



Introdução à Análise de Dados com Linguagem R

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1 Data Frames

dataframe indiscutivelmente é a estrutura de dados mais importante em R, é nesta estrutura que a maioria dos seus dados será armazenada para análise. Combina a estrutura de uma matriz com a flexibilidade de ter diferentes tipos de dados em cada coluna. Pense em cada coluna como um vetor armazenando um tipo de dado específico. Para criar um dataframe utilizamos a função `dataframe()`.

1.1 Criar um data frame

```
# criar um data frame
df <- data.frame(
  # Coluna id
  id = c(1, 2, 3, 4, 5),
  # Coluna nome
```

```

nome = c('Mezilaurus itauba', 'Apuleia leiocarpa', 'Cedrela odorata',
          'Amburana acreana', 'Hymenolobium excelsum'),
# Coluna volume
volume = c(3.25, 6.51, 7.45, 8.81, 4.35)
)

# mostrar os dados na tela
df

```

```

##   id      nome volume
## 1  1 Mezilaurus itauba 3.25
## 2  2 Apuleia leiocarpa 6.51
## 3  3 Cedrela odorata 7.45
## 4  4 Amburana acreana 8.81
## 5  5 Hymenolobium excelsum 4.35

```

1.2 Carregar um data frame a partir de um arquivo

Em R é possível a leitura de vários formatos de arquivos utilizados para armazenamento de dados, a exemplo de:

- .csv
- .dbf
- .dta (Stata)
- .fst
- .h5
- .mtp (Minitab)
- .parquet
- .rda
- .rds
- .RData
- .spss (SPSS)
- .txt
- .xls e .xlsx
- .xml
- .xport (SAS)

Abordaremos neste módulo apenas os formatos mais frequentemente utilizados, a saber: .csv, .txt, .rds e .xls

Para leitura de arquivos nos formatos .csv e .txt, podemos utilizar a função `read.csv()` ou `read.csv2()`, a primeira por padrão lê dados de planilhas onde o separador decimal é o . e o separador de colunas é a ,; ao passo que a segunda função é utilizada para leitura de planilhas onde o separador decimal é a , e o separador de colunas é o ;

1.3 Leitura de Arquivos .csv e .txt

O trecho de código a seguir faz a leitura de uma planilha em formato .csv, a qual é atribuída ao objeto R denominado inventario, o qual após leitura dos dados passa a ser um dataframe, pois as colunas da planilha são importadas como vetores. Assim, podemos definir dataframe como um conjunto de vetores, mas pode também armazenar listas.

```
# Lê uma planilha csv com dados de inventário florestal
inventario <- read.csv2('./data/UMF_4_UPA_4F_SINAFLOV_v03.csv',
                        encoding = 'latin1')
```

A seguir usamos a função head() para mostrar as linhas iniciais do dataframe inventario. Por padrão esta função mostra apenas as seis primeiras linhas do dataframe, caso queiramos ler as dez primeiras linhas, devemos especificar este número após o nome do dataframe: head(inventario, 10)

```
# Mostrar as seis primeiras linhas dos dados no console
head(inventario)
```

```
##   N_arv UPA UT   Nome_Cientifico Nome_Popular DAP_cm Alt   Categoria QF
## 1 10001  6  1 Parkia gigantocarpa  Fava-atanã 114.59 19 Remanescente  1
## 2 10002  6  1 Bagassa guianensis  Tatajuba  67.48 17 Remanescente  1
## 3 10003  6  1   Castilla ulei      Caucho  52.52 11   Explorar  1
## 4 10004  6  1   Castilla ulei      Caucho  40.74 13 Remanescente  1
## 5 10005  6  1  Vochysia maxima  Quaruba  47.75 15 Remanescente  2
## 6 10006  6  1  Copaifera duckei  Copaíba  43.93 18 Remanescente  1
##      Vol      g      lat      lon
## 1 12.4891 1.0313 -5.907904 -54.96910
## 2  4.3893 0.3577 -5.907938 -54.96912
## 3  1.8263 0.2166 -5.907999 -54.96991
## 4  1.1068 0.1304 -5.906353 -54.96999
## 5  1.8325 0.1790 -5.906086 -54.97024
## 6  1.7038 0.1515 -5.905871 -54.97024
```

A seguir usamos a função tail() para mostrar as últimas linhas do dataframe inventario. Por padrão esta função mostra apenas as seis últimas linhas do dataframe, caso queiramos ler as dez últimas linhas, devemos especificar este número após o nome do dataframe: tail(inventario, 10)

```
# Mostrar as seis últimas linhas dos dados no console
tail(inventario)
```

```
##      N_arv UPA UT   Nome_Cientifico Nome_Popular DAP_cm Alt   Categoria
## 18583 290695  6 29   Parkia multijuga  Fava-benguê 52.52 15 Remanescente
## 18584 290696  6 29 Couratari guianensis  Tauari  92.95 24   Explorar
## 18585 290697  6 29   Vochysia maxima  Quaruba 112.68 20 Remanescente
## 18586 290698  6 29  Hymenaea parvifolia  Jutai-mirim 66.53 18 Remanescente
## 18587 290699  6 29   Vochysia maxima  Quaruba 127.32 19   Explorar
## 18588 290700  6 29   Vochysia maxima  Quaruba  54.75 17 Remanescente
##      QF      Vol      g      lat      lon
## 18583  2  2.3001 0.2166 -5.853998 -54.97232
## 18584  1 10.4347 0.6785 -5.853668 -54.97245
## 18585  2 12.6251 0.9972 -5.853556 -54.97230
## 18586  2  4.4416 0.3476 -5.853985 -54.96238
## 18587  1 14.6343 1.2732 -5.854445 -54.96315
## 18588  2  2.7760 0.2354 -5.854735 -54.96475
```

1.4 Obter os nomes das colunas de um Dataframe

Alguns Dataframes contém um número muito grande de colunas e precisamos atribuir os mesmos nomes a outros dataframes que formos criando, para evitar ter que digitar estes nomes outras vezes, podemos usar as função `names()` e `attributes()`.

