

UNIVERSIDADE FEDERAL DE UBERLÂNDIA
FACOM - FACULDADE DE COMPUTAÇÃO
SISTEMA DE INFORMAÇÃO

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Matrícula: 12011ECP022

Primeiro trabalho prático 1

Disciplina: Arquitetura e Organização de Computadores.

Uberlândia
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Instruções

Escreva em assembly um programa que implementa o algoritmo de ordenação quicksort. O programa deve ler um arquivo texto chamado numeros.csv (nos arquivos do grupo) e ordená-los. O programa deve ainda possuir uma função que converte uma string de números para um inteiro

OBs: não consegui fazer a função atoi, o programa apenas lê o arquivo, mas os dados foram colocados em um array

```
#-----
```

```
#quicksort.asm
```

```
#
```

```
#DDA 05.10.2020
```

```
#
```

```
#Aluno: Lucas Albino Martins, Matricula 12011ECP022
```

```
#Obs: não consegui fazer a função atoi, o programa apenas lê o arquivo, mas os dados foram colocados em um array
```

```
#
```

```
#DESC: Ordenação rápida em um documento.
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#
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#-----
```

```
.data
```

```
meuarquivo: .ascii "numero.csv"
```

```
buffer: .space 10000
```

```
msg: .ascii "Programa lê um arquivo e ordena ele rapidamente\n"
```

```
entrada_quicksort: .ascii "\nNumeros sem ordenação do QuickSort:\n"
```

```
saida_quicksort: .ascii "\nNumeros depois de aplicar o QuickSort:\n"
```

```
rtn: .ascii "\n"
```

```
tab: .ascii "\t"
```

```
vetor: .word
```

```
3787,574,6507,6423,2487,9750,8251,2041,8838,2230,6042,24,3376,5664,8360,6938,4700,84  
87,576,1165,9106,4071,7177,3117,9073,195,9950,8536,3663,1667,7394,3983,5067,5081,910  
5,3705,158,8559,1271,8373,4834,7996,467,7998,2214,9421,1861,5468,6775,8777,6948,4291,  
5330,2739,3267,8881,9673,9928,4836,5039,3803,6120,1333,5296,8895,8912,2811,1887,4159
```

