A river system can be represented as a hierarchy. For example, a list of some of the

tributaries that feed into the Missouri River includes the Jefferson, Sun, Yellowstone,

Madison, and Gallatin Rivers. The Jefferson, in turn, is fed by the Beaverhead and Big

Hole rivers. The Yellowstone is fed by the Gardner, Shields, and Boulder rivers, and so

on. In this set of exercises you will create a data definition for a river and its tributaries,

and write programs that answer questions about the quality of the water in the rivers.

Assume that for each river, measurements of the river's pH and DO (dissolved oxygen)

levels are available. Such measurements are taken at the confluence of the rivers (the

point at which the tributaries converge). pH levels can range from 0 (most acidic) to 14

(most alkaline). The normal range for bodies of water are 6.5 - 8.5. DO is measured in

milligrams per liter (mg/L). DO levels are dependent on many factors, including water

temperature, salinity, atmospheric pressure, aeration, and bacterial levels. Dissolved

oxygen levels can range from less than 1 mg/L to more than 20 mg/L depending on how

all of these factors interact.

**1. (10 Points)** Provide data definitions for a river system. For each river in the

hierarchy, you should record the following information: the name of the river, the

pH of the water, the DO in mg/L, and a list of the tributaries (rivers) that feed into

the river. The name of your struct should be **river**. Make sure you define the

fields for a river in the order given in the description.

**2. (5 Points)** Provide an example of a river system that starts with a single river and

consists of at least two levels in the hierarchy below that. You may use the

example given above for the Missouri River, if you wish. (You may make up

numbers for pH and DO - for these exercises we're not concerned about the

accuracy of the information, just that you can provide a correct model for the

information.)

**3. (10 Points)** Provide the templates for your function definitions, i.e. river-fcn

and list-of-river-fcn.

**4. (30 Points)** Develop a function list-acidic-rivers that consumes a river

system and produces a list of string. The function returns a list of the names of

rivers in the system that have a pH level lower than 6.5.

**5. (30 Points)** Develop a function unhealthy? that consumes a river system and

produces a boolean. The function returns true if any river in the system has a pH

below 6.5 or over 8.5 or a DO under 6ppm.

**6. (30 Points)** Acid rain can lower the pH of water in a river system. Develop a

function lower-all-ph that consumes a river system and produces a river

system. The river system that is produced is the same as the original, except that

the pH of all the rivers in the system have been lowered by 0.3.

**7. (30 Points)** Write a function find-subsystem that consumes the name of a

river and a river system and produces either a river system or #false. The

function returns the portion of the original river system that has the named river as

its root. If there is no river in the system with the given name, the function returns

false.

Map

Description automatically generated