A primeira retornará um saída vetorial ao passo que a segunda uma lista com três elementos, o primeiro é `names`: nomes das colunas; `class`: mostra a estrutura de dados, no caso `data.frame`; `row.names`: referente ao nomes dos rótulos das linhas, se houver. Para acessarmos somente os nomes das colunas usando a função `attributes()` devemos chamá-la da seguinte forma: `attributes(dataframe)[1]`

```
# Mostrar os nomes das colunas do data frame
```

```
names(inventario)
```

```
## [1] "N_arv"      "UPA"      "UT"      "Nome_Cientifico"
## [5] "Nome_Popular" "DAP_cm"   "Alt"     "Categoria"
## [9] "QF"        "Vol"     "g"      "lat"
## [13] "lon"
```

```
# Mostrar todos os atributos do data frame
```

```
attributes(inventario)
```

```
## $names
## [1] "N_arv"      "UPA"      "UT"      "Nome_Cientifico"
## [5] "Nome_Popular" "DAP_cm"   "Alt"     "Categoria"
## [9] "QF"        "Vol"     "g"      "lat"
## [13] "lon"
##
## $class
## [1] "data.frame"
##
## $row.names
## [1] 1 2 3 4 5 6 7 8 9 10 11 12
## [13] 13 14 15 16 17 18 19 20 21 22 23 24
## [25] 25 26 27 28 29 30 31 32 33 34 35 36
## [37] 37 38 39 40 41 42 43 44 45 46 47 48
## [49] 49 50 51 52 53 54 55 56 57 58 59 60
## [61] 61 62 63 64 65 66 67 68 69 70 71 72
## [73] 73 74 75 76 77 78 79 80 81 82 83 84
## [85] 85 86 87 88 89 90 91 92 93 94 95 96
## [97] 97 98 99 100 101 102 103 104 105 106 107 108
## [109] 109 110 111 112 113 114 115 116 117 118 119 120
## [121] 121 122 123 124 125 126 127 128 129 130 131 132
## [133] 133 134 135 136 137 138 139 140 141 142 143 144
## [145] 145 146 147 148 149 150 151 152 153 154 155 156
## [157] 157 158 159 160 161 162 163 164 165 166 167 168
## [169] 169 170 171 172 173 174 175 176 177 178 179 180
## [181] 181 182 183 184 185 186 187 188 189 190 191 192
## [193] 193 194 195 196 197 198 199 200 201 202 203 204
## [205] 205 206 207 208 209 210 211 212 213 214 215 216
## [217] 217 218 219 220 221 222 223 224 225 226 227 228
## [229] 229 230 231 232 233 234 235 236 237 238 239 240
## [241] 241 242 243 244 245 246 247 248 249 250 251 252
## [253] 253 254 255 256 257 258 259 260 261 262 263 264
## [265] 265 266 267 268 269 270 271 272 273 274 275 276
## [277] 277 278 279 280 281 282 283 284 285 286 287 288
## [289] 289 290 291 292 293 294 295 296 297 298 299 300
```

##	[301]	301	302	303	304	305	306	307	308	309	310	311	312
##	[313]	313	314	315	316	317	318	319	320	321	322	323	324
##	[325]	325	326	327	328	329	330	331	332	333	334	335	336
##	[337]	337	338	339	340	341	342	343	344	345	346	347	348
##	[349]	349	350	351	352	353	354	355	356	357	358	359	360
##	[361]	361	362	363	364	365	366	367	368	369	370	371	372
##	[373]	373	374	375	376	377	378	379	380	381	382	383	384
##	[385]	385	386	387	388	389	390	391	392	393	394	395	396
##	[397]	397	398	399	400	401	402	403	404	405	406	407	408
##	[409]	409	410	411	412	413	414	415	416	417	418	419	420
##	[421]	421	422	423	424	425	426	427	428	429	430	431	432
##	[433]	433	434	435	436	437	438	439	440	441	442	443	444
##	[445]	445	446	447	448	449	450	451	452	453	454	455	456
##	[457]	457	458	459	460	461	462	463	464	465	466	467	468
##	[469]	469	470	471	472	473	474	475	476	477	478	479	480
##	[481]	481	482	483	484	485	486	487	488	489	490	491	492
##	[493]	493	494	495	496	497	498	499	500	501	502	503	504
##	[505]	505	506	507	508	509	510	511	512	513	514	515	516
##	[517]	517	518	519	520	521	522	523	524	525	526	527	528
##	[529]	529	530	531	532	533	534	535	536	537	538	539	540
##	[541]	541	542	543	544	545	546	547	548	549	550	551	552
##	[553]	553	554	555	556	557	558	559	560	561	562	563	564
##	[565]	565	566	567	568	569	570	571	572	573	574	575	576
##	[577]	577	578	579	580	581	582	583	584	585	586	587	588
##	[589]	589	590	591	592	593	594	595	596	597	598	599	600
##	[601]	601	602	603	604	605	606	607	608	609	610	611	612
##	[613]	613	614	615	616	617	618	619	620	621	622	623	624
##	[625]	625	626	627	628	629	630	631	632	633	634	635	636
##	[637]	637	638	639	640	641	642	643	644	645	646	647	648
##	[649]	649	650	651	652	653	654	655	656	657	658	659	660
##	[661]	661	662	663	664	665	666	667	668	669	670	671	672
##	[673]	673	674	675	676	677	678	679	680	681	682	683	684
##	[685]	685	686	687	688	689	690	691	692	693	694	695	696
##	[697]	697	698	699	700	701	702	703	704	705	706	707	708
##	[709]	709	710	711	712	713	714	715	716	717	718	719	720
##	[721]	721	722	723	724	725	726	727	728	729	730	731	732
##	[733]	733	734	735	736	737	738	739	740	741	742	743	744
##	[745]	745	746	747	748	749	750	751	752	753	754	755	756
##	[757]	757	758	759	760	761	762	763	764	765	766	767	768
##	[769]	769	770	771	772	773	774	775	776	777	778	779	780
##	[781]	781	782	783	784	785	786	787	788	789	790	791	792
##	[793]	793	794	795	796	797	798	799	800	801	802	803	804
##	[805]	805	806	807	808	809	810	811	812	813	814	815	816
##	[817]	817	818	819	820	821	822	823	824	825	826	827	828
##	[829]	829	830	831	832	833	834	835	836	837	838	839	840
##	[841]	841	842	843	844	845	846	847	848	849	850	851	852
##	[853]	853	854	855	856	857	858	859	860	861	862	863	864
##	[865]	865	866	867	868	869	870	871	872	873	874	875	876
##	[877]	877	878	879	880	881	882	883	884	885	886	887	888
##	[889]	889	890	891	892	893	894	895	896	897	898	899	900
##	[901]	901	902	903	904	905	906	907	908	909	910	911	912
##	[913]	913	914	915	916	917	918	919	920	921	922	923	924
##	[925]	925	926	927	928	929	930	931	932	933	934	935	936
##	[937]	937	938	939	940	941	942	943	944	945	946	947	948