,1908,6282,9041,8309,902,8959,9509,3405,424,7080,3741,6303,3145,4824,5694,8997,5254,5
712,7450,8621,625,1072,7977,5466,2551,9050,1270,3836,7263,5280,6598,8689,4493,9676,9
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7237,451,4403,7023,6902,8667,6407,1998,4891,4007,5499,6393,4353,9711,5750,7555,3686,
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448,936,5147,7168,7329,5054,8925,7327,1107,3132,185,7758,3503,7186,635,8933,3719,473
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99,6752,7924,7985,1327,8734,6201,3678,7554,9355,1066,1642,3806,4772,3875,9721,1505,2
305,9149,6660,5365,8962,1490,4708,982,7596,5097,3892,30,5241,9935,3396,1680,4319,752
6,1242,2412,150,9829,445,3154,9335,3689,4804,9869,4858,3254,7683,5610,6030,1813,6224,
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76,3162,2672,1539,9815,3089,5743,3510,8282,6410,2193,6549,8948,773,3528,1676,5860,33
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74,3643,7442,5140,6836,4113,6450,1476,280,3759,9743,6670,1399,2449,5601,3948,9414,25
54,9424,630,4641,3107,7568,3926,5516,2520,4946,6642,1898,9123,1633,3506,7169,3492,76
58,2349,9653,1927,7342,5438,8090,689,3166,7934,9914,728,2587,5528,1371,2367,7202,709
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3,1937,3914,1795,5189,2610,6703,1354,1227,1772,9886,5291,3991,6164,1058,5085,1678,12
7,582,6270,3428,2588,6223,5121,559,8016,8461,1431,4436,5345,5724,4878,7875,3708,3268,
1038,3227,3602,8407,4941,2925,2820,8438,7216,6710,7682,6701,9323,4861,4582,5412,2534
,1325,9446,6551,1177,7689,3323,8049,863,8586,5870,1161,4468,6651,4897,5693,9275,4970,
4066,5839,2706,8085,4222,4944,2405,6106,2239,5462,8940,7970,9749,7622,143,2815,3712,
4742,9994,5073,585,34,1071,4397,4904,5094,7403,1214,6176,9159,3822,1306,3420,7903,24
76,6839,4867,2625,182,6935,925,2234,4053,9836,6354,2395,2877,5888,7105,3245,3384,763
8,6932,1382,4188,3771,7473,1883,4474,5222,1854,4274,1698,9897,8530,6435,7267,8518,73
43,5317,6998,6612,6547,389,377,9330,5935,4610,5435,578,168,6477,5844,3025,2723,2932,1
65,1478,2955,977,9054,657,9376,7520,8163,202,123,18,3904,3374,1567,4907,4653,4080,700
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37,1039,8214,6982,9898,9595,296,8307,8585,9112,9896,1336,2971,6178,4523,1016,8313,19
36,570,1905,4067,8372,3971,8101,2850,1776,2821,1734,5729,794,8870,9621,1365,3201,326
3,9650,835,7548,5479,940,2981,4762,3406,725,769,5329,6575,5593,9430,4488,1091,2864,60
12,7108,4715,6326,2740,9538,4295,8866,3896,6796,1914,9406,9442,5586,9090,3860,1747,9
327,6856,3199,7669,5589,5556,6865,3295,4442,9384,4541,2544,1079,2237,1064,4973,349,5
669,5204,6947,2752,2133,6624,1991,48,6975,1671,916,7038,5489,3062,8452,3177,1848,10,1
732,1694,5247,5573,3566,6822,9831,5230,7831,1387,9113,4489,6374,3902,1392,135,270,22
83,70,598,8935,173,9556,1073,4705,4433,3243,1375,5367,2111,7262,558,4374,4380,6824,15
9,1847,9141,1596,8609,5963,3596,6761,3212,8884,4408,684,5658,8696,4960,3507,8891,205
4,9307,587,8736,2071,96,8904,5984,1977,5252,1085,6428,9021,5228,4914,6163,5700,6485,6
190,6691,3156,6002,2827,4928,479,7000,6489,4213,6044,8334,3479,9828,6750,2240,4994,1
49,1823,7546,4961,6890,7754,2198,8562,2040,4593,9906,9383,5721,6010,3411,2135,1556,3
379,512,5728,5311,1903,6417,9071,632,8478,4923,9824,670,4591,8805,7285,1792,2597,642
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4000,4036,5745,1862,2415,6005,6695,8315,4656,2436,1578,2044,5859,4481,6793,7585,6518,
5277,6269,9717,3431,4847,7514,7031,4562,5947,9377,2937,1657,8729,8448,2913,9475,519,
2184,3176,6377,2213,41,9267,3933,6891,9570,4892,1543,6724,5541,7691,4143,1164,1894,7
670,2443,694,4392,3495,9380,4358,3283,8780,7075,6628,3477,7772,4480,1868,4551,8454,5
