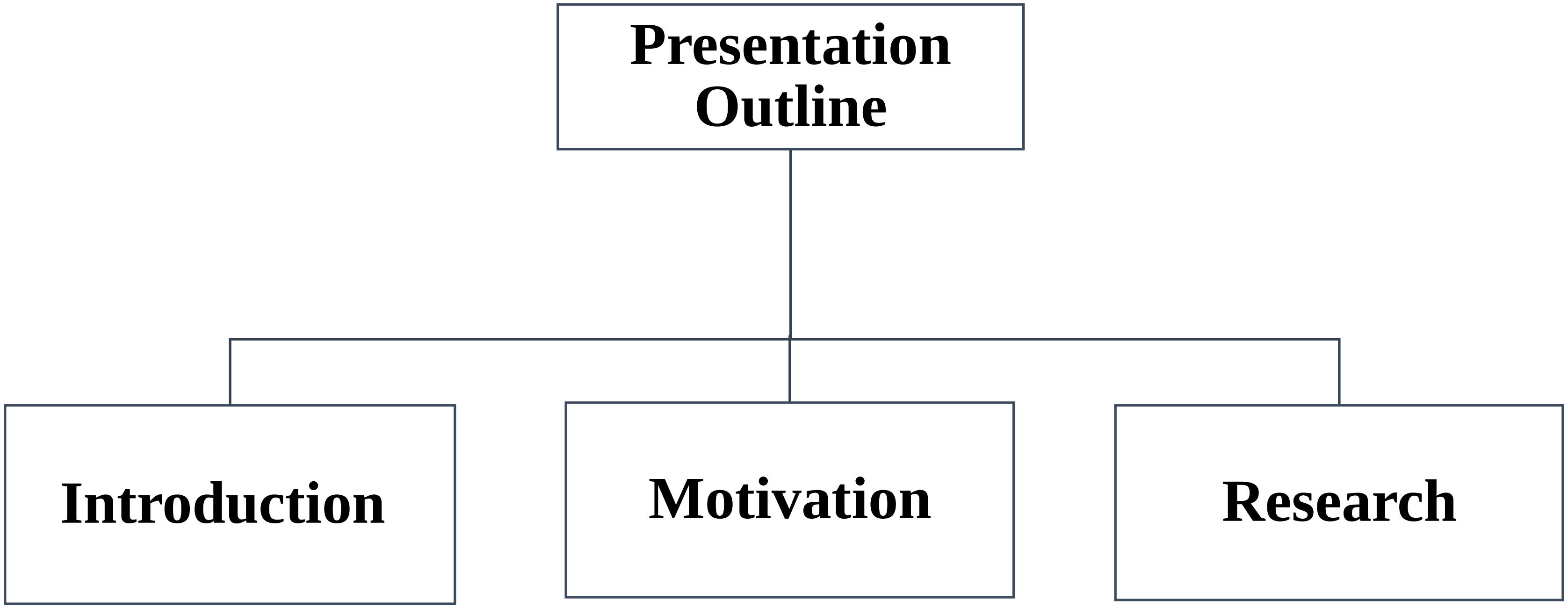
Presentation

Mohamed Abuella

mabuella@cit.edu.ly
mhdabuella@gmail.com


Presentation Outline
Introduction
Motivation
Research

Introduction

Mohamed Abuella
https://mohamedabuella.github.io https://www.linkedin.com/in/mohamed-abuella/

About Me..
An electrical engineer by training, traditionally is interested in Mathematical and Computational Analysis, Modeling and Optimization, and who is recently passionate in Artificial Intelligence and Data-driven Analytics.

A researcher works to modernize the electric grid and optimize its integration of distributed energy resources by applying descriptive, predictive and prescriptive analytics.

An adaptative to work in a diversive environment for an interdisciplinary research.

Introduction

To sum it up in a broad sense, let's imagine that.. If my professional development was a book, its title would be **“Electric Power Systems Operation and Planning”**

Thus, the chapters of this book would be as follows:

Ch.1 Fundamentals of Electrical Engineering. This chapter covers Instrumentation & Control, Basics of Power Electronics such as Diodes & Thyristors as rectifiers, (maneuvered by applying Laws of Physics). With getting hands-on electrical installation & wiring and maintenance of electrical control equipment at pumping stations.

Ch.2 Power Systems Analysis. It includes Power Flow and Faults Calculations, (applying Numerical Analysis methods, such as Newton methods, Differential eqs & Integrals, etc). Get hands-on some simulations of power systems and programmable logic controllers (PLC).

Ch.3 Optimal Power Flow (OPF) and Security-Constrained Economic Dispatch (SCED). It is considering renewables as well, specifically for wind energy resouces at the transmission level, (applying Optimization techniques). Get hands-on more of modeling and analysis of power systems.

Ch.4 Optimize the Integration of Renewables into the Grid. Solar Power Modeling and Forecasting, (applying Descriptive, Predictive and Prescriptive Analytics, AI and ML techniques). Get hands-on data-driven analytics and become more familiar with conducting & publishing research.

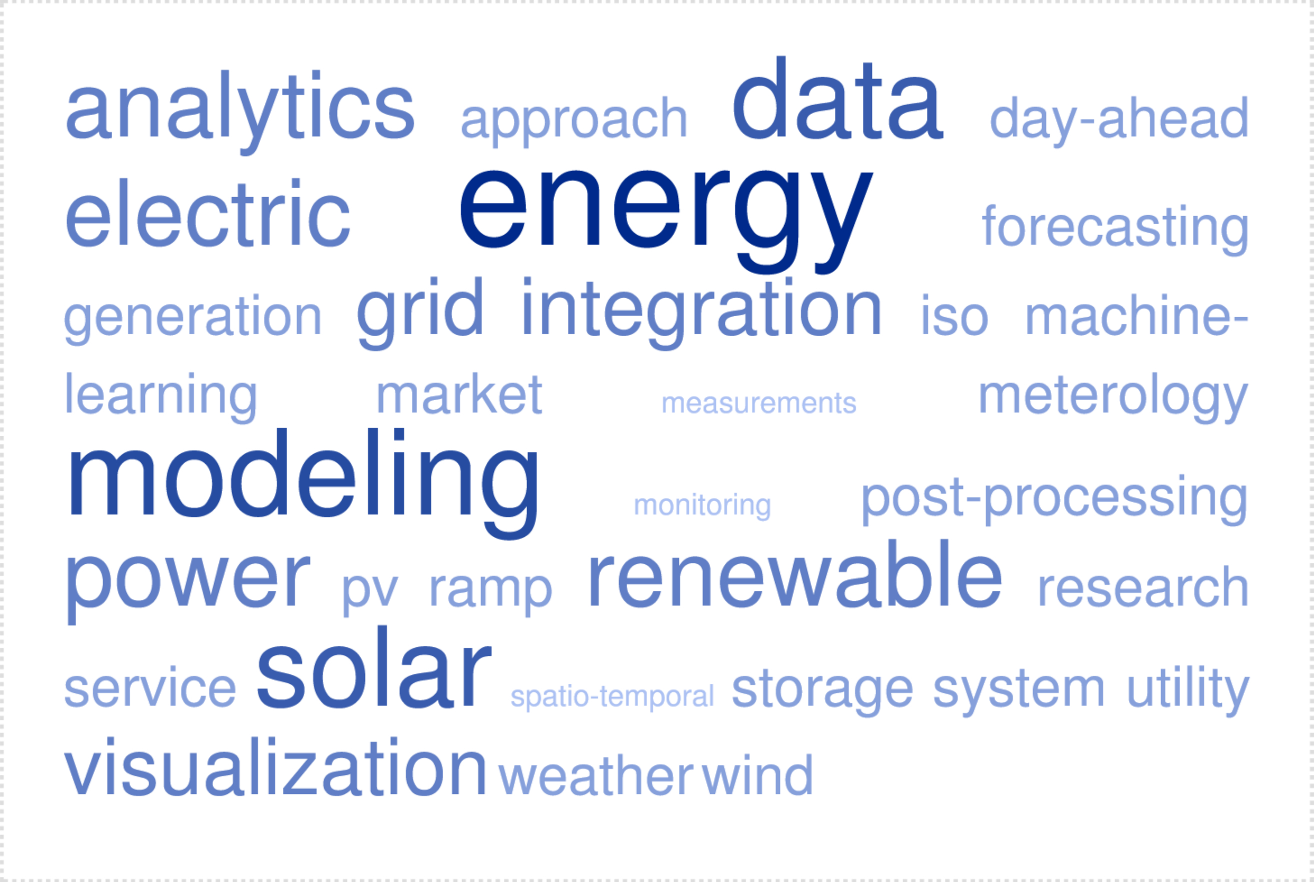
Ch.5 Who knows!

Introduction

In a nutshell, what I am often doing is finding the optimal & root values and curve fitting of nonlinear equations.

..But usually it is not as simple as that!

For more details, you may have a look at pdf copies of my CV and Cloud of Key Skills & Interests.