##	[949]	949	950	951	952	953	954	955	956	957	958	959	960
##	[961]	961	962	963	964	965	966	967	968	969	970	971	972
##	[973]	973	974	975	976	977	978	979	980	981	982	983	984
##	[985]	985	986	987	988	989	990	991	992	993	994	995	996
##	[997]	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008
##	[1009]	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020
##	[1021]	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032
##	[1033]	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044
##	[1045]	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056
##	[1057]	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068
##	[1069]	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080
##	[1081]	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092
##	[1093]	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104
##	[1105]	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116
##	[1117]	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128
##	[1129]	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140
##	[1141]	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152
##	[1153]	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164
##	[1165]	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176
##	[1177]	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188
##	[1189]	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200
##	[1201]	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212
##	[1213]	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224
##	[1225]	1225	1226	1227	1228	1229	1230	1231	1232	1233	1234	1235	1236
##	[1237]	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248
##	[1249]	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260
##	[1261]	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272
##	[1273]	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284
##	[1285]	1285	1286	1287	1288	1289	1290	1291	1292	1293	1294	1295	1296
##	[1297]	1297	1298	1299	1300	1301	1302	1303	1304	1305	1306	1307	1308
##	[1309]	1309	1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320
##	[1321]	1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331	1332
##	[1333]	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342	1343	1344
##	[1345]	1345	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356
##	[1357]	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368
##	[1369]	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380
##	[1381]	1381	1382	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392
##	[1393]	1393	1394	1395	1396	1397	1398	1399	1400	1401	1402	1403	1404
##	[1405]	1405	1406	1407	1408	1409	1410	1411	1412	1413	1414	1415	1416
##	[1417]	1417	1418	1419	1420	1421	1422	1423	1424	1425	1426	1427	1428
##	[1429]	1429	1430	1431	1432	1433	1434	1435	1436	1437	1438	1439	1440
##	[1441]	1441	1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452
##	[1453]	1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463	1464
##	[1465]	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476
##	[1477]	1477	1478	1479	1480	1481	1482	1483	1484	1485	1486	1487	1488
##	[1489]	1489	1490	1491	1492	1493	1494	1495	1496	1497	1498	1499	1500
##	[1501]	1501	1502	1503	1504	1505	1506	1507	1508	1509	1510	1511	1512
##	[1513]	1513	1514	1515	1516	1517	1518	1519	1520	1521	1522	1523	1524
##	[1525]	1525	1526	1527	1528	1529	1530	1531	1532	1533	1534	1535	1536
##	[1537]	1537	1538	1539	1540	1541	1542	1543	1544	1545	1546	1547	1548
##	[1549]	1549	1550	1551	1552	1553	1554	1555	1556	1557	1558	1559	1560
##	[1561]	1561	1562	1563	1564	1565	1566	1567	1568	1569	1570	1571	1572
##	[1573]	1573	1574	1575	1576	1577	1578	1579	1580	1581	1582	1583	1584
##	[1585]	1585	1586	1587	1588	1589	1590	1591	1592	1593	1594	1595	1596