093,1713,1229,178,4604,2853,3073,3032,9656,6886,5806,9924,7223,734,9592,6694,8505,30
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54,2918,2831,683,6052,1709,8342,3864,7205,7101,5409,5996,4022,7507,6736,8537,532,981,
2911,3883,2785,367,7481,7818,9964,2996,3567,4777,9784,5373,8721,8445,6130,4560,8636,
46,3083,429,4485,4559,9365,3003,9394,2792,628,4854,2549,9993,4105,5543,2109,9358,191
5,3898,1190,7295,3085,9015,946,2218,5832,802,5825,6871,883,8079,8146,2095,8119,115,72
83,7096,137,979,4041,903,3238,5733,8994,1579,4037,7502,9615,749,8908,6218,7897,2865,4
309,6399,7302,3389,7778,6674,9276,9611,7357,2393,6298,708,609,3289,7995,1675,3294,81
18,286,4778,551,6487,5496,7049,7813,1221,9910,1790,9901,5288,9974,7426,26,2197,8718,4
308,2341,108,3815,7651,2497,9562,6903,4787,3478,4171,7217,1822,5950,5581,3830,6895,6
032,3399,2954,6329,7207,9027,6415,6985,6396,6951,9007,4161,3290,3234,161,9495,9860,8
507,6378,1160,3635,3959,1972,5482,789,5441,1688,1474,2235,9644,626,4895,1533,4622,59
98,5180,2642,3690,3851,2160,912,9956,6726,5200,8340,3659,9796,3900,4555,8385,2777,55
26,7577,5111,4588,7849,6594,1004,8813,5185,8243,7181,8429,2302,7865,2312,8974,5061,8
691,107,9110,3980,3125,5686,1816,2070,4543,7882,4416,8617,3737,7662,6215,8404,5461,3
429,4250,1985,8527,8111,3811,3588,166,8177,4131,3613,8983,398,1929,5690,1373,4386,23
59,5469,8377,5155,6509,4423,2801,5333,9862,731,2756,1930,1111,3612,3696,465,8453,702
4,6227,4331,3918,7004,6036,7504,1704,9001,3816,1921,58,308,4075,780,3587,3841,2243,14
47,85,4664,741,1805,797,2666,427,6029,1252,7612,5010,6135,9506,1764,5787,7310,6979,60
64,8825,5375,6431,3547,218,7587,2079,2306,4814,9702,3838,8141,5192,1500,4447,5030,62
78,7562,6606,5689,9059,5047,8025,9920,2407,2131,6770,7118,4702,8112,4951,8024,1726,8
922,2046,7862,2092,1406,1534,2114,5485,136,2186,833,3489,3455,3550,7048,1007,7566,80
51,5361,7701,1961,4539,1662,3063,2675,9832,7841,963,4707,4051,3930,1157,3093,8832,84
09,6841,9580,5176,6831,9219,918,9393,8695,4776,1615,3916,7741,9309,272,7293,4357,915
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558,1629,2629,8985,8237,1512,1769,7341,9030,8569,4076,3439,9198,5683,6587,6794,4840,
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132,7200,4020,2861,6145,6414,5781,5786,7400,2829,1760,9820,6157,4389,4691,629,6085,4
752,224,1178,1630,2146,9091,6258,650,8147,2984,1240,7034,3559,1011,7949,7409,6881,44
34,5457,5816,7540,5287,5842,5363,5334,6640,9471,7052,6809,3825,1581,6471,3610,677,54
52,997,3710,6375,8684,8300,9629,3466,4324,133,5525,5904,4278,7616,8943,2078,4786,879
3,1238,9371,8200,4910,3899,8038,6475,1301,6161,4997,4185,4676,7139,7448,5347,4808,62
63,7609,2985,5603,9705,3026,8059,8519,8093,5431,5514,4165,6672,6056,8902,4843,8194,9
770,5922,2021,8041,8593,5481,6094,6853,7269,1733,9520,9660,535,9401,3645,8711,2780,2
002,2745,8602,7501,9812,9618,1340,8967,5847,1757,8015,1928,8945,8164,3691,3809,101,5
038,6755,9714,1147,3516,3607,3260,5903,2764,5208,1277,8105,796,9778,9137,9361,1989,2
532,6373,2596,8697,4062,567,2692,5962,6851,7033,8414,8143,7244,6297,3642,764,1300,17
74,4147,23,3625,266,2650,7008,3432,3315,9760,9087,7990,8257,5886,7081,5789,1241,1475,
2586,8271,5599,3288,6108,4175,7227,5475,2466,2294,1420,691,709,3518,4063,5607,4160,3
360,6844,3862,6815,4977,3929,5364,3424,8905,2702,471,8209,5477,1501,2315,4404,6543,1
866,807,151,3827,8081,3435,6314,5552,3317,8232,8553,7359,3210,779,7178,8220,2637,696
7,5079,7272,2735,5569,7751,7709,816,2161,6845,6949,2889,1233,5134,8583,233,6530,2608,
7883,5537,7071,3824,9459,2281,6336,2679,962,4345,983,5774,3823,5636,6470,970,7783,27
69,4980,7163,1865,3577,1895,1817,9431,5563,1832,791,1114,6709,2557,7522,4255,754,275