Motivation

- Professional Advancement
  - ✓ Get an opportunity to collaborate and work with the experts of the field.
  - ✓ To transfer, improve, and acquire knowledge and skills.

- Personal Advancement
  - ✓ Better alignment with personal values and interests.
  - ✓ Better self-esteem.
  - ✓ Better financial security.

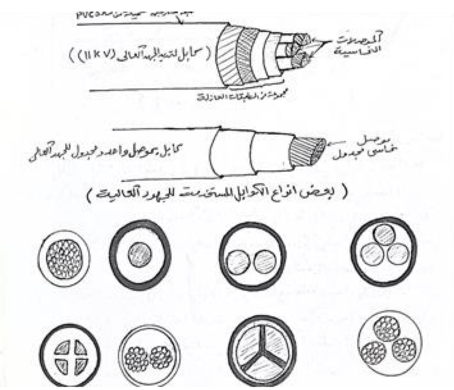
Research

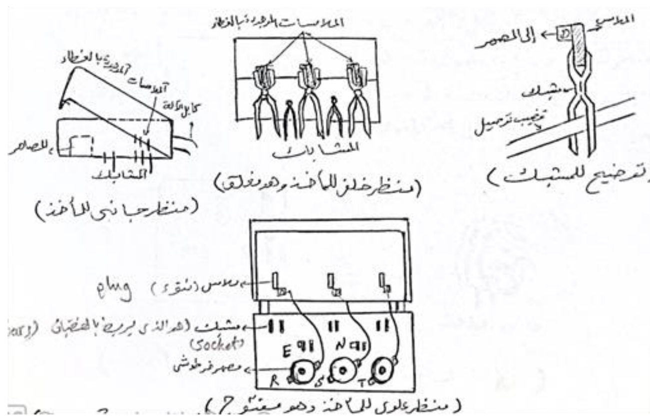
Technical Report of Operation & Maintenance, Internship at Shoes Factory in Misurata, Libya

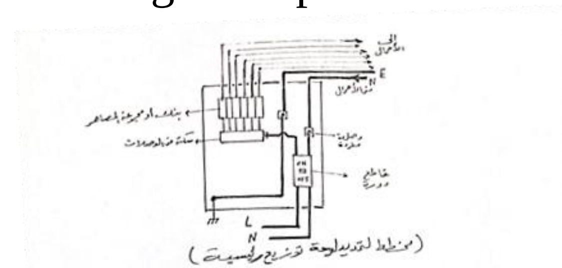
https://www.researchgate.net/publication/344772515_Technical_report_of_maintenance_and_operation_internship_at_shoes_factory_in_Misurata_Libya

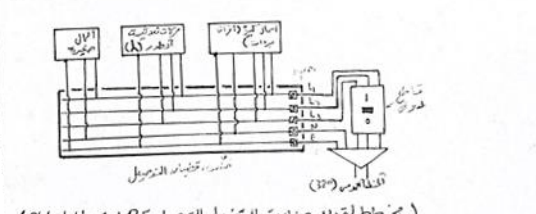
Mohamed Abuella, 2000 at Higher Center of Poly-Profession, Misurata, Libya

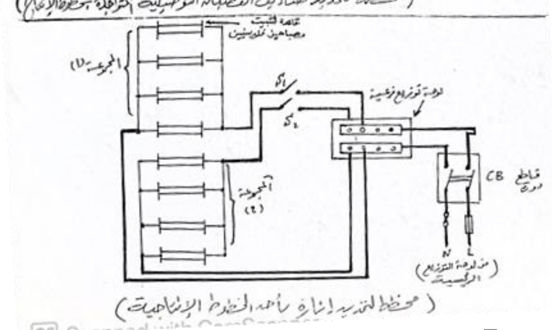
Electrical Operation & Maintenance for fulfilling requirement of the Higher Diploma

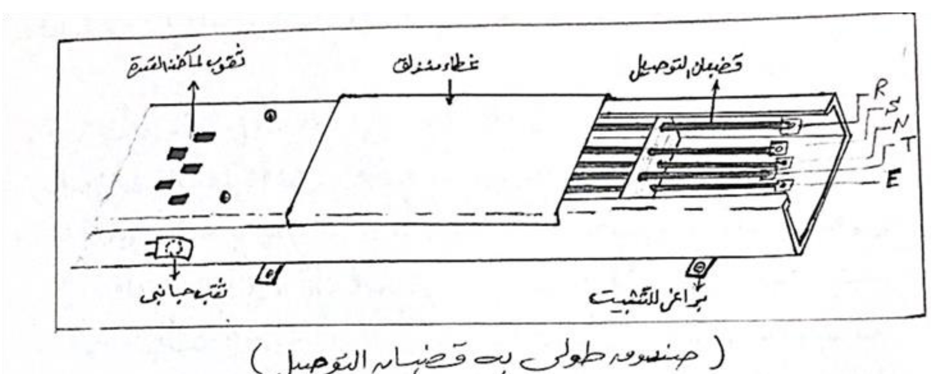












Research

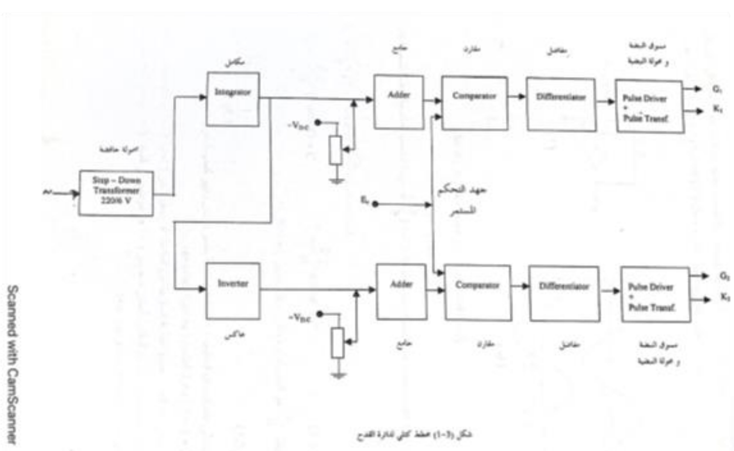
Triggering Circuit for SCR Thyristors of an AC-DC Converter

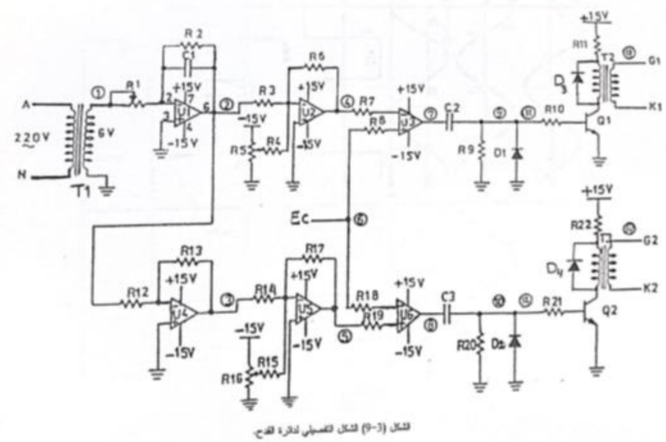
https://www.researchgate.net/publication/277109663_Triggering_Circuit_for_SCR_Thyristors_of_an_AC-DC_Converter

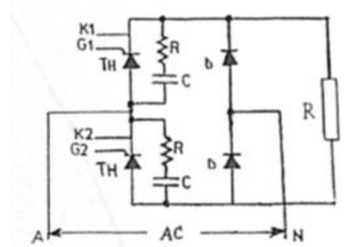
Mohamed Abuella, Ali Mohamed, Al Sayed Hamady, Advisor: Safa Samarmad
Tech Diploma Project, 2001 at Higher Center of Poly-Profession, Misurata, Libya

Higher Diploma project was in Power Electronics area. Since the task of the project of three-members-group was to build a triggering electronic circuit for a rectification bridge of Thyristors

Acquired Expertise: Electrical Wiring & Installations, Maintenance & Operation







Number:
Status: Production
Package Type: TO-48 (1/4)
Circuit Type: DISCRETE
Support Docs: datasheet
Product Line: SCR Phase Control (discrete)
FOD #: 30060

TO 48

Parameter	Limit	Units	Condition	Value
VDRM	MIN	Volts	NA	1200
IT(RMS)	MAX	Amps	NA	35
IT(av) comp.(a)	MAX	Amps	NA	22
@ TC	---	o C	NA	85
ITSM (50Hz)	MAX	Amps	NA	335
ITSM (60Hz)	MAX	Amps	NA	355
Vgt	Max	Volts	NA	2
Igt	Max	mAmps	NA	60
VTM comp.(a)	MAX	Volts	NA	1.7
@ ITM comp. (a)	---	Amps	NA	70
DV/DT	MAX	V/us	NA	300
Rth(JC)	MAX	o C/W	NA	.86