##	[1597]	1597	1598	1599	1600	1601	1602	1603	1604	1605	1606	1607	1608
##	[1609]	1609	1610	1611	1612	1613	1614	1615	1616	1617	1618	1619	1620
##	[1621]	1621	1622	1623	1624	1625	1626	1627	1628	1629	1630	1631	1632
##	[1633]	1633	1634	1635	1636	1637	1638	1639	1640	1641	1642	1643	1644
##	[1645]	1645	1646	1647	1648	1649	1650	1651	1652	1653	1654	1655	1656
##	[1657]	1657	1658	1659	1660	1661	1662	1663	1664	1665	1666	1667	1668
##	[1669]	1669	1670	1671	1672	1673	1674	1675	1676	1677	1678	1679	1680
##	[1681]	1681	1682	1683	1684	1685	1686	1687	1688	1689	1690	1691	1692
##	[1693]	1693	1694	1695	1696	1697	1698	1699	1700	1701	1702	1703	1704
##	[1705]	1705	1706	1707	1708	1709	1710	1711	1712	1713	1714	1715	1716
##	[1717]	1717	1718	1719	1720	1721	1722	1723	1724	1725	1726	1727	1728
##	[1729]	1729	1730	1731	1732	1733	1734	1735	1736	1737	1738	1739	1740
##	[1741]	1741	1742	1743	1744	1745	1746	1747	1748	1749	1750	1751	1752
##	[1753]	1753	1754	1755	1756	1757	1758	1759	1760	1761	1762	1763	1764
##	[1765]	1765	1766	1767	1768	1769	1770	1771	1772	1773	1774	1775	1776
##	[1777]	1777	1778	1779	1780	1781	1782	1783	1784	1785	1786	1787	1788
##	[1789]	1789	1790	1791	1792	1793	1794	1795	1796	1797	1798	1799	1800
##	[1801]	1801	1802	1803	1804	1805	1806	1807	1808	1809	1810	1811	1812
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## [16933] 16933 16934 16935 16936 16937 16938 16939 16940 16941 16942 16943 16944
## [16945] 16945 16946 16947 16948 16949 16950 16951 16952 16953 16954 16955 16956
## [16957] 16957 16958 16959 16960 16961 16962 16963 16964 16965 16966 16967 16968
## [16969] 16969 16970 16971 16972 16973 16974 16975 16976 16977 16978 16979 16980
## [16981] 16981 16982 16983 16984 16985 16986 16987 16988 16989 16990 16991 16992
## [16993] 16993 16994 16995 16996 16997 16998 16999 17000 17001 17002 17003 17004
## [17005] 17005 17006 17007 17008 17009 17010 17011 17012 17013 17014 17015 17016
## [17017] 17017 17018 17019 17020 17021 17022 17023 17024 17025 17026 17027 17028
## [17029] 17029 17030 17031 17032 17033 17034 17035 17036 17037 17038 17039 17040
## [17041] 17041 17042 17043 17044 17045 17046 17047 17048 17049 17050 17051 17052
## [17053] 17053 17054 17055 17056 17057 17058 17059 17060 17061 17062 17063 17064
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## [17077] 17077 17078 17079 17080 17081 17082 17083 17084 17085 17086 17087 17088
## [17089] 17089 17090 17091 17092 17093 17094 17095 17096 17097 17098 17099 17100
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## [17113] 17113 17114 17115 17116 17117 17118 17119 17120 17121 17122 17123 17124
## [17125] 17125 17126 17127 17128 17129 17130 17131 17132 17133 17134 17135 17136
## [17137] 17137 17138 17139 17140 17141 17142 17143 17144 17145 17146 17147 17148

```

```

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## [17185] 17185 17186 17187 17188 17189 17190 17191 17192 17193 17194 17195 17196
## [17197] 17197 17198 17199 17200 17201 17202 17203 17204 17205 17206 17207 17208
## [17209] 17209 17210 17211 17212 17213 17214 17215 17216 17217 17218 17219 17220
## [17221] 17221 17222 17223 17224 17225 17226 17227 17228 17229 17230 17231 17232
## [17233] 17233 17234 17235 17236 17237 17238 17239 17240 17241 17242 17243 17244
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## [17353] 17353 17354 17355 17356 17357 17358 17359 17360 17361 17362 17363 17364
## [17365] 17365 17366 17367 17368 17369 17370 17371 17372 17373 17374 17375 17376
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## [17389] 17389 17390 17391 17392 17393 17394 17395 17396 17397 17398 17399 17400
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## [17461] 17461 17462 17463 17464 17465 17466 17467 17468 17469 17470 17471 17472
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## [17653] 17653 17654 17655 17656 17657 17658 17659 17660 17661 17662 17663 17664
## [17665] 17665 17666 17667 17668 17669 17670 17671 17672 17673 17674 17675 17676
## [17677] 17677 17678 17679 17680 17681 17682 17683 17684 17685 17686 17687 17688
## [17689] 17689 17690 17691 17692 17693 17694 17695 17696 17697 17698 17699 17700
## [17701] 17701 17702 17703 17704 17705 17706 17707 17708 17709 17710 17711 17712
## [17713] 17713 17714 17715 17716 17717 17718 17719 17720 17721 17722 17723 17724
## [17725] 17725 17726 17727 17728 17729 17730 17731 17732 17733 17734 17735 17736
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## [17785] 17785 17786 17787 17788 17789 17790 17791 17792 17793 17794 17795 17796

```

```

## [17797] 17797 17798 17799 17800 17801 17802 17803 17804 17805 17806 17807 17808
## [17809] 17809 17810 17811 17812 17813 17814 17815 17816 17817 17818 17819 17820
## [17821] 17821 17822 17823 17824 17825 17826 17827 17828 17829 17830 17831 17832
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## [17845] 17845 17846 17847 17848 17849 17850 17851 17852 17853 17854 17855 17856
## [17857] 17857 17858 17859 17860 17861 17862 17863 17864 17865 17866 17867 17868
## [17869] 17869 17870 17871 17872 17873 17874 17875 17876 17877 17878 17879 17880
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## [17929] 17929 17930 17931 17932 17933 17934 17935 17936 17937 17938 17939 17940
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## [18085] 18085 18086 18087 18088 18089 18090 18091 18092 18093 18094 18095 18096
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## [18229] 18229 18230 18231 18232 18233 18234 18235 18236 18237 18238 18239 18240
## [18241] 18241 18242 18243 18244 18245 18246 18247 18248 18249 18250 18251 18252
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## [18277] 18277 18278 18279 18280 18281 18282 18283 18284 18285 18286 18287 18288
## [18289] 18289 18290 18291 18292 18293 18294 18295 18296 18297 18298 18299 18300
## [18301] 18301 18302 18303 18304 18305 18306 18307 18308 18309 18310 18311 18312
## [18313] 18313 18314 18315 18316 18317 18318 18319 18320 18321 18322 18323 18324
## [18325] 18325 18326 18327 18328 18329 18330 18331 18332 18333 18334 18335 18336
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## [18397] 18397 18398 18399 18400 18401 18402 18403 18404 18405 18406 18407 18408
## [18409] 18409 18410 18411 18412 18413 18414 18415 18416 18417 18418 18419 18420
## [18421] 18421 18422 18423 18424 18425 18426 18427 18428 18429 18430 18431 18432
## [18433] 18433 18434 18435 18436 18437 18438 18439 18440 18441 18442 18443 18444

```