8,9972,6361,4616,9830,9266,9465,6900,1529,9450,5642,3112,4049,3532,6873,2345,8074,16
17,3699,7665,1612,5448,8365,251,3863,4962,4032,5707,9044,4686,7305,869,6621,4746,550
1,8535,1098,2177,6152,4088,6846,7064,5355,6663,7164,2301,6795,9268,6138,5007,7902,80
66,6213,7362,8604,3812,7328,8465,6675,2290,3356,8927,352,1787,8642,179,5734,7107,930
6,1458,246,1195,5725,7127,3557,5401,2025,3940,2511,3736,7445,7112,1635,2775,442,3195,
6150,2439,6605,5913,1639,461,2334,6971,8675,4409,2817,4453,6019,7574,335,586,921,986,
7187,2541,2467,7876,9979,837,4316,6737,3010,5095,6527,3498,4378,8668,6125,1104,7887,
9402,8382,1360,8705,7488,3346,9288,2150,9126,2326,1172,6497,9893,56,5256,5791,8018,3
629,3985,5956,9470,2129,3471,5290,3840,9255,7486,2710,9589,7888,8651,8872,9905,7890,
1174,7635,4224,7152,9039,6835,6418,7318,7260,8883,8166,7133,3407,3877,3808,1272,4639
,8241,9919,1200,730,5955,9478,9999,6625,5160,8199,6523,8844,1637,9645,5249,3568,3820,
7043,2210,8703,47,9996,8120,8814,692,7046,6465,1089,8600,347,485,8050,7896,7136,661,7
517,4979,4109,2260,9856,1518,7873,6149,9004,1669,8576,7719,6504,1843,33,7315,2075,20
17,1444,7614,3344,1330,8528,935,2370,7340,2023,8772,5911,6490,8047,8048,9576,6638,99
59,9633,2959,8944,4803,762,1250,4505,7416,7838,7760,7350,9566,7759,8776,4132,490,929
0,2013,6180,6926,1425,6758,213,7077,3068,8252,5606,4654,7798,3539,8538,7011,712,1524,
9225,9,3302,4108,6687,4699,3599,2348,4511,1359,6247,6129,206,2909,3618,5818,2754,557
8,1264,4506,2420,6564,4240,8475,8868,5799,1742,8614,5631,1737,9610,6448,4120,6136,70
30,7563,9067,8921,8704,5759,4649,4554,5091,9434,3142,2266,5463,8384,5500,6118,6999,1
192,2923,9211,225,8287,2327,7134,2353,3589,2181,4741,9707,453,7968,1967,1949,1326,30
70,4139,9719,1577,6240,4157,7827,6503,1906,9454,3362,2360,3907,9992,5651,4356,9432,4
992,5016,439,3009,3801,4948,4709,8972,8028,3644,1321,7940,7255,3461,5920,928,8378,14
13,1551,8616,8503,3207,2298,9612,8289,2317,7436,2930,3412,6114,5726,6289,4151,1710,8
060,3101,1294,4168,8268,1439,1812,667,6363,8156,9620,2248,6513,3520,9942,7722,3936,7
4,4621,7853,5645,1502,8248,3204,5381,8153,6079,7258,8361,3355,2249,1485,8978,9671,62
85,7678,9095,7625,6928,5941,413,1401,5633,8063,7250,3855,4334,8239,3867,4993,6313,93
51,7296,4856,5776,8575,9582,1162,2295,5021,6446,9158,9569,3949,3220,9284,1666,6279,3
175,6039,7313,5999,6804,7261,1825,9578,7440,9375,9230,5497,904,3426,1175,40,6574,681,
818,6115,4426,9333,3128,6746,5214,755,6614,6684,5613,8258,6319,2086,430,7913,9609,63
69,285,1197,1530,1363,6771,7945,1430,5959,3088,3443,3856,2912,8183,6776,6331,4260,63
6,4978,8347,8738,8949,9648,3434,8228,8608,8548,1010,2165,2180,2583,2022,1811,6035,77
61,7842,4558,8482,6315,4144,5221,9756,5044,3963,6261,961,6722,4431,5595,8229,8215,68
40,7128,1745,2680,6596,7687,9551,753,1103,8222,1095,5059,1489,4484,1624,5434,8830,70
42,7668,8831,1995,1696,4060,7068,6965,7955,4471,8958,8849,1202,3770,1121,6508,9443,6
216,9093,2212,4385,4909,3781,333,6572,9164,603,4019,945,1022,5051,3846,8929,2358,859,
1755,4339,4145,7497,2090,5752,9120,3228,8639,4200,2465,214,6788,1209,1446,7724,6092,
516,7829,5416,2840,1717,4547,1658,412,876,8213,7837,78,4518,3084,2333,1000,4479,2689,
5596,2039,8195,9404,4618,5835,5965,2124,9777,9241,944,2175,1204,2207,2330,7915,5366,
3298,8647,3527,6548,8731,394,5849,6912,4743,6000,4242,5737,444,896,9917,7157,9762,48
66,9767,2700,778,7794,6072,4724,5005,3066,3179,7306,9296,649,5643,6300,9883,3109,519
0,894,2654,611,7816,8565,2901,9985,2787,7704,6429,1303,5627,9313,9875,513,4681,3205,2
303,9265,5274,1265,3307,7866,2096,3681,2117,8468,3453,6561,1201,5923,2299,2660,3866,
7557,3889,3096,2222,2421,5970,5377,2533,9129,1622,4472,5773,4040,2695,6186,7114,5535
,4122,3807,5841,3336,5266,4196,6988,8320,6076,204,5161,7173,7935,897,6992,4252,4597,1
414,2638,8970,5512,9497,2615,4258,8283,2329,4739,7699,2065,8244,6714,5782,3123,2947,
5033,5418,7830,8446,9804,1407,9984,6385,6105,500,9591,2477,240,1088,1783,9619,7395,4
288,2125,954,8294,385,540,3276,6957,4369,2335,4552,3163,2717,3222,9666,2464,5242,778