Research

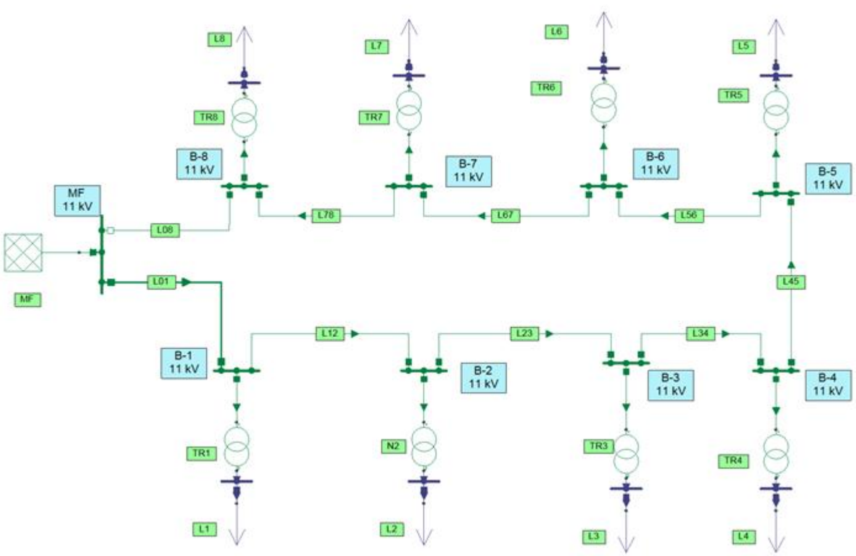
Study of NEPLAN Software for Power Flow and Short Faults Analysis

https://www.researchgate.net/publication/277110587_Study_of_NEPLAN_Software_for_Load_Flow_and_Short_Faults_Analysis/stats

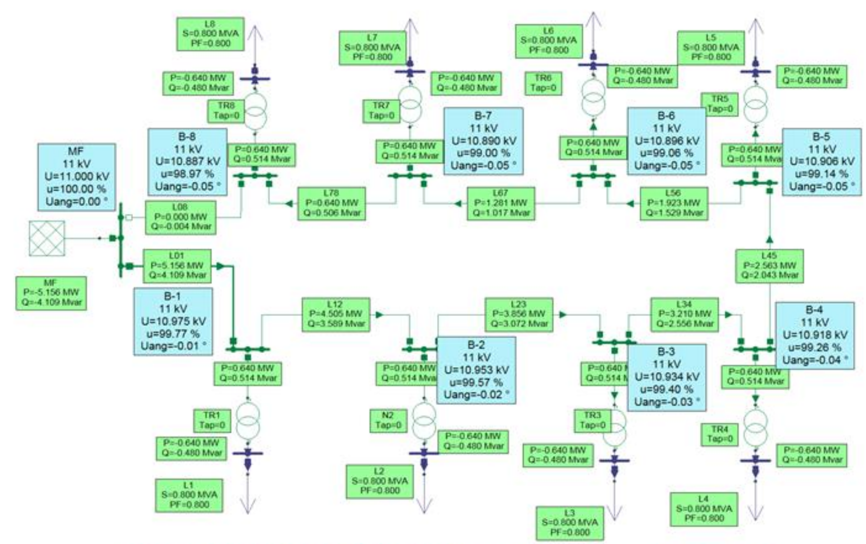
B.Tech Project, 2008 at College of Industrial Technology, Misurata, Libya
Advisor: Mohamed Shetwan

Acquired Expertise: Teaching, Tutorials, Lab Modeling & Simulations, Curriculum Revision & Prepartion, Dedication, Listening, "Try to Modeling the Student’s Way of Thinking.”
Software Tools including: MS Office, MATLAB, NEPLAN, PLC’s Ladder Logic

شبكة التوزيع الكهربائية (11/0.4 KV) للوحدات السكنية



• حساب سريان القدرة لشبكة التوزيع:



النتائج ظاهرة على مخطط شبكة التوزيع الكهربائية (11/0.4 KV) للوحدات السكنية

Research

SMART GRID, Seminar

https://www.slideshare.net/MohamedAbuella/smart-grid-37661484
Smart Grid Presentation in Seminar Course, 2012 at Southern Illinois University at Carbondale

Study of particle swarm for optimal power flow in IEEE benchmark systems including wind power generators

https://www.proquest.com/openview/21da3b4335a4c23278e9bd91d67a7784/1?pq-origsite=gscholar&cbl=18750
Master of Science Thesis, 2012 at Southern Illinois University at Carbondale, USA
Advisor: Constantine Hatziadoniu

Acquired Expertise: Power Systems Analysis, Operation and Planning, Systems Optimization, Smart Grid, Research Conducting, Software Tools: MATPOWER, PowerWorld, PSAT, LaTeX

Research

Study of particle swarm for optimal power flow in IEEE benchmark systems including wind power generators

https://www.proquest.com/openview/21da3b4335a4c23278e9bd91d67a7784/1?pq-origsite=gscholar&cbl=18750

CARBONDALE

Master of Science Thesis, 2012 at Southern Illinois University at Carbondale, USA

Advisor: Constantine Hatziadoniu

$$J_{Min} = \sum^{M} C_i(p_i) + \sum^{N} C_{wi}(w_i) + \sum^{N} C_{p,i}(w_i) + \sum^{N} C_{r,i}(w_i)$$

Subject to:

$$p_{i,\min} \le p_i \le p_{i,\max}$$

$$0 \le w_i \le w_{r,i}$$

$$\sum_i^M p_i + \sum_i^N w_i = L$$

$$V_i^{\min} \le V_i \le V_i^{\max}$$

$$S_{line,i} \le S_{line,i}^{\max}$$

Where:

$$C_i = a_i P_i^2 + b_i P_i + c_i$$

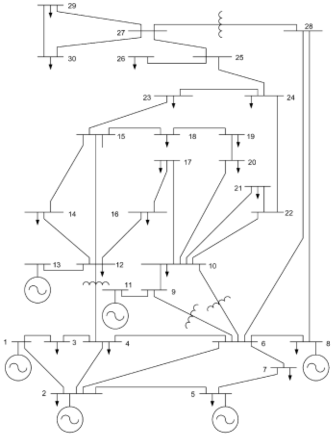
$$C_{w,i} = d_i w_i$$

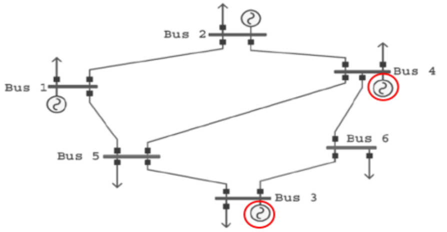
$$C_{p,i} = k_{p,i} \int_{w_i}^{w_{r,i}} (w - w_i)\, f_W(w)\, dw \text{ (underestimation)}$$

$$C_{r,i} = k_{r,i} \int_0^{w_i} (w_i - w)\, f_W(w)\, dw \text{(overestimation)}$$

$$C_i = a_i P_i^2 + b_i P_i + c_i$$

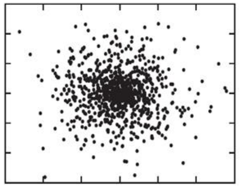
$$C_{w,i} = d_i w_i$$





Gen. No.	a (\$/MW^2.hr)	b (\$/MW.hr)	c	PG_low (MW)	PG_high (MW)
1	0.012	12	105	50	250
2	0.0096	9.6	96	50	250
3	0	8	0	0	40
4	0	6	0	0	40

