# Homework 5: K-way Graph Partitioning Using JaBeJa

Submit Assignment

**Due** Sunday by 11:59pm **Points** 3 **Submitting** a file upload

***The homework can be done in a group of 2 students.***

The goal of this assignment is to understand distributed graph partitioning using gossip-based peer-to-peer techniques, such as, JaBeJa described in [**F. Rahimian, et al., *JA-BE-JA: A Distributed Algorithm for Balanced Graph Partitioning*, SASO2013**.]

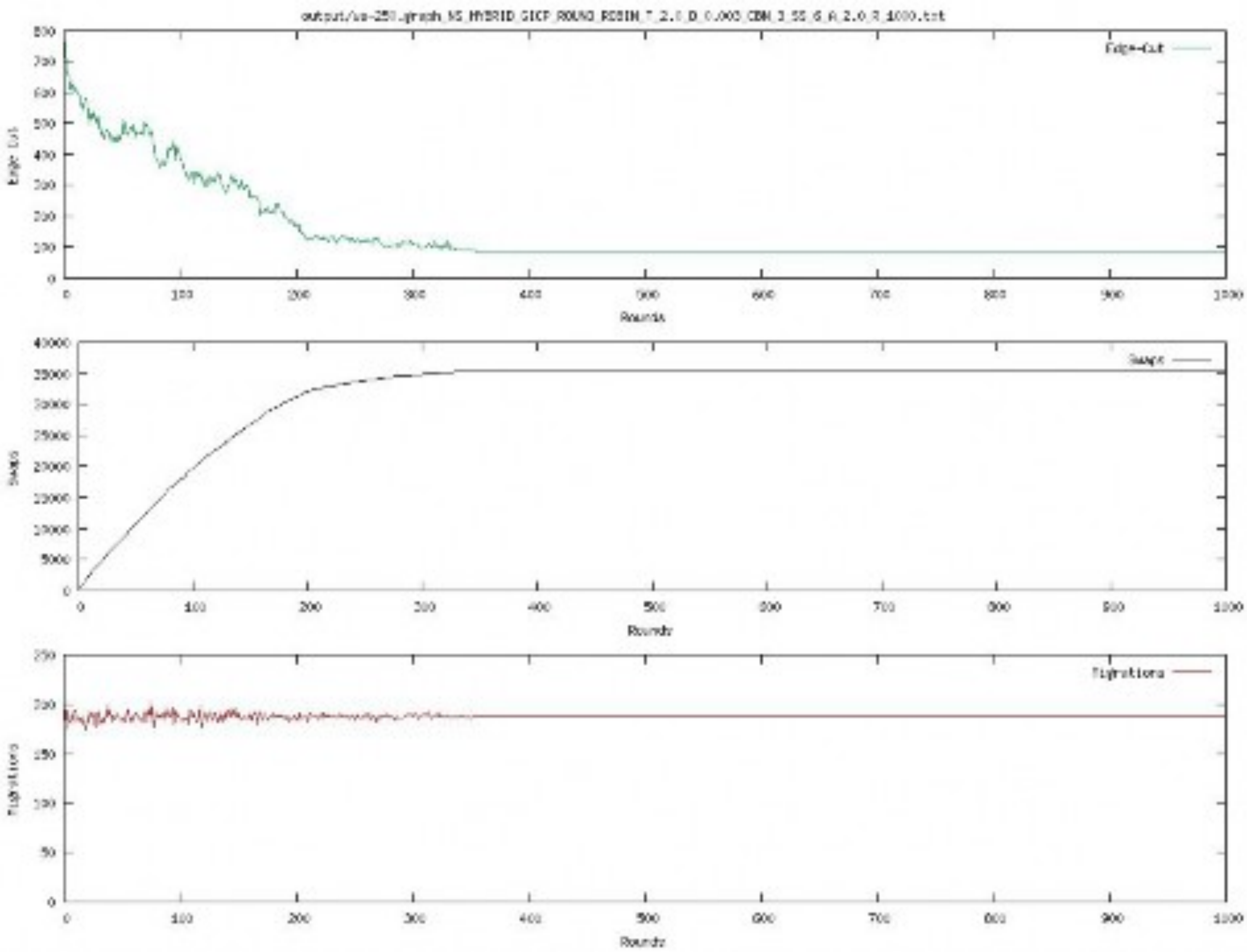
This assignment consists of the following two tasks.