8,5164,848,2232,1765,3368,2783,674,6054,4712,526,6738,1116,9291,8847,9417,5940,7130,6058,7588,5905,2688

dimensao_array: .word 1000

.text

abrindo o arquivo

li \$v0, 13

la \$a0, meuarquivo

li \$a1, 0

li \$a2, 0

syscall

move \$s0, \$v0

lendo arquivo

li \$v0, 14

move \$a0, \$s0

la \$a1, buffer

li \$a2, 11

syscall

.globl main

main:

Entrada do programa

entrada:

```
la          $a0,msg
addi        $v0,$zero,4
syscall
```

imprime a entrada de dados antes de entrar no quicksort

imprime_entrada_no_array_quicksort:

```
la          $a0,entrada_quicksort
addi        $v0,$zero,4
syscall
```

```
la          $a0,vetor          # $a0=&(vetor+0).
la          $s0,dimensao_array
lw          $a1,0($s0) # $a1=dimensao_array.
jal         imprime_array # imprime array (vetor,dimensao_array).
nop
```

#inicia o quicksort(ordenação rapida)

inicio_quicksort:

```
la          $a0,vetor # $a0=&(vetor+0).
addiu       $a1,$zero,0 # $a1=m=0.
lw          $a2,0($s0) # $a2=dimensao_array.
subu        $a2,$a2,1 # $a2=(dimensao_array-1).
jal         quicksort # quicksort(vetor,0,dimensao_array-1).
nop
```

imprime a saida do quicksort

imprime_saida_array_quicksort:

```
la          $a0,saida_quicksort
addi        $v0,$zero,4
```


syscall

la \$a0,vetor #\$a0=&(vetor+0).

lw \$a1,0(\$s0) #\$a1=dimensao_array.

jal imprime_array # imprime_array(vetor,dimensao_array).

nop

sai do programa

sai_do_programa:

addi \$v0,\$zero,10

syscall

Inicia a função quicksort \$a0=&(vetor+0), \$a1=m, \$a2=n

quicksort:

subu \$sp,\$sp,16 # aloca 16 bytes. Void quicksort(int vetor[],int m,int n): 4 byte
pra \$ra, 4 byte pra \$a0=&(vetor+0), 4 byte pra \$a1=m, 4 byte pra \$a2=n.

sw \$ra,0(\$sp)

sw \$a0,4(\$sp)

sw \$a1,8(\$sp)

sw \$a2,12(\$sp)

slt \$t0,\$a1,\$a2 # \$t0=1 iff m<n. \$t0=0 iff m=>n.

beq \$t0,\$zero,m_maior_igual_n # salta a m_maior_igual_n m=>n.

nop

m_menor_n:

addiu \$a0,\$a1,0 #\$a0=m, argumento m para o pivo_escolhido(m,n).

addiu \$a1,\$a2,0 #\$a1=n, argumento n para o pivo_escolhido(m,n).

jal pivo_escolhido # pivo_escolhido(m,n).