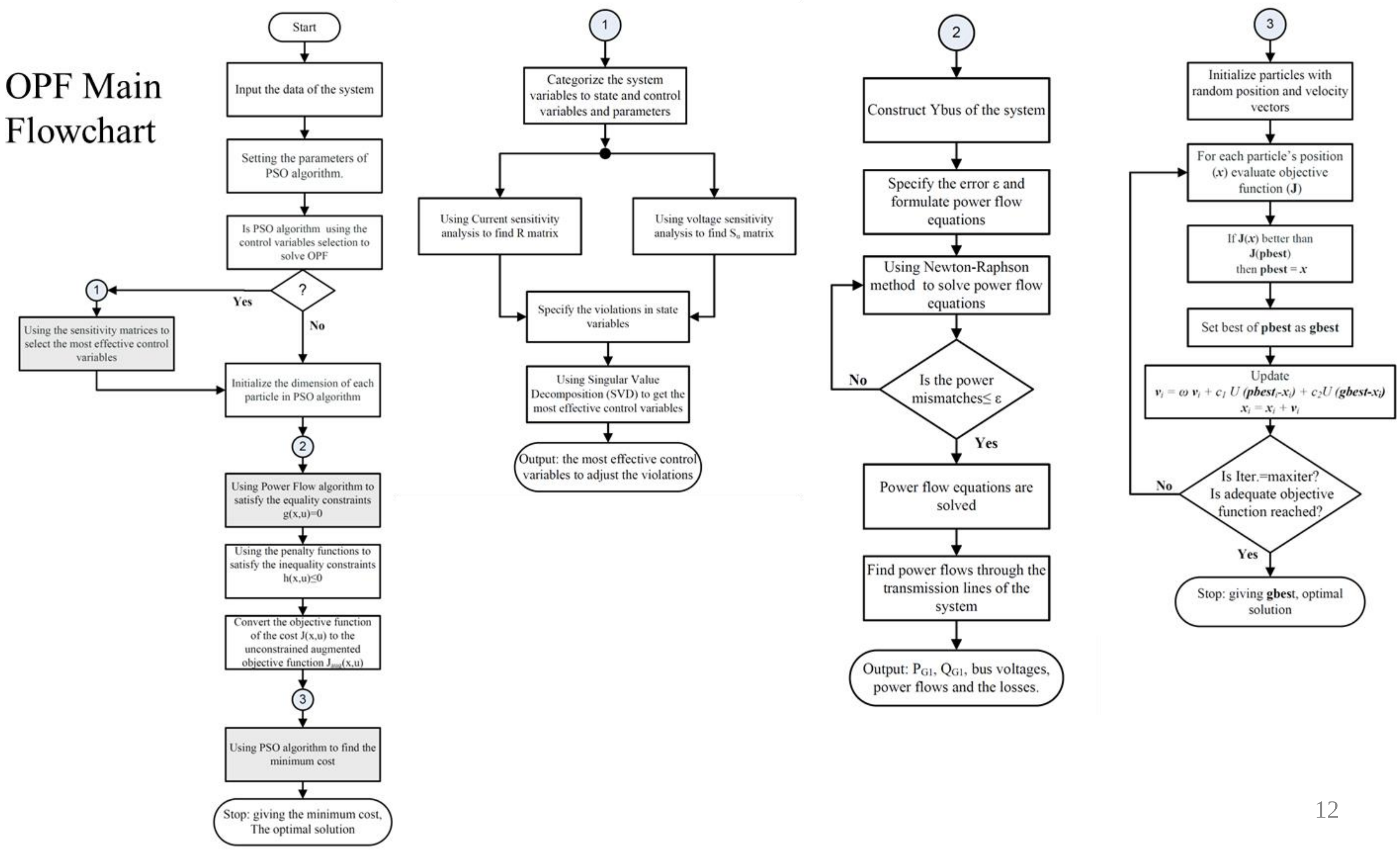
PSO



Particle Swarm Optimization (PSO) algorithm is used for solving this optimization problem.

Research

Study of particle swarm for optimal power flow in IEEE benchmark systems including wind power generators

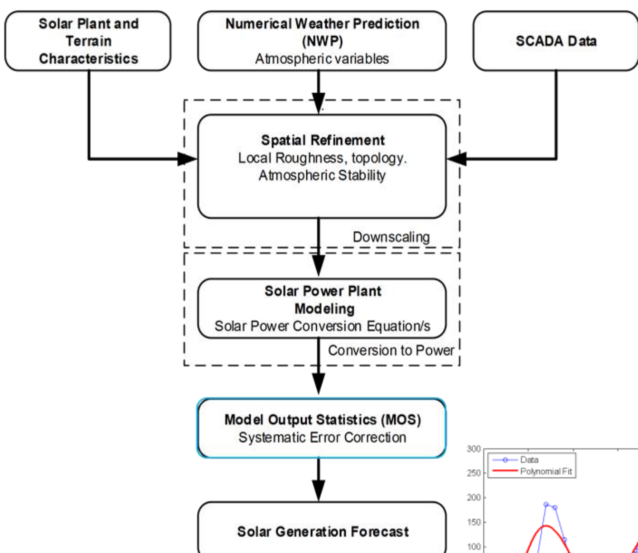


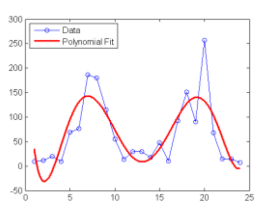
Research

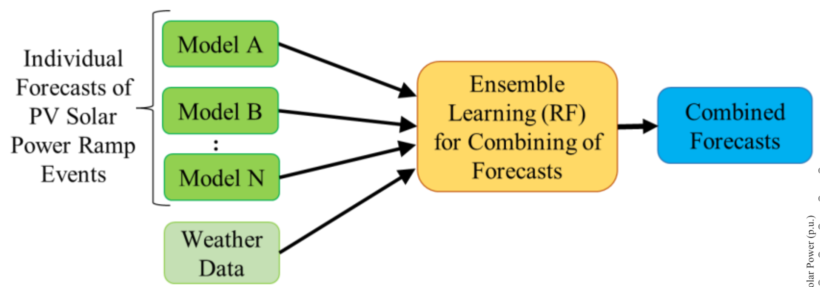
A Post-Processing Approach for Solar Power Combined Forecasts of Ramp Events
https://www.proquest.com/openview/42049145119c7760f93ea736b37a0930/1.pdf?pq-origsite=gscholar&cbl=18750
PhD Thesis, 2018 at University of North Carolina at Charlotte, USA
Advisor: Badrul Chowdhury

UNC CHARLOTTE

Acquired Expertise: Energy Analytics, Energy Markets, Renewable Energy Integration, Asset & Supply Chain, Time Series Analysis & Modeling, Risk & Uncertainty Quantification, Machine Learning, Big-Data Processing, Research Publishing & Peer Reviewing, Software Tools including SAS, R, and Python

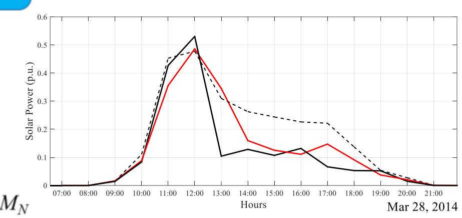


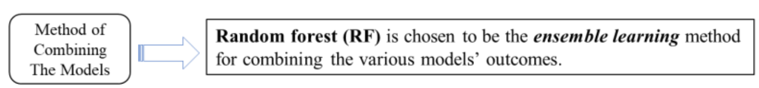




General diagram of combining different models

$$F_{comb}=W_A*M_A+W_B*M_B+W_C*M_C \,....+W_N*M_N$$





Research

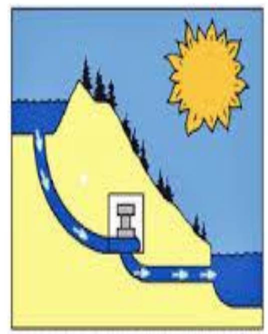
$$P_{Supply} = P_{Demand} + P_{Loss}$$

Why Forecast?

PV Solar Power Generations are Too Variable

Coordination with Operating Reserves and Energy Storage Systems

Reducing Cost and Pollution



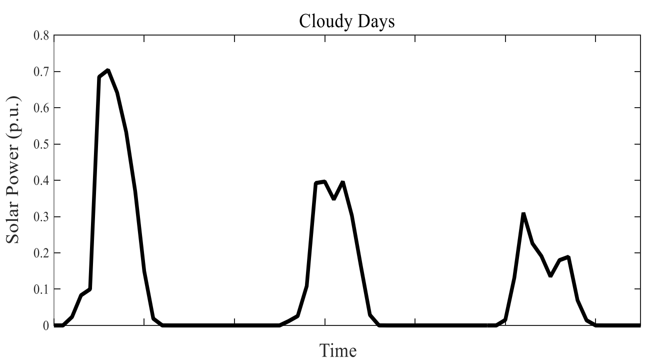


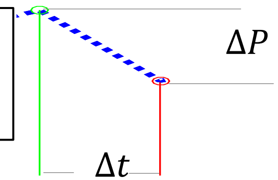
Illustration of the motivation of PV solar power forecasts

Research

Definition of Ramp Events

Solar power ramp rate (RR) is *the change of solar power during a certain time interval.*

$$Ramp\ Rate, RR(t) = \frac{dP(t)}{dt} = \frac{P(t+D) - P(t)}{D}$$



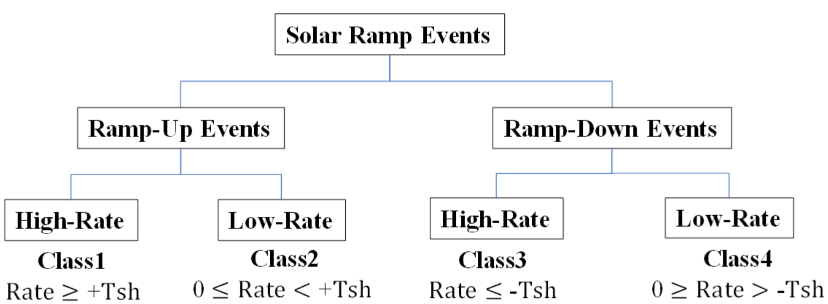
where P(t) is the solar power of the target hour, it can also be its forecast F(t); D is the time duration for which the ramp rate is determined.

