Case study 1 - generalities about the package

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```
using EcologicalNetwork
```

The purpose of this case study is to illustrate the ways to access information about the different types, and how to manipulate the networks. It contains a few lines starting with `@test` – this is because when validating the code, the case studies are part of the test suite. If one of the line starting by `@test` return an error, there is something wrong with the package.

We start by loading a network, in this case the one by Fonseca & Ganade (1996). This is a bipartite network.

```
N = fonseca_ganade_1996()
```

Let's look at the type of this network:

```
typeof(N)
```

```
EcologicalNetwork.BipartiteQuantitativeNetwork{Int64,String}
```

This is a bipartite network, which contains quantitative information about species interactions, stored as `Int64`. The species are identified by `String` objects.

The type of networks have a hierarchy between them. We can test that this network is bipartite:

```
@test typeof(N) <: AbstractBipartiteNetwork
```

```
Test Passed
```

We can also check that it is quantitative:

```
@test typeof(N) <: QuantitativeNetwork
```

```
Test Passed
```

Finally, we can also check that it is not probabilistic:

```
@test typeof(N) <: DeterministicNetwork
```

```
Test Passed
```

This is a network with 25 insects and 16 plants. We can check that this richness is indeed 41::

```
richness(N)
```

```
41
```

We can check the number of species on either side, using another method for `richness`:

```
@test richness(N,1) == 25
richness(N,1)
```

```
25
```

The side `1` is the top-level species, and the side `2` is the bottom-level species. Interactions go from species on side `1` to species on side `2`.

We can look at the species that make up all sides:

```
species(N)
```

```
41-element Array{String,1}:
 "Camponotus balzanii"
 "Azteca alfari"
 "Azteca isthmica"
 "Azteca aff. Isthmica"
 "Allomerus D"
 "Allomerus prancei"
 "Allomerus aff. Octoarticulata"
 "Solenops A"
 "Allomerus auripunctata"
 "Crematogaster B"

 "Duroia saccifera"
 "Cordia nodosa"
 "Cordia aff. Nodosa"
 "Tococa bullifera"
 "Maieta guianensis"
 "Maieta poeppiggi"
 "Tachigali polyphylla"
 "Tachigali myrmecophila"
 "Amaioua aff. Guianensis"
```

Note that this also works for either side:

```
species(N,2)
```

```
16-element Array{String,1}:
 "Cecropia purpuracens"
 "Cecropia concolor"
 "Cecropia distachya"
 "Cecropia ficifolia"
 "Pouruma heterophylla"
 "Hirtella myrmecophila"
 "Hirtella physophora"
 "Duroia saccifera"
 "Cordia nodosa"
 "Cordia aff. Nodosa"
```

```
 "Tococa bullifera"
 "Maieta guianensis"
 "Maieta poeppiggi"
 "Tachigali polyphylla"
 "Tachigali myrmecophila"
 "Amaioua aff. Guianensis"
```

We can look for the presence of interactions between species in a few different ways. First, we can use their *position* in the network:

```
N[3,4]
```

```
1
```

But it's probably more intuitive to look at the species by names:

```
t3 = species(N,1)[3]
b4 = species(N,2)[4]
t3, b4
```

```
("Azteca isthmica", "Cecropia ficifolia")
```

We can access the interaction between these species:

```
N[t3,b4]
```

```
1
```

The package also offers a way to test the *existence* of an interaction, regardless of the network type:

```
has_interaction(N, t3,b4)
```

```
true
```

An interesting thing we can do is extract a subset of the network using collections of species. We will extract the species belonging to the genus *Azteca*, and to the genus *Cecropia*:

```
all_azteca = filter(x -> contains(x, "Azteca "), species(N,1))
all_cecropia = filter(x -> contains(x, "Cecropia "), species(N,2))
```

Now, we can get a sub-network (the induced subgraph on these nodes):

```
M = N[all_azteca, all_cecropia]
```

We can also use slices in a more general way, for example to have all interactions from the *Azteca* genus:

```
N[all_azteca,:]
```

```
EcologicalNetwork.BipartiteQuantitativeNetwork{Int64,String}([1 0 … 0 0;
1 1 … 0 0; … ; 0 0 … 2 0; 0 0 … 0 3], String["Azteca alfari", "Azte
ca isthmica", "Azteca aff. Isthmica", "Azteca HC", "Azteca G", "Azteca CO",
 "Azteca TO", "Azteca schummani", "Azteca D", "Azteca polymorpha", "Azteca
Q"], String["Cecropia purpuracens", "Cecropia concolor", "Cecropia distachy
a", "Cecropia ficifolia", "Pouruma heterophylla", "Hirtella myrmecophila",
"Hirtella physophora", "Duroia saccifera", "Cordia nodosa", "Cordia aff. No
```

```
dosa", "Tococa bullifera", "Maieta guianensis", "Maieta poeppiggi", "Tachig
ali polyphylla", "Tachigali myrmecophila", "Amaioua aff. Guianensis"])
```

Note how extracting by collections of species names returns another network, of the same type as the parent!

```
typeof(M)
```

```
EcologicalNetwork.BipartiteQuantitativeNetwork{Int64,String}
```

We can ask a few questions about the degree of this induced network:

```
degree(N)
```

```
Dict{String,Int64} with 41 entries:
  "Pseudomyrmex concolor"         => 2
  "Hirtella myrmecophila"         => 1
  "Azteca isthmica"               => 4
  "Cordia nodosa"                 => 1
  "Cordia aff. Nodosa"            => 7
  "Tococa bullifera"              => 6
  "Cecropia purpuracens"          => 4
  "Azteca schummani"              => 2
  "Solenops A"                    => 2
  "Pseudomyrmex nigrescens"       => 2
  "Crematogaster B"               => 3
  "Crematogaster C"               => 2
  "Azteca D"                      => 1
  "Cecropia distachya"            => 1
  "Tachigali polyphylla"          => 3
  "Maieta guianensis"             => 3
  "Allomerus aff. Octoarticulata" => 3
  "Azteca G"                      => 3
  "Amaioua aff. Guianensis"       => 1
                                  =>
```

We can also look at the degree on either sides, for example the degree of plants (*i.e.* number of insects interacting with them):

```
degree(N,2)
```

```
Dict{String,Int64} with 16 entries:
  "Hirtella myrmecophila"   => 1
  "Cordia nodosa"           => 1
  "Cordia aff. Nodosa"      => 7
  "Tococa bullifera"        => 6
  "Cecropia purpuracens"    => 4
  "Cecropia distachya"      => 1
  "Tachigali polyphylla"    => 3
  "Maieta guianensis"       => 3
  "Duroia saccifera"        => 4
  "Amaioua aff. Guianensis" => 1
  "Cecropia concolor"       => 1
```

```
"Hirtella physophora"     => 4
"Pouruma heterophylla"    => 1
"Cecropia ficifolia"      => 2
"Maieta poeppiggi"        => 3
"Tachigali myrmecophila"  => 6
```