nop

```

addiu    $t3,$v0,0      #$t3=k=pivo_escolhido(m,n).
lw       $a0,4($sp)     #restaura $a0=&(vetor+0).
lw       $a1,8($sp)     #restaura $a1=m.

sll      $t4,$a1,2      #$t4=4*m.
add      $a0,$a0,$t4    #$a0=&vetor[m], argumento per swap(&vetor[m],&vetor[k]).
lw       $t4,4($sp)     #$t4=$a0=&(A+0).
sll      $t5,$t3,2      #$t5=4*k.
add      $a1,$t4,$t5    #$a1=&vetor[k], argumento para swap(&vetor[m],&vetor[k]).
jal      swap           # swap(&vetor[m],&vetor[k]).
nop

lw       $a0,4($sp)     #restura $a0=&(vetor+0).
lw       $a1,8($sp)     #restaura $a1=m.

sll      $t4,$a1,2      #$t4=4*m.
add      $t4,$a0,$t4    #$t4=&vetor[m].
lw       $t5,0($t4)     #$t5=key=vetor[m].

addiu    $t1,$a1,1      #i=(m+1).
addiu    $t2,$a2,0      #j=n.

while_1:
slt      $t0,$t2,$t1    #$t0=1 iff j<i. $t0=0 iff j=>i.
bne      $t0,$zero,fim_while_1 #pula para o final do while j<i.
nop

while_2:
slt      $t0,$a2,$t1    #$t0=1 iff n<i. $t0=0 iff n=>i.
bne      $t0,$zero,fim_while_2 #pula para o final do while n<i.
nop

```

```

sll      $t6,$t1,2 # $t6=4*i.
add      $t6,$a0,$t6 # $t6=&vetor[i].
lw       $s1,0($t6) # $s1=vetor[i].

slt      $t0,$t5,$s1 # $t0=1 iff key<vetor[i]. $t0=0 iff key=>vetor[i].
bne      $t0,$zero,fim_while_2 # pula para o final do while key<vetor[i].
nop

addiu    $t1,$t1,1 # i++.
j while_2 #salta al ciclo while 2.
nop

fim_while_2:
nop

while_3:
slt      $t0,$t2,$a1 # $t0=1 iff j<m. $t0=0 iff j=>m.
bne      $t0,$zero,fim_while_3 # pula para o fim do while j<m.
nop

sll      $t7,$t2,2 # $t7=4*j.
add      $t7,$a0,$t7 # $t7=&vetor[j].
lw       $s2,0($t7) # $s2=vetor[j].

slt      $t0,$t5,$s2 # $t0=1 iff key<vetor[j]. $t0=0 iff key=>vetor[j].
beq      $t0,$zero,fim_while_3 # pula para o fim do while key=>vetor[j].
nop

subu     $t2,$t2,1 # j-.
j while_3 #salta a ciclo while 3.
nop

```

fim_while_3:

nop

if:

slt \$t0,\$t1,\$t2 #\$t0=1 iff i<j. \$t0=0 iff i=>j.

beq \$t0,\$zero,fim_if #pula para o fim do if i=>j.

nop

sll \$t6,\$t1,2 #\$t6=4*i.

add \$a0,\$a0,\$t6 #\$a0=&vetor[i], argumento per swap(&vetor[i],&vetor[j]).

lw \$t4,4(\$sp) #\$t4=\$a0=&(vetor+0).

sll \$t7,\$t2,2 #\$t7=4*j.

add \$a1,\$t4,\$t7 #\$a1=&vetor[j], argumento para swap(&vetor[i],&vetor[j]).

jal swap # swap(&vetor[m],&vetor[k]).

nop

lw \$a0,4(\$sp) #restaura \$a0=&(vetor+0).

lw \$a1,8(\$sp) #restaura \$a1=m.

fim_if:

j while_1 #pula para o while 1.

nop

fim_while_1:

nop

sll \$t4,\$a1,2 #\$t4=4*m.

add \$a0,\$a0,\$t4 #\$a0=&A[m], argumento para swap(&vetor[m],&vetor[j]).

lw \$t4,4(\$sp) #\$t4=\$a0=&(vetor+0).

sll \$t5,\$t2,2 #\$t5=4*j.

add \$a1,\$t4,\$t5 # \$a1=&vetor[j], argumento para swap(&vetor[m],&vetor[j]).
jal swap #swap(&vetor[m],&vetor[j]).
nop

lw \$a0,4(\$sp) #restaura \$a0=&(A+0), argumento para o quicksort(A,m,j-1).
lw \$a1,8(\$sp) #restaura \$a1=m, argumento para o quicksort(A,m,j-1).
subu \$a2,\$t2,1 # \$a2=j-1, argumento para o quicksort(A,m,j-1).