```
## [18445] 18445 18446 18447 18448 18449 18450 18451 18452 18453 18454 18455 18456
## [18457] 18457 18458 18459 18460 18461 18462 18463 18464 18465 18466 18467 18468
## [18469] 18469 18470 18471 18472 18473 18474 18475 18476 18477 18478 18479 18480
## [18481] 18481 18482 18483 18484 18485 18486 18487 18488 18489 18490 18491 18492
## [18493] 18493 18494 18495 18496 18497 18498 18499 18500 18501 18502 18503 18504
## [18505] 18505 18506 18507 18508 18509 18510 18511 18512 18513 18514 18515 18516
## [18517] 18517 18518 18519 18520 18521 18522 18523 18524 18525 18526 18527 18528
## [18529] 18529 18530 18531 18532 18533 18534 18535 18536 18537 18538 18539 18540
## [18541] 18541 18542 18543 18544 18545 18546 18547 18548 18549 18550 18551 18552
## [18553] 18553 18554 18555 18556 18557 18558 18559 18560 18561 18562 18563 18564
## [18565] 18565 18566 18567 18568 18569 18570 18571 18572 18573 18574 18575 18576
## [18577] 18577 18578 18579 18580 18581 18582 18583 18584 18585 18586 18587 18588
```

```
# Mostrar apenas o primeiro atributo (nomes das colunas)
attributes(inventario)[1]
```

```
## $names
## [1] "N_arv"          "UPA"            "UT"             "Nome_Cientifico"
## [5] "Nome_Popular"   "DAP_cm"         "Alt"            "Categoria"
## [9] "QF"            "Vol"           "g"              "lat"
## [13] "lon"
```

1.5 Obter número de linhas e colunas de uma Dataframe

A função `dim()` recebe como parâmetro um dataframe e retorna o número de linhas e colunas.

```
# Mostrar as dimensões do data frame
dim(inventario)
```

```
## [1] 18588    13
```

- Podemos acessar apenas o número de linhas ou de colunas: `dim(inventario)[1]` e `dim(inventario)[2]`, respectivamente.

```
# Mostrar apenas o número de linhas do dataframe
dim(inventario)[1]
```

```
## [1] 18588
```

```
# Mostrar apenas o número de colunas do dataframe
dim(inventario)[2]
```

```
## [1] 13
```

Os comandos acima podem ser simplificados com o uso apenas das funções `nrow()` e `ncol()`. veja os exemplos a seguir:

```
# Obter o número de linhas de um dataframe
nrow(inventario)
```

```
## [1] 18588
```

```
# Obter o número de colunas de um dataframe
ncol(inventario)
```

```
## [1] 13
```

Dos exemplos acima podemos observar que foram inventariadas 18.588 árvores (número de linhas) e que o dataframe contém 13 variáveis (colunas)

1.6 Obter a Estrutura dos Dados de um DataFrame

```
# Verificar a estrutura dos dados
```

```
str(inventario)
```

```
## 'data.frame':    18588 obs. of  13 variables:
## $ N_arv          : int  10001 10002 10003 10004 10005 10006 10007 10008 10009 10010 ...
## $ UPA            : int   6  6  6  6  6  6  6  6  6  6 ...
## $ UT             : int   1  1  1  1  1  1  1  1  1  1 ...
## $ Nome_Cientifico: chr   "Parkia gigantocarpa" "Bagassa guianensis" "Castilla ulei" "Castilla ulei"
## $ Nome_Popular   : chr   "Fava-atanã" "Tatajuba" "Caucho" "Caucho" ...
## $ DAP_cm         : num  114.6 67.5 52.5 40.7 47.8 ...
## $ Alt            : int   19 17 11 13 15 18 16 20 20 15 ...
## $ Categoria      : chr   "Remanescente" "Remanescente" "Explorar" "Remanescente" ...
## $ QF             : int   1  1  1  1  2  1  2  1  1  1 ...
## $ Vol            : num  12.49 4.39 1.83 1.11 1.83 ...
## $ g              : num   1.031 0.358 0.217 0.13 0.179 ...
## $ lat            : num  -5.91 -5.91 -5.91 -5.91 -5.91 ...
## $ lon            : num  -55 -55 -55 -55 -55 ...
```

1.7 Resumo dos Dados de um Dataframe