For the illustrated cloudy day below:

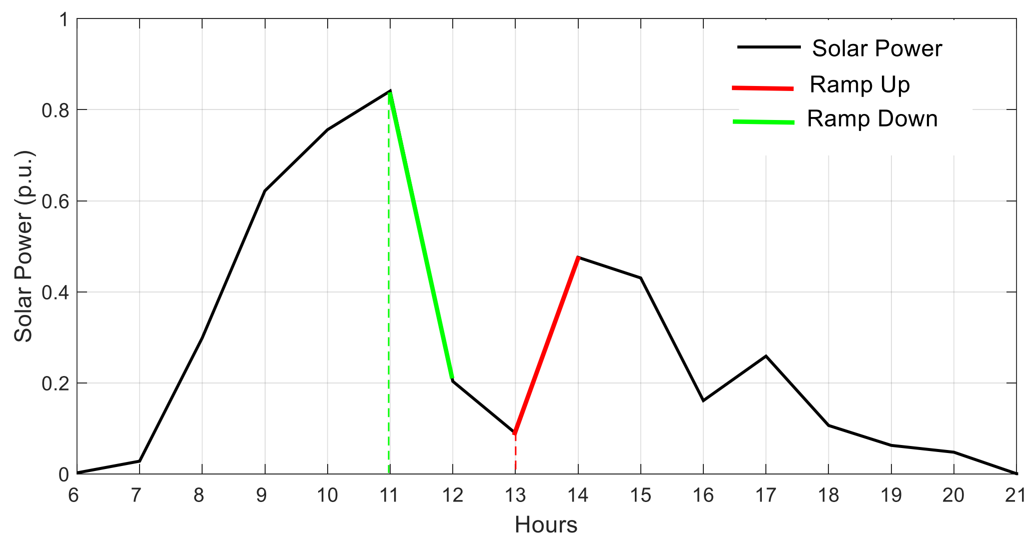
Ramp rate, $\frac{\Delta P}{\Delta t} = \frac{0.2-0.85}{12{:}00-11{:}00} = -0.65\ (-65\%)\ ramp\ down\ of\ its\ normal\ capacity,\ (pu/hr)$

Ramp rate, $\frac{\Delta P}{\Delta t} = \frac{0.48-0.1}{14{:}00-13{:}00} = +0.38\ (+38\%)\ ramp\ up\ of\ its\ normal\ capacity,\ (pu/hr)$

Some ramps are with low rates, while others with high rates.



Distribution of the classes of solar power ramp events



Ramp Events During a Cloudy Day

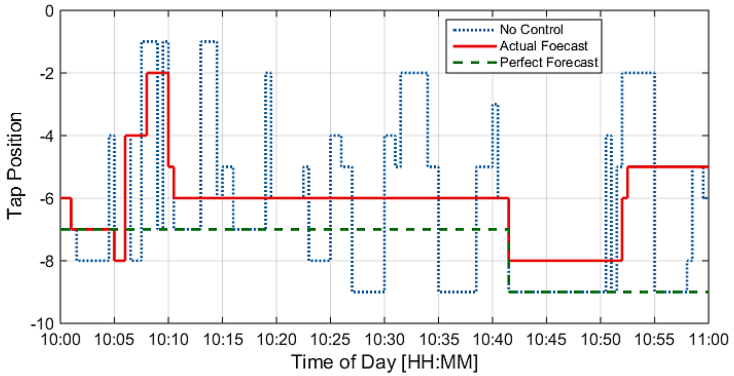
Research

Potential Applications

There are several applications of power systems that rely on solar power ramp event forecasts

Distribution level:

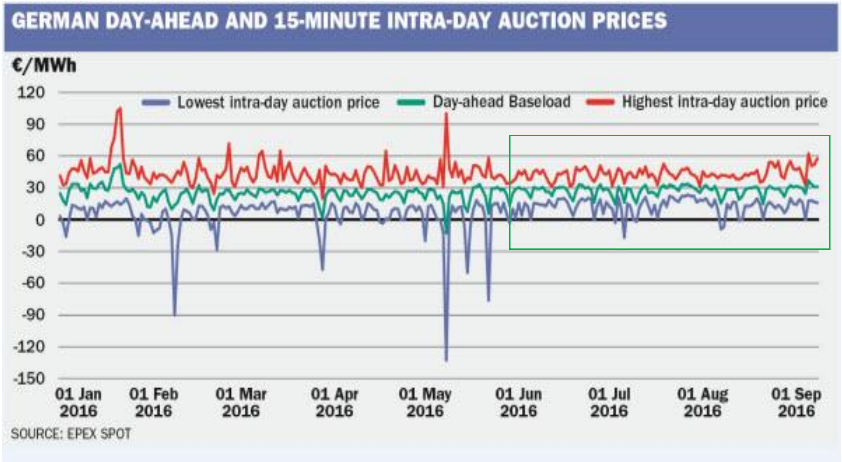
- Optimizing the voltage regulation equipment.
- Control schemes of energy storage systems.



Optimizing the Transformer's Tap Changer position sequences using the solar forecast

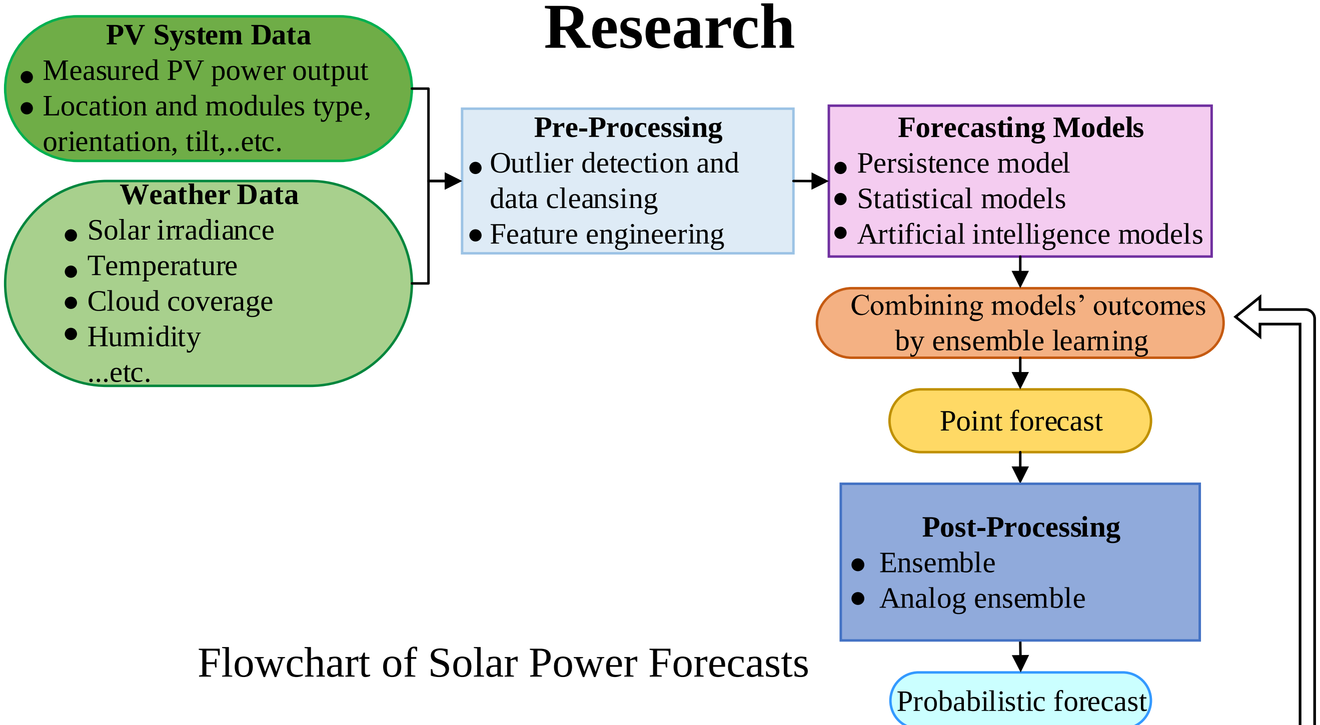
Transmission / bulk level:

- Trading & dispatching the operating reserve.
- Managing the ramp capability / system flexibility with high-level of renewable energy integration.

