POLITECNICO
MILANO 1863

Performance Evaluation and Applications

Project D
AA. 2023-2024

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Scope

The **aim of the project** is to find the optimal configuration (i.e. best throughput) by testing different configuration in terms of number of episodes being produced, and number of units being used considering a target throughput and production time less or equal than 60 days. The production can afford two other units to work either on audio, video or VFX.

Firstly, I tried on **Matlab** different distributions for audio, video, vfx and compositing stages to find the best fitting.

*For the Story writing and Shooting stages I considered the given Erlang distributions.

Fitting Audio Editing Trace

Parameters (DISP from Matlab) of the distributions **AUDIO EDITING:**

PARAMETERS HYPEREXP AUDIO EDITING:

0.0542 0.2165 0.2080

PARAMETERS EXP AUDIO EDITING:

0.1334

PARAMETERS WEIBULL AUDIO EDITING:

5.9513 0.7039

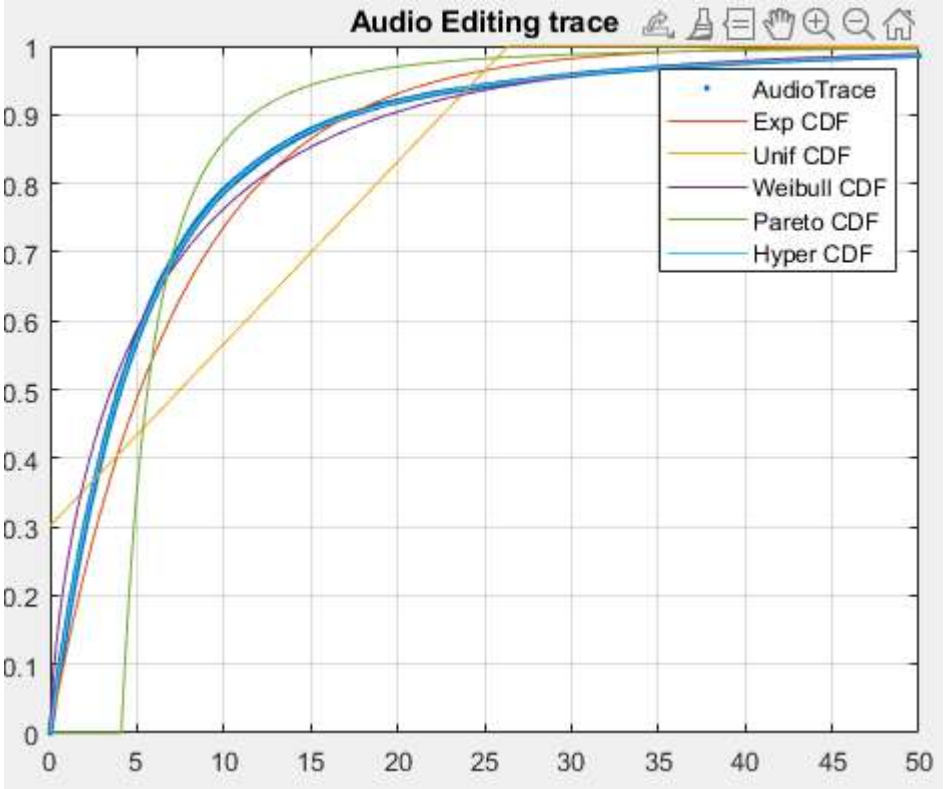
PARAMETERS PARETO AUDIO EDITING:

2.2139 4.1090

PARAMETERS UNIFORM AUDIO EDITING:

-11.3686 26.3567

* Erlang not suitable



Fitting Video Editing Trace

Parameters (DISP from Matlab) of the distributions **VIDEO EDITING:**

PARAMETERS HYPEREXP VIDEO EDITING:

0.0493 0.1964 0.1944

PARAMETERS EXP VIDEO EDITING:

0.1243

PARAMETERS WEIBULL VIDEO EDITING:

6.3692 0.7013

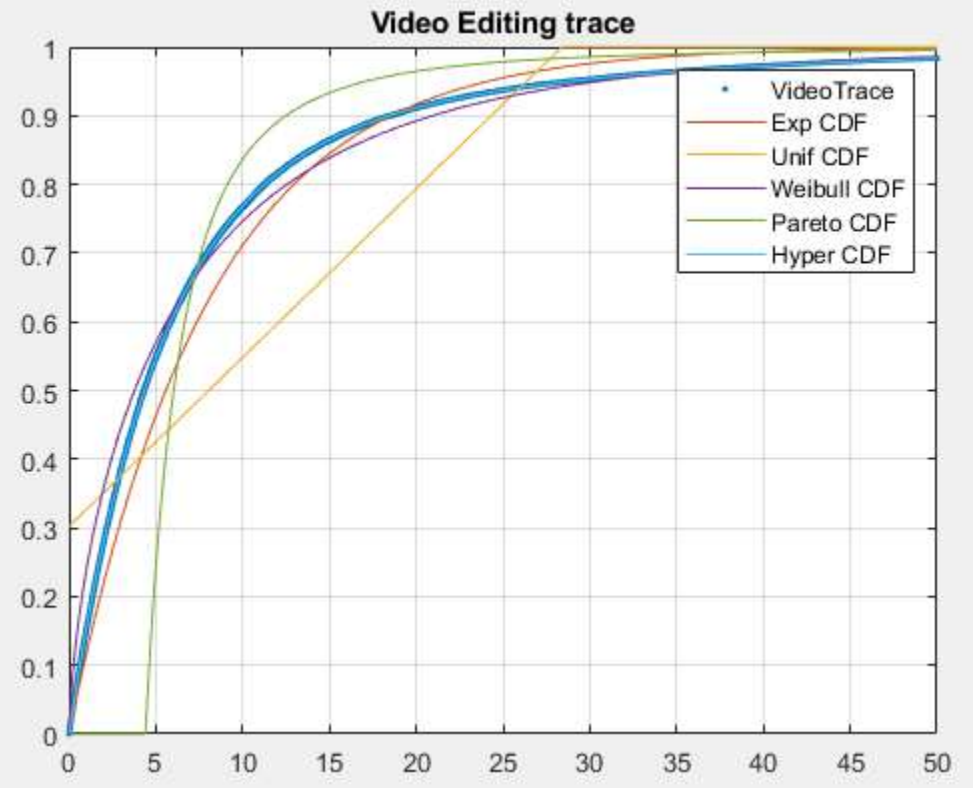
PARAMETERS PARETO VIDEO EDITING:

2.2123 4.4100

PARAMETERS UNIFORM VIDEO EDITING:

-12.2929 28.3884

* Erlang not suitable



Fitting VFX Trace

Parameters (DISP from Matlab) of the distributions **VFX:**

PARAMETERS HYPEREXP VFX:

0.0406 0.1602 0.2042

PARAMETERS EXP VFX:

0.1000

PARAMETERS WEIBULL VFX:

7.9604 0.7058

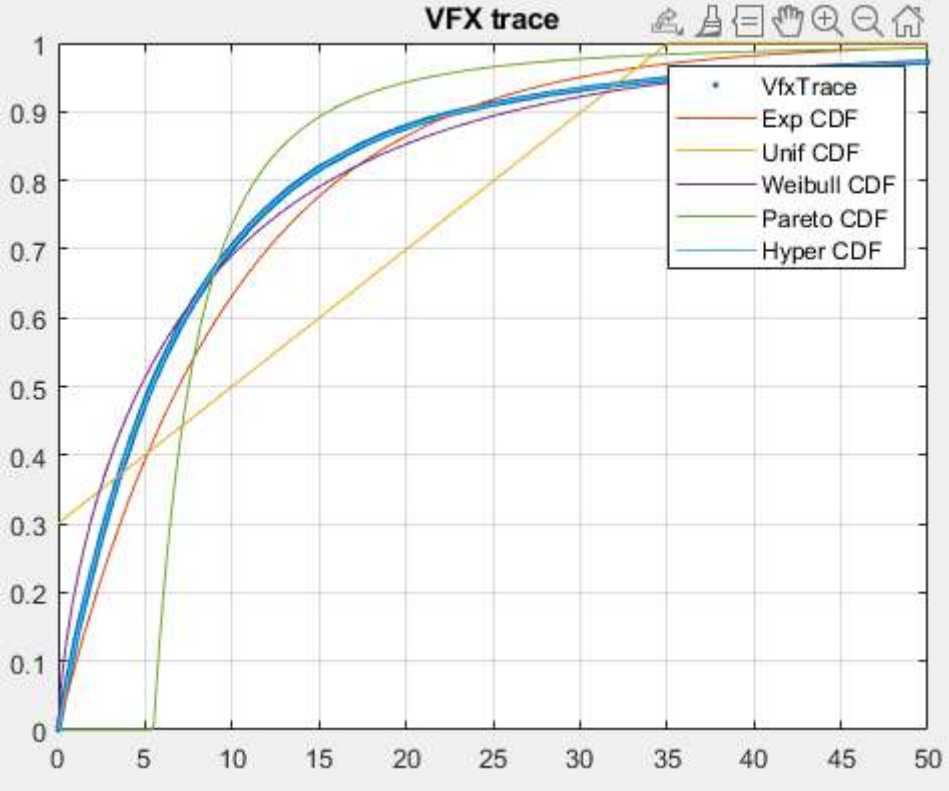
PARAMETERS PARETO VFX:

2.2151 5.4844

PARAMETERS UNIFORM VFX:

-15.0873 35.0829

* Erlang not suitable



Fitting Compositing Trace

Parameters (DISP from Matlab) of the distributions **COMPOSITING:**

PARAMETERS HYPEREXP COMPOSITING:

0.2881 4.9851 0.9984

PARAMETERS EXP COMPOSITING:

0.2886

PARAMETERS WEIBULL COMPOSITING:

3.4646 0.9993

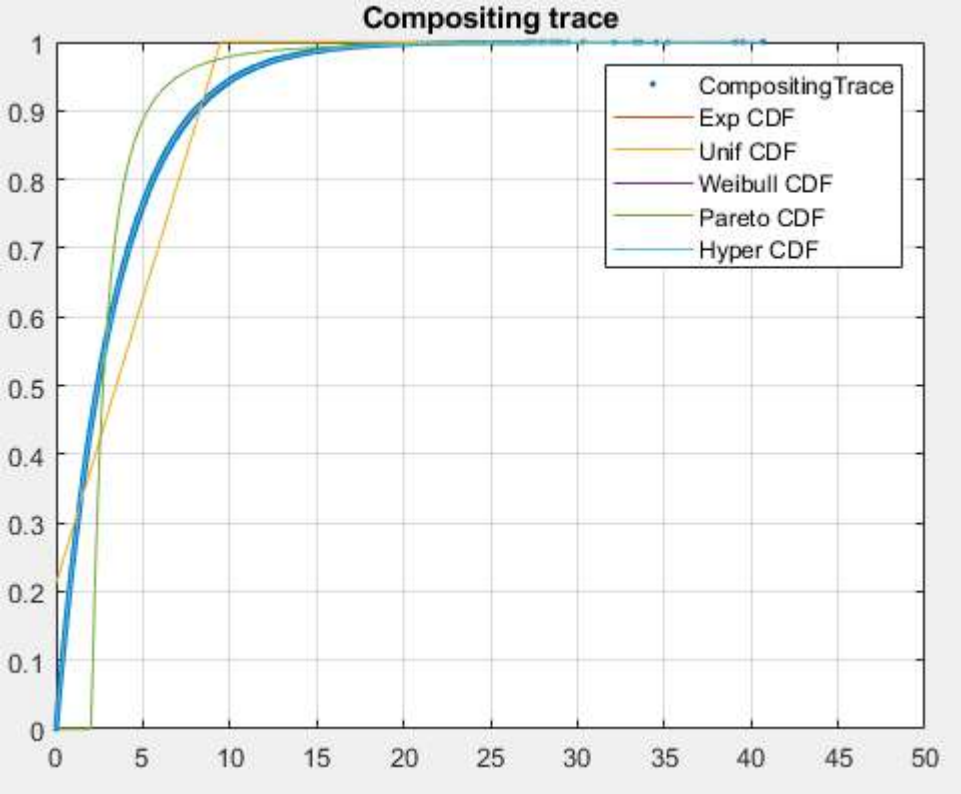
PARAMETERS PARETO COMPOSITING:

2.4137 2.0298

PARAMETERS UNIFORM COMPOSITING:

-2.5409 9.4720

* Erlang not suitable



Distribution Parameters

The distribution which fits better the samples is the **HyperExponential** for all the stages:

- **Audio editing** → lambda1 = 0.054226907827379, lambda2 = 0.216503199437902, p1 = 0.208010070660864
- **Video editing** → lambda1 = 0.049271322004497, lambda2 = 0.196379739222654, p1 = 0.194408203608659
- **VFX** → lambda1 = 0.040597712741720, lambda2 = 0.160212116919602, p1 = 0.204243742616619
- **Compositing** → lambda1 = 0.288123500939979, lambda2 = 4.985082669381305, p1 = 0.998407144503040

Model - JMT

Then I decided to model the problem as a **Queuing Network** defined through **queuing stations**. I considered it as an **OPEN, single class model with a deterministic arrival rate**.