```
# Mostrar o resumo dos dados
```

```
summary(inventario)
```

```
##      N_arv          UPA          UT      Nome_Cientifico
## Min.   : 10001    Min.   :6    Min.   : 1.00    Length:18588
## 1st Qu.: 90010    1st Qu.:6    1st Qu.: 9.00    Class :character
## Median :160623    Median :6    Median :16.00    Mode  :character
## Mean   :161674    Mean   :6    Mean   :16.13
## 3rd Qu.:240164    3rd Qu.:6    3rd Qu.:24.00
## Max.   :290700    Max.   :6    Max.   :29.00
## Nome_Popular      DAP_cm      Alt      Categoria
## Length:18588      Min.   : 39.79    Min.   : 7.00    Length:18588
## Class :character  1st Qu.: 54.11    1st Qu.:16.00    Class :character
## Mode  :character  Median : 66.85    Median :18.00    Mode  :character
##                  Mean   : 71.95    Mean   :18.12
##                  3rd Qu.: 84.99    3rd Qu.:20.00
##                  Max.   :312.26    Max.   :40.00
##      QF          Vol          g          lat
## Min.   :1.000    Min.   : 0.7213    Min.   :0.1243    Min.   : -5.918
## 1st Qu.:1.000    1st Qu.: 2.7023    1st Qu.:0.2300    1st Qu.: -5.897
## Median :1.000    Median : 4.4863    Median :0.3509    Median : -5.881
## Mean   :1.282    Mean   : 5.5925    Mean   :0.4523    Mean   : -5.883
## 3rd Qu.:2.000    3rd Qu.: 7.3581    3rd Qu.:0.5673    3rd Qu.: -5.871
## Max.   :3.000    Max.   :39.0858    Max.   :7.6582    Max.   : -5.848
##      lon
## Min.   : -55.00
## 1st Qu.: -54.97
## Median : -54.96
## Mean   : -54.96
## 3rd Qu.: -54.95
## Max.   : -54.94
```

1.8 Acessar colunas do data frame

Para acessar uma coluna específica de um data frame usamos o sinal \$, se queremos acessar somente a coluna referente a variável volume, denominada em nossa data frame de Vol: inventario\$Vol. Isso nos permite aplicar uma função apenas a esta coluna:

```
# Selecionar a coluna "Vol" e Mostrar o resumo dos dados da coluna "Vol"
summary(inventario$Vol)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7213  2.7023  4.4863  5.5925  7.3581 39.0858
```

1.9 Filtrar Linhas e/ou Colunas de uma Data Frame

Em função do data frame possuir duas dimensões, é possível localizar uma linha e/ou uma coluna através das coordenadas de suas dimensões. Vamos considerar como exemplo os dados referente a lista de espécies da fauna brasileira ameaçadas de extinção.

```
fauna <- read.csv2('./data/DF_port_MMA_300-2022_fauna.csv')
```

```
head(fauna)
```

```
##      n port443 classe      ordem      familia      especie_subespecie
## 1 1          *   Aves Accipitriformes Accipitridae Amadonastur lacernulatus
## 2 2          *   Aves Accipitriformes Accipitridae      Circus cinereus
## 3 3          *   Aves Accipitriformes Accipitridae      Harpia harpyja
## 4 4          *   Aves Accipitriformes Accipitridae      Leptodon forbesi
## 5 5          *   Aves Accipitriformes Accipitridae      Morphnus guianensis
## 6 6          *   Aves Accipitriformes Accipitridae      Urubitinga coronata
##      categoria
## 1          VU
## 2          VU
## 3          VU
## 4          EN
## 5          VU
## 6          EN
```

Para filtrar a segunda linha passamos o endereço desta linha no data frame

```
fauna[2, ]
```

```
##      n port443 classe      ordem      familia especie_subespecie categoria
## 2 2          *   Aves Accipitriformes Accipitridae      Circus cinereus      VU
```

Para filtrar apenas a terceira coluna

```
print(fauna[, 3])
```

```
##      [1] "Aves"      "Aves"      "Aves"      "Aves"
##      [5] "Aves"      "Aves"      "Anthozoa"   "Arachnida"
##      [9] "Arachnida" "Arachnida" "Arachnida"   "Arachnida"
##     [13] "Arachnida" "Arachnida" "Arachnida"   "Arachnida"
##     [17] "Malacostraca" "Malacostraca" "Malacostraca" "Malacostraca"
##     [21] "Malacostraca" "Malacostraca" "Malacostraca" "Malacostraca"
##     [25] "Malacostraca" "Malacostraca" "Malacostraca" "Malacostraca"
##     [29] "Malacostraca" "Malacostraca" "Aves"        "Hydrozoa"
##     [33] "Amphibia"    "Amphibia"    "Diplopoda"   "Diplopoda"
##     [37] "Amphibia"    "Amphibia"    "Amphibia"    "Amphibia"
##     [41] "Amphibia"    "Amphibia"    "Amphibia"    "Amphibia"
```

##	[45]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[49]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[53]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[57]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[61]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[65]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[69]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[73]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[77]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[81]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[85]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[89]	"Amphibia"	"Amphibia"	"Amphibia"	"Amphibia"
##	[93]	"Amphibia"	"Holothuroidea"	"Aves"	"Aves"
##	[97]	"Aves"	"Aves"	"Aves"	"Aves"
##	[101]	"Aves"	"Aves"	"Aves"	"Aves"
##	[105]	"Arachnida"	"Arachnida"	"Arachnida"	"Arachnida"
##	[109]	"Arachnida"	"Arachnida"	"Arachnida"	"Arachnida"
##	[113]	"Arachnida"	"Arachnida"	"Arachnida"	"Arachnida"
##	[117]	"Arachnida"	"Arachnida"	"Arachnida"	"Arachnida"
##	[121]	"Arachnida"	"Arachnida"	"Arachnida"	"Arachnida"
##	[125]	"Arachnida"	"Arachnida"	"Arachnida"	"Arachnida"
##	[129]	"Actinopterygii"	"Insecta"	"Gastropoda"	"Gastropoda"
##	[133]	"Gastropoda"	"Echinoidea"	"Aves"	"Aves"
##	[137]	"Chondrichthyes"	"Chondrichthyes"	"Chondrichthyes"	"Chondrichthyes"
##	[141]	"Chondrichthyes"	"Chondrichthyes"	"Chondrichthyes"	"Chondrichthyes"
##	[145]	"Chondrichthyes"	"Chondrichthyes"	"Chondrichthyes"	"Chondrichthyes"
##	[149]	"Chondrichthyes"	"Chondrichthyes"	"Chondrichthyes"	"Chondrichthyes"
##	[153]	"Chondrichthyes"	"Chondrichthyes"	"Chondrichthyes"	"Chondrichthyes"
##	[157]	"Chondrichthyes"	"Chondrichthyes"	"Chondrichthyes"	"Mammalia"
##	[161]	"Mammalia"	"Mammalia"	"Mammalia"	"Mammalia"
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[illegible]

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## [1229] "Aves" "Aves" "Aves" "Collembola"
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## [1261] "Asteroidea" "Asteroidea" "Insecta" "Insecta"
## [1265] "Insecta" "Insecta"
```

