"""SST simulator case type II.

Basic simulator of an organization of Stand By, stabilizati
on
and transport of a cryonic case.
Where the system (SST) is composed of:
+ a subject (patient)
+ three agents (doctor, thanatopractician, ambulance)
+ a variable set of time ranges.
The objective is to simulate a set of cases to extract the
average and statistics to decide how to improve a
cryonic suspension procedure.

NOTE: This is non ideal case, at home, out of hospital.
It means if this is a patient election it's very importante
make other type of arrangements.

"""

In [1]:
```
# Imports
import simpy
import random
import statistics
from colorama import init
from termcolor import colored
import matplotlib.pyplot as plt
```

In [2]:
```
# Variables
wait_times = []
population = 25 # Population based in detach range who can't be in a
```

"""SST.

SST = Stand By, Stabilization, Transport
Embalmer = thanatopractitioner
Medico = dispensing death certificate and embalming
Stand By = metabolic support and hypothermia of the patien
t,
manual (voluntary) or mechanical (ECMO, LUCA)
Stabilisation = controlled perfusion of cryoprotective flui
ds,
following IC protocol and formulas for reasons of economy.

This class instantiates the environment with its constituen
t
agents to iterate their actions with varying times, simulat
e good and bad times,
collect them and make a statistic of the average time.

Allowing to make simulations ahead of any practice and
thus reduce incidences or hazards for the patient.

In [3]:
```
class Sst(object):
    # Environment
    def __init__(self, env, agent_embalmer, agent_doctor, agent_ambu
        self.env = env
        self.embalmer = simpy.Resource(env, agent_embalmer)
        self.doctor = simpy.Resource(env, agent_doctor)
        self.ambulance = simpy.Resource(env, agent_ambulance)
        self.place = simpy.Resource(env, agent_place)

    def death_authorization(self, patient):
        # Remember: timeout is limited to 12 hours
        yield self.env.timeout(random.randint(1, 6))

    def embalming_authorization(self, patient):
        yield self.env.timeout(random.randint(1, 6))

    def stand_by(self, patient):
        # No more than 1h support
        yield self.env.timeout(random.randint(0, 1))

    def perfusion(self, patient):
        # Time is optimizing for only head perfusion.
        yield self.env.timeout(random.randint(0, 1))
```

"""Deanimation.

State of legal death of patiente.
Call the variables and instance of environment, patient and
SST.
Simulate de arrivel, embalmer taking the death authorizatio
n,
embalming authorization and open option of start Stand By
under doctor control. Take the generated times by step.

In resume: start the event of cryonics suspenson by deanima
tion
and take the generated data with random factor times to gen
erate
all possible states of every case.

"""

In [4]:
```
def deanimation(env, patient, sst):
    # patient arrives at the Sst
    arrival_time = env.now

    if random.choice([True, False]): # Hypotetical case of extreme
        with sst.doctor.request() as request: # apply stand by or s
            yield request
            yield env.process(sst.stand_by(patient))

    with sst.embalmer.request() as request:
        yield request
        yield env.process(sst.death_authorization(patient))
```

```
    with sst.ambulance.request() as request:
        yield request
        yield env.process(sst.embalming_authorization(patient))

    with sst.place.request() as request:
        # Means place to perfusion: hospital or funeral home or spe
        yield request
        yield env.process(sst.perfusion(patient))

    # patient heads into the Sst
    wait_times.append(env.now - arrival_time)
```

"""Run SST.

Function who runs the procedure of execution environment.
Take the constants and variables Environment, Embalmer,
Doctor, ambulance.

Launch one deanimation per patient.
And generate another case after ending the last.
For take enought data for statistics.

"""

In [5]:
```
def run_Sst(env, agent_embalmer, agent_doctor, agent_ambulance, age
    # Execute instantiation environment and get agents to simulate.
    sst = Sst(env, agent_embalmer, agent_doctor, agent_ambulance, a

    for patient in range(population): # Stimated population of acti
        env.process(deanimation(env, patient, sst))

    while True:
        yield env.timeout(0.20)  # Wait a bit before generating a n

        patient += 1
        env.process(deanimation(env, patient, sst))
```

"""Get average wait time.

Function with procedure to generate the average time and
feed the result to show general average time of
suspension.

"""

In [6]:
```
def get_average_wait_time(wait_times):
    average_wait = statistics.mean(wait_times)
    # Pretty print the results
    minutes, frac_minutes = divmod(average_wait, 1)
    seconds = frac_minutes * 60
    return round(minutes), round(seconds)
```

In [7]:
```
def graph_and_statistics(wait_times):
    time_limit=[50]
    average_wait = statistics.mean(wait_times)
    mode_wait = statistics.mode(wait_times)
    median_wait = statistics.median(wait_times)
```

```
    print("Print mode times: ",mode_wait)
    print("Print median times: ",median_wait)
    print("Print wait times list: ",wait_times)
    print("Print average wait: ", round(average_wait),'red line')
    plt.axhline(round(average_wait), color="red")
    plt.bar(wait_times,wait_times)
    plt.title("global wait times per case")
    plt.ylabel('Max time: 100 hours')
    plt.xlabel('Sorted generated cases')
    plt.show()
```

"""Get user input.

