thirty years
(Note: mouse-over will no work outside *Mathematica*)

```
Export["FertilityAndDevelopment.gif", Table[MyChart[y], {y, 1975, 2005, 1}]]
```

Use *Mathematica*'s built in dynamic graphics to view animation

```
Manipulate[
 MyChart[y],
 {y, 1975, 2005, 1}]
```