

# Задание 1. Алгоритм Борувки.

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## 1 Постановка задачи

## 2 Компиляция и запуск

1. `cd 2022-plgp-mst`
2. `g++ graph_tools.o mst_reference.o gen_valid_info.o -o gen_valid_info -O3 -lrt`
3. `g++ validation.o graph_tools.o -o validation -O3 -lrt`
4. `g++ main.o mst_reference.o graph_tools.o -o mst_reference -O3 -lrt`
5. `mpic++ -O3 -Wall -o mst.o -c mst.cpp`
6. `mpic++ main.o mst.o graph_tools.o -o mst -O3 -lrt`

`mpirun -np <p> ./mst -in <name>`

<p> - количество процессов; <name> - название графа.

Флаг `-oversubscribe` когда <p> превышает количество процессоров (`mpirun -oversubscribe -np 8 ./mst -in rmat-10`)

## 3 Генерация и тестирование графов

**Генерация обычного графа:**

`./gen_random -n <n> -m <m> -out <name>`

**Генерация RМAT графов:**

`./gen_RMAT -s <s>`

### Запуск эталонного тестирования:

`./mst_reference -in <name>`

<n> - количество вершин; <m> - количество ребер; <s> - степень двойки == количество вершин; <name> - имя файла для сохранения или тестирования.

## 4 Спецификация системы

Процессор: AMD Ryzen 5 3500U with Radeon Vega Mobile Gfx 2.10 GHz  
Число вычислительных ядер: 4

## 5 Результаты выполнения

Генерация графа - `./gen_RMAT -s 10`

Возьмем для примера *RMAT* граф с количеством вершин  $2^{10}$ . Результат выполнения ленивого алгоритма (`./mst_reference -in rmat-10`) представлен на рисунке 1. Алгоритм Борувки с использованием функций `send/recv` написан в файле `mst.cpp`. На рисунках 2, 3 и 4 показан результат запуска алгоритма на 1ом, 2х и 4х процессах соответственно. На рисунке 5 демонстрируется проверка программы на валидность (`./validation -in_graph rmat-10 -in_result rmat-10.mst -in_valid rmat-10.vinfo`)

```
MST 47 ... finished. Time is 0.1026 secs
MST 48 ... finished. Time is 0.0933 secs
MST 49 ... finished. Time is 0.1531 secs
MST 50 ... finished. Time is 0.0956 secs
MST 51 ... finished. Time is 0.1491 secs
MST 52 ... finished. Time is 0.0929 secs
MST 53 ... finished. Time is 0.1054 secs
MST 54 ... finished. Time is 0.1106 secs
MST 55 ... finished. Time is 0.1221 secs
MST 56 ... finished. Time is 0.1118 secs
MST 57 ... finished. Time is 0.0864 secs
MST 58 ... finished. Time is 0.0903 secs
MST 59 ... finished. Time is 0.1169 secs
MST 60 ... finished. Time is 0.1530 secs
MST 61 ... finished. Time is 0.0930 secs
MST 62 ... finished. Time is 0.1140 secs
MST 63 ... finished. Time is 0.0937 secs
algorithm iterations finished.
rmat-10: vertices = 1024 edges = 32768 trees = 1 nIters = 64 MST performance min = 0.1655 avg = 0.2910
max = 0.3817 MTEPS
Performance = 0.2910 MTEPS
```

Рис. 1: Результат выполнения ленивого алгоритма.

```

MST 47 ... finished. Time is 0.0011 secs
MST 50 ... finished. Time is 0.0025 secs
MST 51 ... finished. Time is 0.0023 secs
MST 52 ... finished. Time is 0.0023 secs
MST 53 ... finished. Time is 0.0022 secs
MST 54 ... finished. Time is 0.0022 secs
MST 55 ... finished. Time is 0.0016 secs
MST 56 ... finished. Time is 0.0022 secs
MST 57 ... finished. Time is 0.0016 secs
MST 58 ... finished. Time is 0.0012 secs
MST 59 ... finished. Time is 0.0010 secs
MST 60 ... finished. Time is 0.0010 secs
MST 61 ... finished. Time is 0.0011 secs
MST 62 ... finished. Time is 0.0012 secs
MST 63 ... finished. Time is 0.0011 secs
algorithm iterations finished.
rmat-10: vertices = 1024 edges = 32768 trees = 1 nIters = 64 MST performance min = 6.6717 avg = 14.9611
max = 33.0939 MTEPS
Performance = 14.9611 MTEPS

```

Рис. 2: Запуск mst.cpp на 1ом процессе.

```

MST 47 ... finished. Time is 0.0011 secs
MST 48 ... finished. Time is 0.0022 secs
MST 49 ... finished. Time is 0.0018 secs
MST 50 ... finished. Time is 0.0020 secs
MST 51 ... finished. Time is 0.0016 secs
MST 52 ... finished. Time is 0.0014 secs
MST 53 ... finished. Time is 0.0016 secs
MST 54 ... finished. Time is 0.0021 secs
MST 55 ... finished. Time is 0.0014 secs
MST 56 ... finished. Time is 0.0018 secs
MST 57 ... finished. Time is 0.0012 secs
MST 58 ... finished. Time is 0.0010 secs
MST 59 ... finished. Time is 0.0009 secs
MST 60 ... finished. Time is 0.0009 secs
MST 61 ... finished. Time is 0.0013 secs
MST 62 ... finished. Time is 0.0011 secs
MST 63 ... finished. Time is 0.0010 secs
algorithm iterations finished.
rmat-10: vertices = 1024 edges = 32768 trees = 1 nIters = 64 MST performance min = 11.5049 avg = 22.9312
max = 38.1882 MTEPS
Performance = 22.9312 MTEPS

```

Рис. 3: Запуск mst.cpp на 2х процессах.

```

MST 45 ... finished. Time is 0.0011 secs
MST 46 ... finished. Time is 0.0010 secs
MST 47 ... finished. Time is 0.0014 secs
MST 48 ... finished. Time is 0.0016 secs
MST 49 ... finished. Time is 0.0012 secs
MST 50 ... finished. Time is 0.0013 secs
MST 51 ... finished. Time is 0.0010 secs
MST 52 ... finished. Time is 0.0012 secs
MST 53 ... finished. Time is 0.0010 secs
MST 54 ... finished. Time is 0.0010 secs
MST 55 ... finished. Time is 0.0012 secs
MST 56 ... finished. Time is 0.0010 secs
MST 57 ... finished. Time is 0.0012 secs
MST 58 ... finished. Time is 0.0010 secs
MST 59 ... finished. Time is 0.0009 secs
MST 60 ... finished. Time is 0.0011 secs
MST 61 ... finished. Time is 0.0014 secs
MST 62 ... finished. Time is 0.0014 secs
MST 63 ... finished. Time is 0.0010 secs
algorithm iterations finished.
rmat-10: vertices = 1024 edges = 32768 trees = 1 nIters = 64 MST performance min = 8.6946 avg = 23.3568
max = 37.3087 MTEPS
Performance = 23.3568 MTEPS

```

Рис. 4: Запуск mst.cpp на 4х процессах.

```

nastya@LAPTOP-S30HMKRR:~/study/Graphs/2022-plgp-mst$ ./validation -in_graph rmat-10 -in_result rmat-10.mst
-in_valid rmat-10.vinfo
reading trees from      rmat-10.mst ...      finished
reading weights from    rmat-10.vinfo ...    finished
starting validation      ...                ok

```

Рис. 5: Проверка на валидность.