Também podemos filtrar um data frame com base em uma coluna

```
fauna[fauna$especie_subespecie == 'Euvola ziczac', ]
```

```
##      n port443  classe      ordem  familia especie_subespecie categoria
## 672 679      * Bivalvia Ostreoida Pectinidae      Euvola ziczac      EN
```

1.10 Filtrar dados com a função subset

```
# Gerar um subconjunto das árvores selecionadas para corte
especies_explorar <- subset(inventario, Categoria == 'Explorar')

# Mostrar o subconjunto
head(especies_explorar)
```

```
##      N_arv UPA UT      Nome_Cientifico Nome_Popular DAP_cm Alt
## 3  10003   6  1      Castilla ulei      Caucho  52.52  11
## 7  10007   6  1 Pseudopiptadenia psilostachya Timborana  59.52  16
```

```
## 9 10009 6 1 Hymenolobium petraeum Angelim-pedra 72.57 20
## 13 10013 6 1 Goupia glabra Cupiúba 74.80 16
## 23 10023 6 1 Manilkara elata Maçaranduba 74.17 19
## 24 10024 6 1 Goupia glabra Cupiúba 63.66 14
## Categoria QF Vol g lat lon
## 3 Explorar 1 1.8263 0.2166 -5.907999 -54.96991
## 7 Explorar 2 3.2062 0.2783 -5.905860 -54.97020
## 9 Explorar 1 5.7342 0.4137 -5.905200 -54.97010
## 13 Explorar 2 5.1779 0.4395 -5.903429 -54.97043
## 23 Explorar 1 5.7705 0.4320 -5.906069 -54.97048
## 24 Explorar 1 3.3641 0.3183 -5.906245 -54.97040
```

```
# Número de Árvores a Explorar
nrow(especies_explorar)
```

```
## [1] 8221
```

1.11 Criar uma nova coluna

Iremos criar uma coluna em função de um filtro baseado em dados de outro data frame. Vamos filtrar os dados onde as espécies do `inventario` são espécies ameaçadas de extinção, as espécies que forem ameaçadas receberão a denominação conforme sua categoria definida na Portaria MMA 300/2022, para isso teremos que utilizar carregar um *data frame* com os dados da portaria e criar uma coluna no `inventario` denominada `status_ecologico`, a qual receberá a categoria de ameaça.

```
# ler os dados da portaria MMA 300/2022
port_300_flora <- read.csv2('./data/DF_port_MMA_300-2022_flora.csv')
```

```
# Mostrar na tela apenas 6 linhas do data frame
head(port_300_flora)
```

```
## n port443 familia especie_subespecie_var categoria
## 1 1 * Acanthaceae Aphelandra espirito-santensis EN
## 2 2 * Acanthaceae Aphelandra margaritae VU
## 3 3 * Acanthaceae Aphelandra maximiliana EN
## 4 4 Acanthaceae Aphelandra rigida EN
## 5 5 Acanthaceae Aphelandra stephanophysa VU
## 6 6 * Acanthaceae Dyschoriste lavandulacea EN
```

```
# Filtrar as espécies do inventario que coincidem as espécies da Portaria
# MMA 300/2022 e atribuir a categoria de ameaça a uma nova coluna em inventario,
# a ser denominada status_ecologico.
```

```
inventario_ameacadas <- inventario[inventario$Nome_Cientifico %in% port_300_flora$especie_subespecie_var,
```

Agora podemos saber quais espécies do inventário florestal são ameaçadas de extinção:

```
unique(inventario_ameacadas$Nome_Cientifico)
```

```
## [1] "Bertholletia excelsa" "Apuleia leiocarpa" "Cedrela odorata"
## [4] "Hymenaea parvifolia" "Virola surinamensis" "Mezilaurus itauba"
```

1.12 Excluir Linhas e Colunas de um Data Frame

```
# Excluir a linha 2
fauna <- fauna[-2, ]
```

```
# Conferir a remoção da linha 2
head(fauna)
```

```
##   n port443   classe      ordem      familia      especie_subespecie
## 1 1      *      Aves Accipitriformes Accipitridae Amadonastur lacernulatus
## 3 3      *      Aves Accipitriformes Accipitridae      Harpia harpyja
## 4 4      *      Aves Accipitriformes Accipitridae      Leptodon forbesi
## 5 5      *      Aves Accipitriformes Accipitridae      Morphnus guianensis
## 6 6      *      Aves Accipitriformes Accipitridae      Urubitinga coronata
## 7 7      * Anthozoa      Actiniaria  Actiniidae      Condylactis gigantea
##   categoria
## 1      VU
## 3      VU
## 4      EN
## 5      VU
## 6      EN
## 7      EN
```

```
# Excluir a coluna n
fauna$n <- NULL
```

```
# Conferir a remoção da coluna 1
head(fauna)
```

```
##   port443   classe      ordem      familia      especie_subespecie
## 1      *      Aves Accipitriformes Accipitridae Amadonastur lacernulatus
## 3      *      Aves Accipitriformes Accipitridae      Harpia harpyja
## 4      *      Aves Accipitriformes Accipitridae      Leptodon forbesi
## 5      *      Aves Accipitriformes Accipitridae      Morphnus guianensis
## 6      *      Aves Accipitriformes Accipitridae      Urubitinga coronata
## 7      * Anthozoa      Actiniaria  Actiniidae      Condylactis gigantea
##   categoria
## 1      VU
## 3      VU
## 4      EN
## 5      VU
## 6      EN
## 7      EN
```