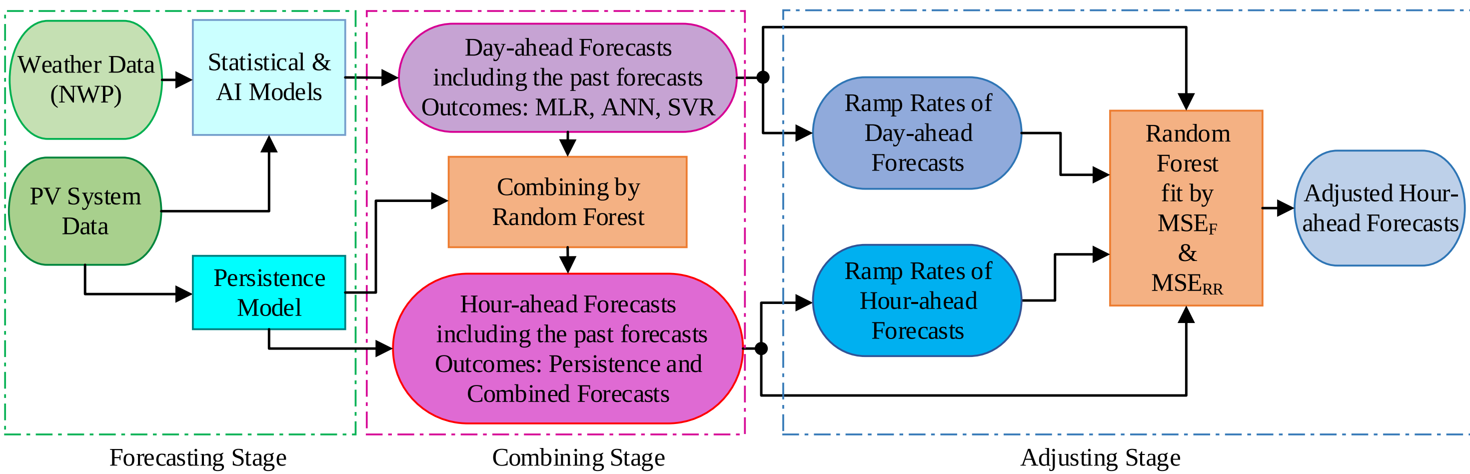


EPEX: European power exchange spot trading

Research

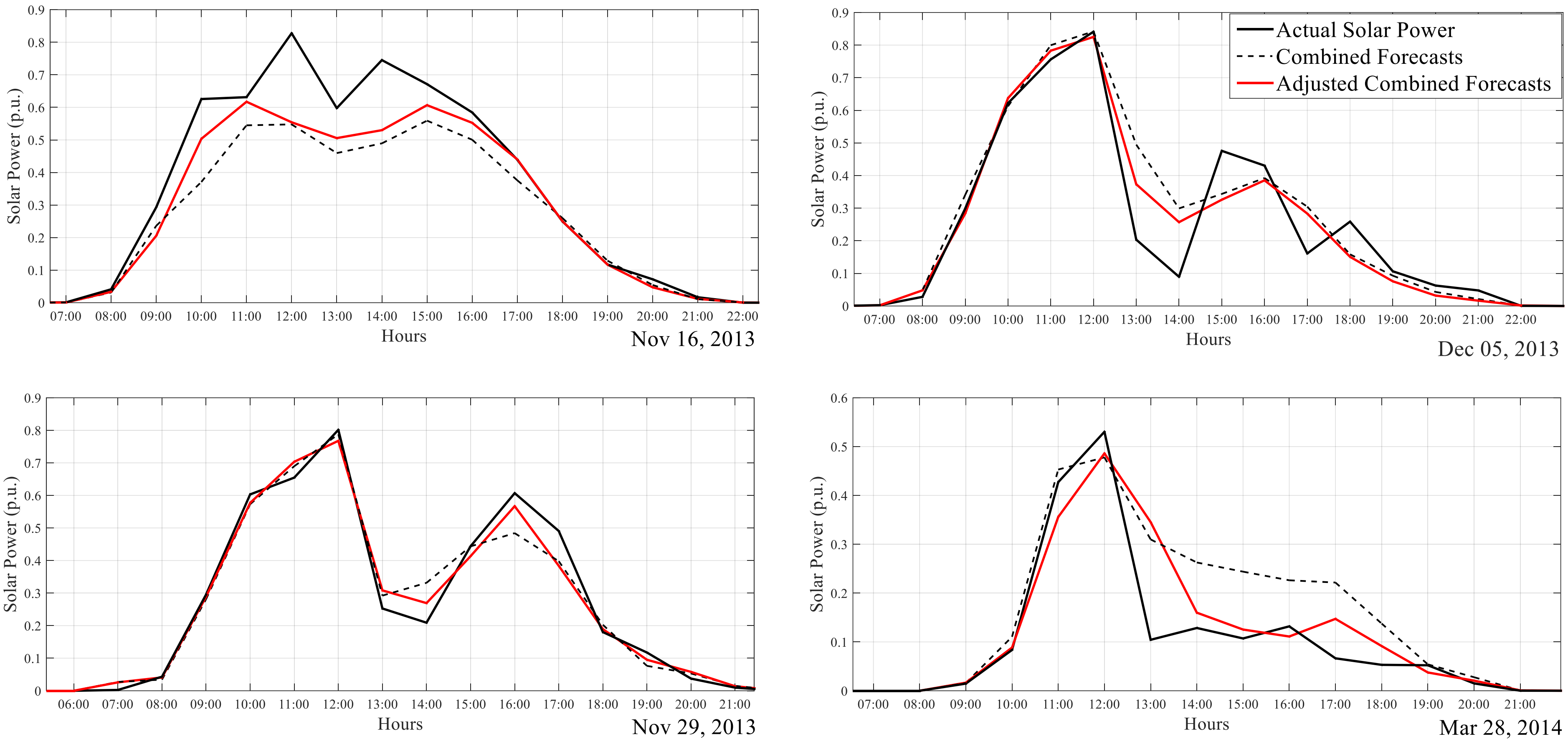


Flowchart of Solar Power Forecasts



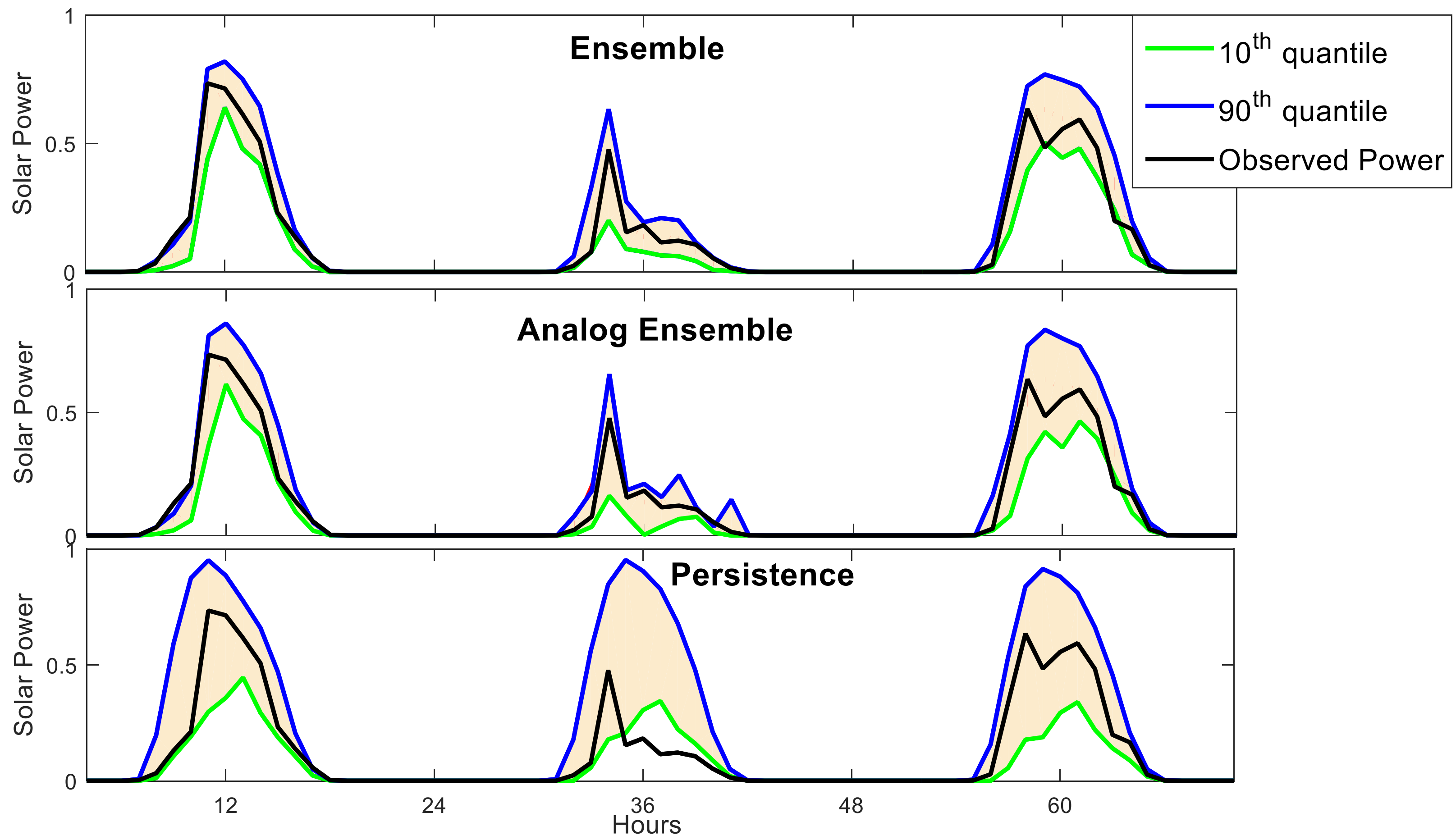
Block diagram of the adjusting approach

Research



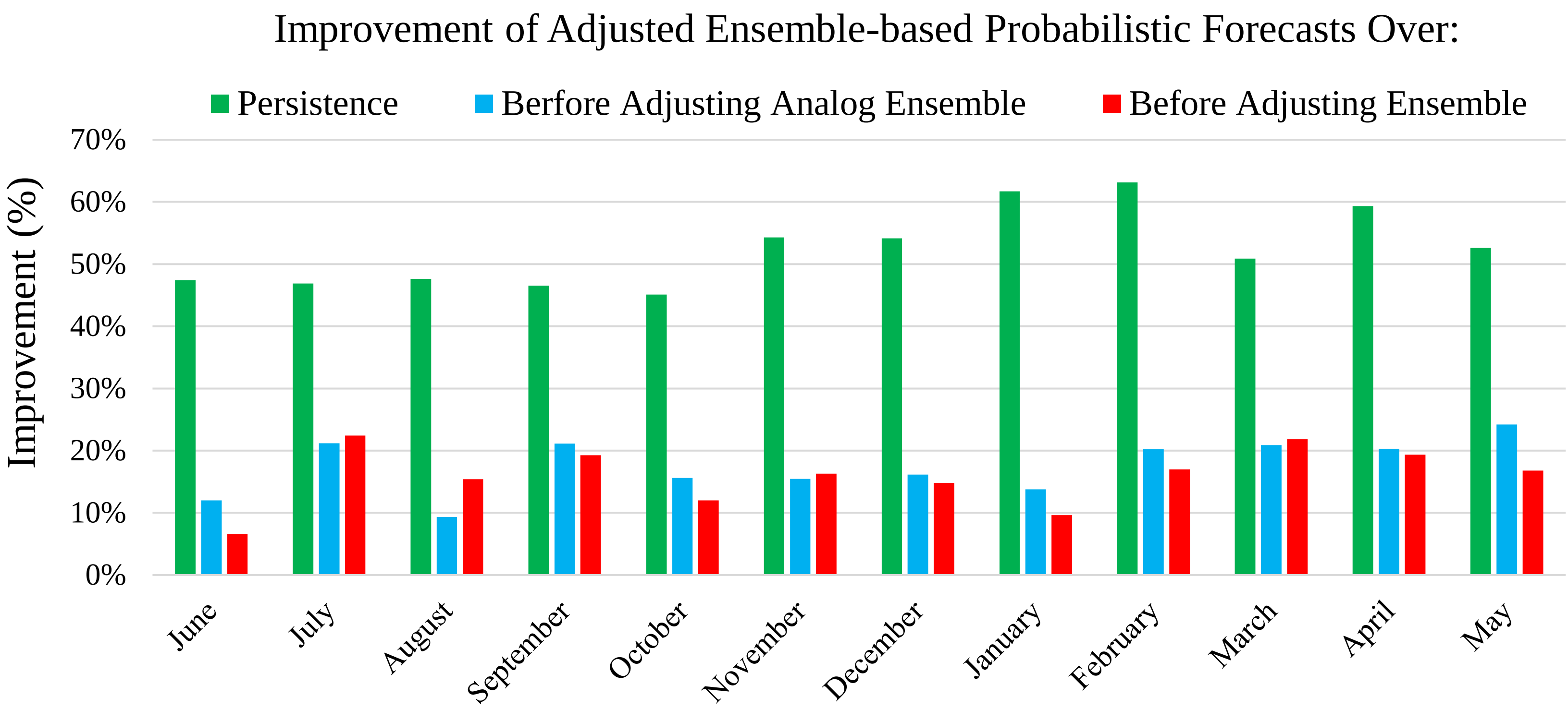
Combined forecasts of solar power for cloudy days before and after applying the adjusting

Research



Graphs of the probabilistic forecasts of the three methods for three days

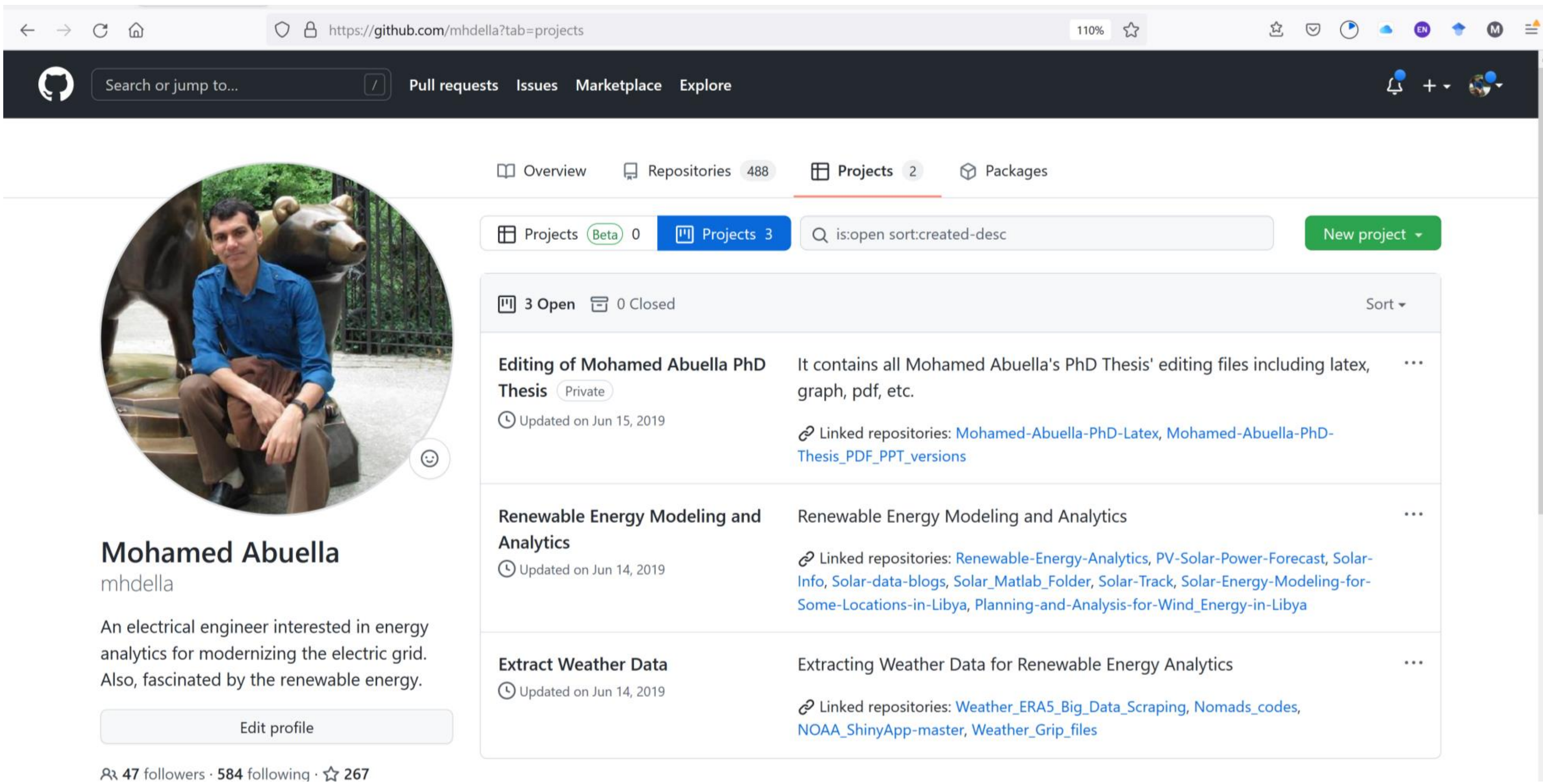
Research



$$Skill\ Score\ (\%) = \left(1 - \frac{Metric_{method}}{Metric_{reference}}\right) * 100$$

Research

Some other Projects in GitHub: https://github.com/mhdella?tab=projects



Research

Keep up some blogs on : https://mohamedabuella.github.io/blog/

Blogs

•01 Sep 2021 » Blog Planning and Analysis for Wind Energy in Libya
•19 Jul 2021 » Blog Planning and Analysis for Solar Energy in Libya
•11 Dec 2019 » Blog Reading and Reflection on a Book of Solar Energy
•19 Aug 2019 » Blog Does the Educational Curricula Keep the Pace with the Advancements in Energy Technologies?
•09 Aug 2019 » Blog Wind and Solar Energy Resources Modeling and Analysis
•30 Jul 2019 » Blog Net Load Forecasting for Microgrid Resiliency
•29 Jul 2019 » Blog How a Subtle Lack of Knowledge Could Lead to Catastrophic Consequences
•23 Jun 2019 » Blog Reading a Big-picture Book after a While of Focusing on Elaborate Technical Stuff
•17 Jun 2019 » website Website Launched