## Task 1

In the first task, you are to implement the Ja-Be-Ja algorithm. We provide a scaffolding source code for Ja-Be-Ja simulation for one-host-one-node model. The source code is available on **github (https://github.com/smkniazi/id2222)** . The simulator is written in Java. To compile the results you need **gnuplot (http://gnuplot.sourceforge.net/)** , a portable command-line driven graphing utility.

You can run the program using the **run.sh** script. Run **./run.sh -help** to see all the possible command line parameters. All the sample graphs are stored in the **./graphs** directory; use the **3elt**, **add20**, and **Facebook/Twitter** graphs in your experiments. After running the experiment, the results are stored in the **./output** directory. Use the **plot.sh** to visualize the results. **plot.sh** generates a **graph.png** file in the current directory.

```
>> ./compile.sh
>> ./run -graph ./graphs/3elt.graph
>>./plot .sh output/result
```



In order to implement Ja-Be-Ja, you need to modify the **JaBeJa.java** class. All the methods that you need to implement are marked using the with **TODO** tags. You have to implement the **sampleAndSwap(...)** method and the **findPartner(...)** method as described in the paper. This should be an easy task as all the supporting code is already implemented.

# Task 2

In the second task you will tweak different JaBeJa configurations in order to find the smallest edge cuts for the given graphs.

In this task, you are to analyze how the performance of the algorithm is affected when different parameters are changed, specially the effect of simulated annealing. Currently, Ja-Be-Ja uses a linear function to decrease the temperature (lines 9 - 13 of the Ja-Be-Ja algorithm) and the temperature is multiplied to the cost function (line 26 of the Ja-Be-Ja algorithm). You will now analyze how changing the simulated annealing parameters and the acceptance probability function affects the performance of Ja-Be-Ja.

1. First you will implement a different simulated mechanism described [here](http://katrinaeg.com/simulated-annealing.html) (http://katrinaeg.com/simulated-annealing.html) . Observe how this change affects the rate of convergence. You can tweak different parameters. Remember that when using this method, the maximum initial temperature is 1.
2. You should notice that once the parameter **T** reaches its final value (that is, no more bad swaps are allowed) then Ja-Be-Ja converges to an edge cut rapidly and the edge cut does not change over time. You will investigate how the Ja-Be-Ja algorithm behaves when the simulated annealing is restarted after Ja-Be-Ja has converged. For example if **T** is 2 and **delta** is 0.01 then after 200 rounds the temperature will cool down to 1 and no more bad-swaps will be accepted. Ja-Be-Ja will converge soon after that. You can restart simulated-annealing again after 400 rounds. Experiment with different parameters and configurations to find lower edge cuts.

# Sample graphs

All the sample graphs are stored in the **./graphs** directory. Analyse the **3elt**, **add20**, and **Facebook/Twitter** graphs in your experiments for both tasks.

# Optional task for extra bonus

Define your own acceptance probability function or change the Ja-Be-Ja algorithm (in order to improve its performance) and evaluate how your changes affects the performance of graph partitioning.

# Readings

- **Lecture**
- F. Rahimian, A. H. Payberah, S. Girdzijauskas, M. Jelasity and S. Haridi, ***JA-BE-JA: A Distributed Algorithm for Balanced Graph Partitioning***, SASO2013, pp. 51-60.Submission, Presentation and Demonstration

**You upload your solution in a zip file to Canvas**. To get bonus, you should upload your solution before the deadline. Canvas records the submission time. Bonus will not be given, if you miss the deadline. **Your homework solution must include**

1. Source code;
2. Report (in PDF) with the analysis of the given graphs. Analyze the **3elt**, **add20**, **Facebook/Twitter** graphs. In your report discuss how your changes affect the performance of the algorithm in terms of
   a) Number of swaps;
   b) Time to converge;
   c) Minimum edge cut observed.

Within a week after the homework deadline, **you present and demonstrate** your homework on your own laptop to a course instructor. A time-slot pool will be provided to **book a time slot for presentation**.

# Grading and Bonus Policy

The grade for a homework is **pass/fail**. If you submit report your homework on time and your solution is accepted, you will get **3 bonus points** on your first ID2222 exam whenever you take it. This homework includes the **optional task for extra bonus**.