1.13 Ler Dados de Arquivo Demilitado por Tabulação

```
dados <- read.delim2('./data/Bivalvia_tab.txt')
head(dados)
```

```
##      n port443   classe      ordem      familia especie_subespecie categoria
## 1  679      * Bivalvia Ostreoida  Pectinidae      Euvola ziczac      EN
## 2 1275      * Bivalvia Unionoida  Hyriidae Diplodon koseritzi      EN
## 3 1276      * Bivalvia Unionoida Mycetopodidae Mycetopoda legumen      EN
```

1.14 Ler Dados de Arquivo Delimitado por Espaço

```
dados <- read.delim2('./data/Separado_por_Espaco.txt', sep = ' ')
head(dados)
```

```
##   id          nome volume
## 1  1    Mezilaurus itauba  3.25
## 2  2    Apuleia leiocarpa  6.51
## 3  3      Cedrela odorata  7.45
## 4  4    Amburana acreana  8.81
## 5  5 Hymenolobium excelsum  4.35
```

1.15 Ler Dados de Arquivo Hospedado na Internet

A seguir é mostrado como ler dados diretamente da internet, como exemplo iremos ler um conjunto de dados do SISTAXON.

```
# Link da planilha com dados do Sistaxon
link <- 'http://www.ibama.gov.br/phocadownload/sinaflor/2022/2022-07-22_Lista_especies_DOF.csv'

# Ler o arquivo csv diretamente do link
#sp_sistaxon <- read.csv(link)

# Mostrar os dados no console
#head(sp_sistaxon)
```

1.16 Leitura de Dados em Formatos de Arquivos de Softwares Proprietários

Arquivo	Pacote	Função
.dbf	foreign	read.dbf()
.dta	foreign	read.tda()
.fst	fst	read_fst()
.mtp	foreign	read.mtp()
.spss	foreign	read.spss()
.xls		read_xls()
.xls		read_xlsx()
.xport	foreign	read.xport()

1.17 Ler Dados de Arquivos .xls e .xlsx

```
# Carregar o pacote readxl
library(readxl)

# Listar as planilhas presentes no arquivo .xls
xls <- excel_sheets('./data/aves_reptilia.xls')
xls
```

```
## [1] "aves"      "reptilia"
```

Por padrão a função `read_xls()` lê a primeira planilha do arquivo.

```
# Ler dados da primeira planilha "aves" e atribuir a um dataframe
dados_fauna <- read_xls('./data/aves_reptilia.xls')
```

```
# Mostrar as primeiras seis linhas do dataframe
head(dados_fauna)
```

```
## # A tibble: 6 x 7
##       n port443 classe ordem      familia  especie_subespecie  categ~1
```

```
##      <dbl> <chr>      <chr>      <chr>      <chr>      <chr>      <chr>
## 1      1 *          Aves      Accipitriformes Accipitridae Amadonastur lacernu~ VU
## 2      2 *          Aves      Accipitriformes Accipitridae Circus cinereus VU
## 3      3 *          Aves      Accipitriformes Accipitridae Harpia harpyja VU
## 4      4 *          Aves      Accipitriformes Accipitridae Leptodon forbesi EN
## 5      5 *          Aves      Accipitriformes Accipitridae Morphnus guianensis VU
## 6      6 *          Aves      Accipitriformes Accipitridae Urubitinga coronata EN
## # ... with abbreviated variable name 1: categoria
```

Para ler uma outra planilha devemos passar essa informação para o parâmetro `sheets`. Se quisermos ler a planilha `reptilia` o código seria: `read_xls('./data/aves_reptilia.xls', sheet = 'reptilia')` ou `read_xls('./data/aves_reptilia.xls', sheet = 2)`

```
# Ler dados da primeira planilha "reptilia" e atribuir a um dataframe
dados_fauna <- read_xls('./data/aves_reptilia.xls', sheet = 'reptilia')

# Mostrar as primeiras seis linhas do dataframe
head(dados_fauna)
```

```
## # A tibble: 6 x 7
##       n port443 classe      ordem      familia      especie_subespecie      categ~1
##   <dbl> <chr>      <chr>      <chr>      <chr>      <chr>      <chr>
## 1  1168 *          Reptilia Squamata Amphisbaenidae Amphisbaena arda EN
## 2  1169 *          Reptilia Squamata Amphisbaenidae Amphisbaena frontalis EN
## 3  1170 *          Reptilia Squamata Amphisbaenidae Amphisbaena nigricauda EN
## 4  1171 *          Reptilia Squamata Amphisbaenidae Amphisbaena supernumer~ EN
## 5  1172 *          Reptilia Squamata Amphisbaenidae Amphisbaena uroxena EN
## 6  1173 *          Reptilia Squamata Amphisbaenidae Leposternon kisteumach~ VU
## # ... with abbreviated variable name 1: categoria
```