Function with procedure to control input
of flow chart in environment.
It is pre-configured to not interaction
with user.

"""

In [8]:
```
def get_user_input():
    agent_embalmer = "1"
    agent_doctor = "1"
    agent_ambulance = "1"
    agent_place = "1"
    params = [agent_embalmer, agent_doctor, agent_ambulance, agent_
    if all(str(i).isdigit() for i in params):  # Check input is val
        params = [int(x) for x in params]
    else:
        print(
            "Could not parse input. Simulation will use default valu
            "\n1 embalmer, 1 doctor, 1 ambulance.",
        )
        params = ["1", "1", "1"]
    return params
```

"""Main.

Main function launch and run all simulation, process and sh
ow the results.

Next objectives:

 + Add param times ambulance.
 + Add individual times of doctor, embalmer, ambulance, wai
t time at funeral home, fly shipping.
 + Add readable and markdown color table he general and spe
cific data.

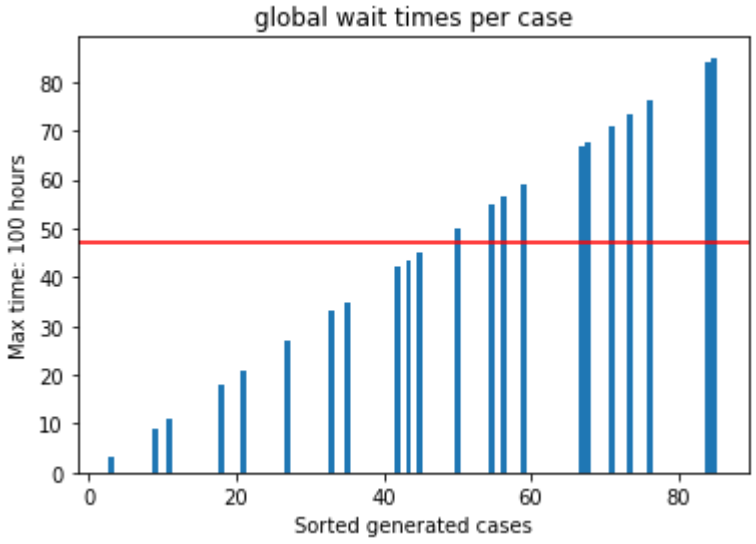
"""

In [9]:
```
def main():
    # Setup
    random.seed(42)
    agent_embalmer, agent_doctor, agent_ambulance, agent_place = ge

    # Run the simulation
    env = simpy.Environment()
```

```
    env.process(run_Sst(env, agent_embalmer, agent_doctor, agent_aml
    env.run(until=90)
    # View the results
    hours, secs = get_average_wait_time(wait_times)
    print(colored(f"Based in stimated population in country: {popula
    print(
        "Running simulation...                \n"+
        "Protocol:                            \n"+
        "1º death authorization               \n"+
        "2º embalming authorization           \n"+
        "3º stand by                          \n"+
        "4º stabilization/perfusion           \n"+
        f"\nThe average wait time is {hours} hours."
    )
    graph_and_statistics(wait_times)
```

In [10]:
```
if __name__ == "__main__":
    main()
```

```
Based in stimated population in country: 25
Running simulation...
Protocol:
1º death authorization
2º embalming authorization
3º stand by
4º stabilization/perfusion

The average wait time is 46 hours.
Print mode times:  3
Print median times:  47.5
Print wait times list:  [3, 9, 11, 18, 21, 27, 33, 35, 42, 43.4, 4
5.0, 50, 54.8, 56.4, 59.0, 67, 67.8, 71, 73.4, 76.2, 85, 84.0]
Print average wait:  47 red line
```



In [11]:
```
# Resources:
# https://github.com/realpython/materials/blob/master/simulation-wi
# https://simpy.readthedocs.io/en/latest/
# https://www.cryonics.org/ci-landing/guide-to-cryonics-procedures/
# https://sociedadcrionica.org
# https://pypi.org/project/colorama/
# https://datatofish.com/bar-chart-python-matplotlib/
# http://matplotlib.1069221.n5.nabble.com/Bar-chart-line-chart-td12
```

In [12]:
```
# Notes:
# Stimation of cryonicist population in Spain: 100, but between peo
```

In [ ]:
```
"""Conclusion:

For type two cases, the possibility of scheduling a euthanasia disc

The thanatopractor would be called to the door of the home with the
But observing the law and security this can generate big problems a

The conclusion of the type two case of sudden death at home involve

There are only two exits:

1. Immediately call the emergency room while performing CPR on the

2. The other option involves under specialist thanatopractitioner e

Translated with www.DeepL.com/Translator (free version)"""
```