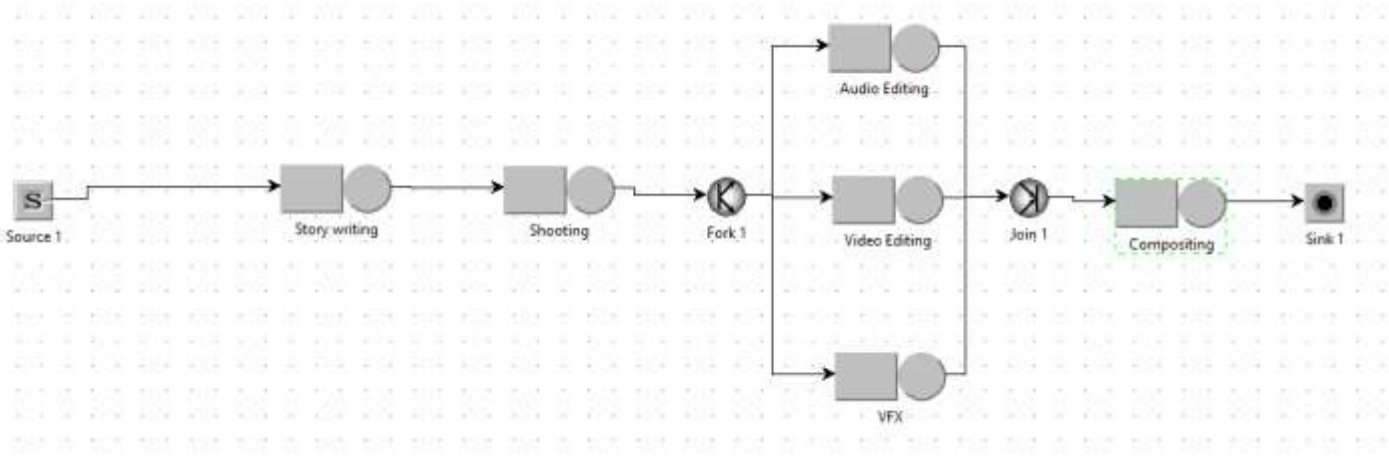
Open model, because I think there is no dependence among jobs within the system. In addition, focusing on an open model, I can calculate a more accurate average value of N obtaining the best throughput respecting the max production time value.

I used JMT with **JSimGraph** in order to design this model.

Model - JMT

Steps of the design of the model on JSimGraph:

- Add all the required **nodes** and **components** of the model;



Model - JMT

- Define an **open class**, setting as Reference Station the Source.

- Set deterministic distribution with also the mean value.

- Set the necessary **parameters** in all the queues, in particular the ones of the chosen distributions for each stage:

Model - JMT

For all stages:

- Queue policy: FCFS and infinite capacity

- Service time distribution according to the fitting (and Erlang for story writing and shooting stages)

- Routing selection: random

Model - JMT

- Define the **performance indices** to be collected and plotted by the simulation engine:
  - System Response Time
  - System Throughput
  - Utilization of each stage

Performance Indices

Define performance indices to be collected and plotted by the simulation engine.

------ Select an index ------

Performance Index	Class/Mode	Station/Region/System	Save Stats	Conf.Int.	Max Rel.Err.
Utilization	--- All Classes ---	Shooting	☐	0.99	0.03
Utilization	--- All Classes ---	Audio Editing	☐	0.99	0.03
Utilization	--- All Classes ---	Video Editing	☐	0.99	0.03
Utilization	--- All Classes ---	VFX	☐	0.99	0.03
Utilization	--- All Classes ---	Compositing	☐	0.99	0.03
Response Time	--- All Classes ---	System	☐	0.99	0.03
Throughput	--- All Classes ---	System	☐	0.99	0.03

Results: 1 Audio, 1 Video and 1 VFX (not final result)

I performed the analysis considering 1 unit for audio, 1 for video editing and 1 for VFX. These are the results (by setting a deterministic distribution with mean value = 14 (obtaining the best throughput within 60 days)):

Average N = 4.1551
Average System Throughput = 0.0714
Average System Response time = 58.1258

Utilizations:

Audio = 0.5347, Video = 0.5849, VFX = 0.7070

So, with this configuration, **bottlenecks** are VFX and Video Editing => I decided to bring directly results with **2 servers** for **these** stations without showing results for intermediate configurations (example: 1 audio 1 video 2 vfx), because by using the fork-join and being stations in parallel, the audio and video editing utilizations will be the same (w.r.t 1-1-1 configuration) considering the same arrival rate. So I added 1 unit for Video Editing and 1 for VFX.

Results: 1 Audio, 2 Video and 2 VFX (final result)

Finally, I performed the analysis considering 1 unit for audio, 2 for video editing and 2 for VFX. These are the results (by setting a deterministic distribution with mean value = 9.3):

System Response Time (R): 57.1441

System Throughput (X): 0.1075

Number of Customers (N): 6.1337

So, considering a response time <= 60 days we can have about N = 6.1337 with a mean throughput (i.e. best throughput) value = 0.1075 (about 1 episode every 9.3 days)

I discovered that this is the configuration (2 units for video editing and 2 for vfx) to obtain the best throughput considering a production time <= 60 days.