subu \$sp,\$sp,4
sw \$t2,0(\$sp)

jal quicksort # quicksort(vetor,m,j-1).
nop

lw \$t2,0(\$sp) #restaura \$t2=j.
addiu \$sp,\$sp,4

lw \$a0,4(\$sp) # \$a0=&(A+0), argumento para o quicksort(vetor,j+1,n).
addiu \$a1,\$t2,1 # \$a1=j+1, argumento para o quicksort(vetor,j+1,n).
lw \$a2,12(\$sp) # \$a2=n, argumento para quicksort(vetor,j+1,n).

subu \$sp,\$sp,4
sw \$t2,0(\$sp)

jal quicksort # quicksort(A,j+1,n).
nop

lw \$t2,0(\$sp) #restaura \$t2=j.
addiu \$sp,\$sp,4

m_maior_igual_n:

```
lw          $ra,0($sp) #carrega o endereço de retorno.
addiu       $sp,$sp,16
jr          $ra
```

```
### fim da função quicksort quicksort(int n, int *A, int m) ###
```

```
### função void swap(int *x, int *y): $a0=&x, $a1=&y ###
```

swap:

```
subu        $sp,$sp,16 # aloca 16 byte para função void swap(int *x, int *y): 4 byte para
$ra, 4 byte para $a0=&x, 4 byte para &y, 4 byte para *x.
```

```
sw          $ra,0($sp)
sw          $a0,4($sp)
sw          $a1,8($sp)
```

```
lw          $t0,0($a0) #$t0=*x.
sw          $t0,12($sp)
```

```
lw          $t0,0($a1) #$t0=*y.
sw          $t0,0($a0) #*x=*y.
```

```
lw          $t0,12($sp) # *x.
sw          $t0,0($a1) #*y=*x
```

```
lw          $ra,0($sp)
addiu       $sp,$sp,16 # desloca da pilha para o void swap(int *x, int *y).
jr          $ra
```

```
### final da função void swap(int *x, int *y) ###
```

```
### função int pivo_escolhido(int i, int j): $a0=i, $a1=j, $v0=pivo_escolhido(i,j) ###
```

pivo_escolhido:

subu \$sp,\$sp,12 # aloca da pilha 12 byte para int pivo_escolhido(int i, int j): 4 byte para \$ra, 4 byte para \$a0=i, 4 byte para \$a1=j.

sw \$ra,0(\$sp)

sw \$a0,4(\$sp)

sw \$a1,8(\$sp)

add \$v0,\$a0,\$a1 #\$v0=(i+j).

srl \$v0,\$v0,1 #\$v0=(i+j)/2.

lw \$ra,0(\$sp)

addiu \$sp,\$sp,12

jr \$ra

fim da função pivo_escolhe(int i, int j)

função void imprime_array(int vetor[],int n): \$a0=&(vetor+0), \$a1=n

imprime_array:

subu \$sp,\$sp,12 # aloca da pilha 12 byte para void print_array(int vetor[],int n): 4 byte para \$ra, 4 byte para \$a0=&(A+0), 4 byte para \$a1=n.

sw \$ra,0(\$sp)

sw \$a0,4(\$sp)

sw \$a1,8(\$sp)

addiu \$t1,\$zero,0 #\$t1=i=0.

addiu \$t2,\$a0,0 #\$t2=\$a0=&(A+0).

addiu \$t3,\$a1,0 #\$t3=\$a1=n.

for:

slt \$t0,\$t1,\$t3 #\$t0=1 iff i<n. \$t2=0 iff i=>n.

beq \$t0,\$zero,fim_for #salta alla fine del ciclo for sse i=>n.

sll \$t4,\$t1,2 #\$t4=4*i.

add \$t5,\$t2,\$t4 #\$t5=&(A+i).

```

lw          $a0,0($t5) #$a0=*(A+i).
addiu       $v0,$zero,1 #codice servizio print int.
syscall

# codigo para imprimir a string
la          $a0,tab
addiu       $v0,$zero,4
syscall

addiu       $t1,$t1,1 #i++
j for

##### retorna pra string de impressao
fim_for:
la          $a0,rtn
addiu       $v0,$zero,4
syscall

lw          $ra,0($sp)
addiu       $sp,$sp,12 # desaloca da pila o void print_array(int A[],int n).
jr $ra

### fim da função void imprime_array(int vetor[],int n) ###

# Fim do programa
li $v0, 10
syscall

```