Research

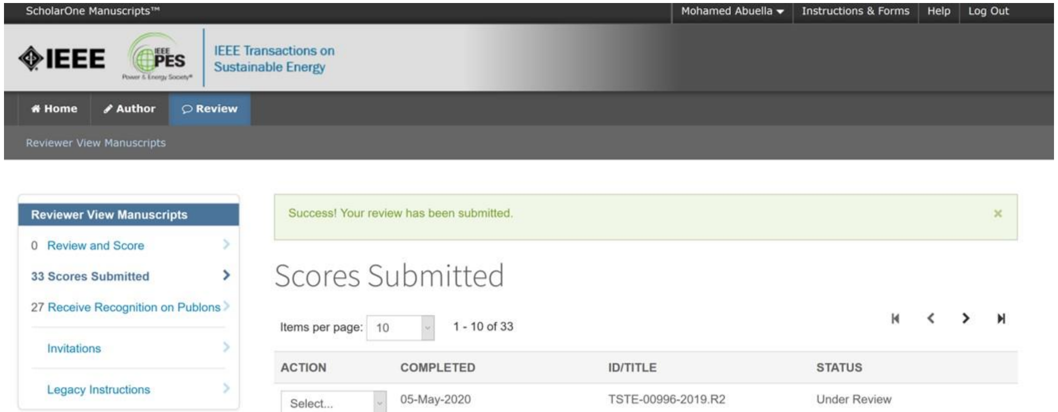
- Power System Flexibility and DG resources management, I have been working on Forecasting and Machine Learning approaches, since 2014

- Techno-economic analysis of HOMER (Report), C:\+HP Folders\+Folder2021\+Homer ProExs and examples of using NREL SAM, C:\Users\Mhdella\Desktop\Exs_SAM

- Writing using Latex (Eqs, Biblio.), Mendeley (>5500 docs, tags), Evernote (organize notes, share them), Dropbox, Google Drive (clouds to back up), iCalendar, etc.

- Research Outreach and Knowledge Dissemination: depending extensively on the online tools, such as Blogs on personal website, LinkedIn, Twitter, Researchgate, Newsletter from relevant groups of interest (ESIG, AI in Smart Grids, ISES, WEMC, etc.)

- Review of IEEE Transactions on Sustainable Energy



Research

Interactive Data Dashboard in Jupyter Notebooks

ipywidgets*, also known as jupyter-widgets or simply widgets, are* [*interactive HTML widgets*](#)

[https://github.com/mhdella/energyDS/blob/master/Prerequisites/08 Plotting.ipynb](https://github.com/mhdella/energyDS/blob/master/Prerequisites/08%20Plotting.ipynb)

To install the widgets on your own computer, follow the instructions at

https://ipywidgets.readthedocs.io/en/latest/user_install.html

Example:

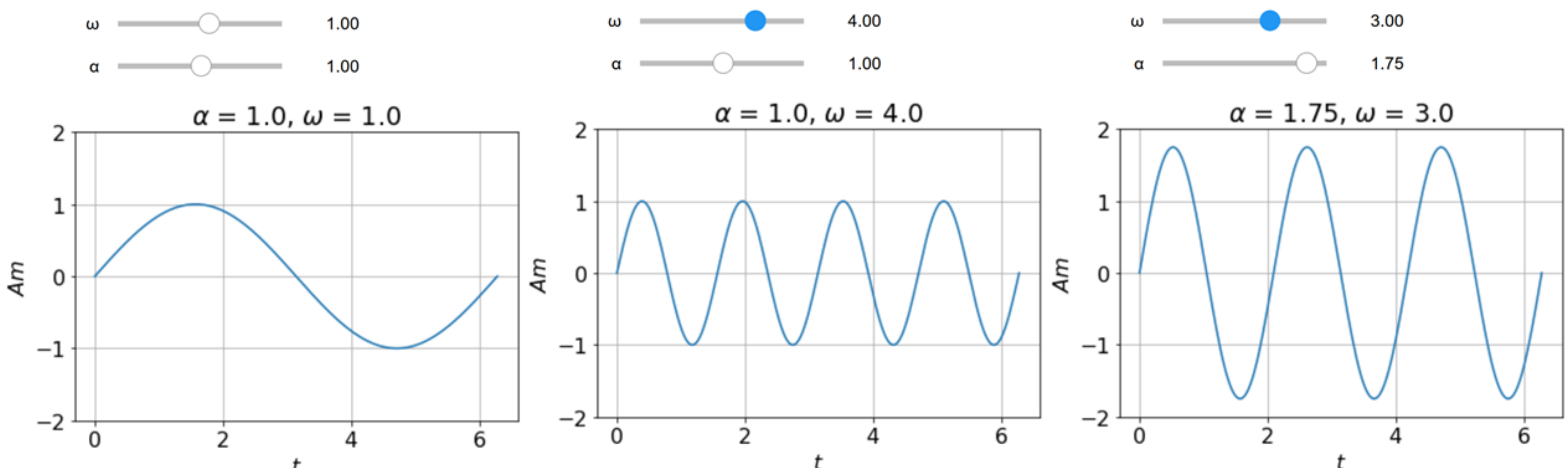
```
from ipywidgets import interact
..
plt.plot(t, α*np.sin(ω*t))
```

In [12]:

```python
def plot(ω=1, α=1):
    t = np.linspace(0, 2*np.pi, 200)
    plt.xlabel('$t$')
    plt.ylabel('$Am$')
    plt.ylim((-2,2))
    plt.title(r"$\alpha$ = {}, $\omega$ = {}".format(α, ω))
    plt.plot(t, α*np.sin(ω*t))
    plt.grid()
    plt.show()
```

In [13]:

```python
interact(plot, ω=(-10, 10, 0.25), α=(0, 2, 0.25));
```

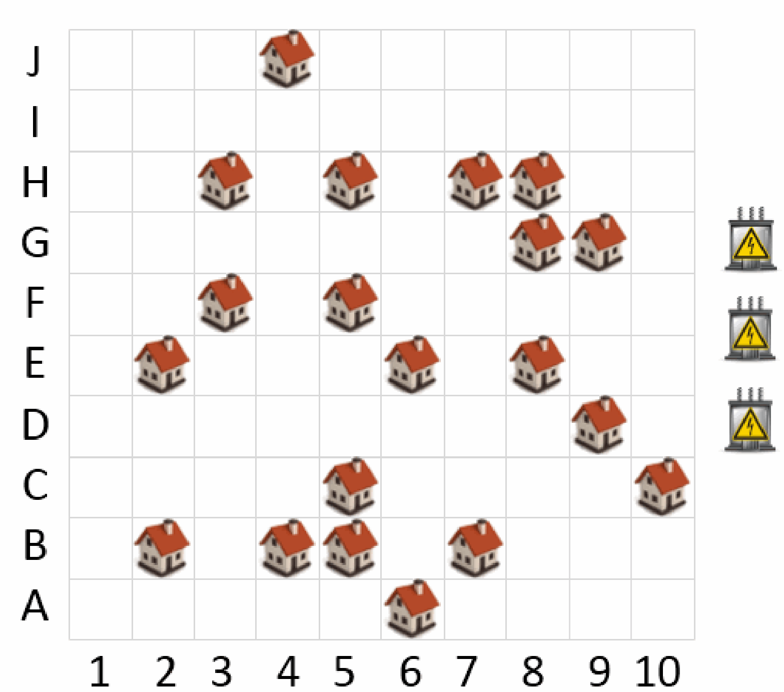


Research

Example of Using Clustering in Electrical Power Systems Planning

C:/Desktop/Py_vars_desktop/optimizatingelectricitytransmission-main/optimizatingelectricitytransmission-main/Electrifying_PuzzlOR_problem.ipynb

Q: What is the minimum cost required to connect all neighborhoods to electricity?

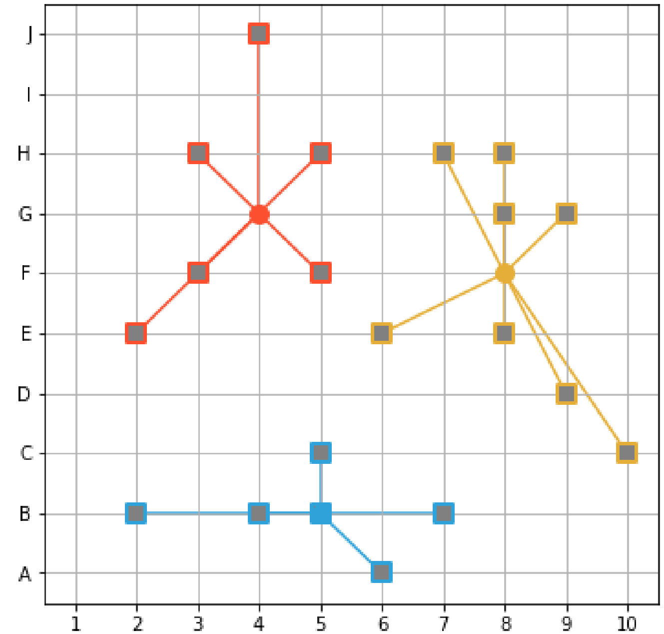



```python
from sklearn.cluster import KMeans

km = KMeans(n_clusters=3)
km.fit(N)

km.cluster_centers_

plot_placements(km.cluster_centers_, N)
```



Thanks for Your Listening

Any Question?

Mohamed Ali Abuella
mabuella@cit.edu.ly
mhdabuella@gmail.com

كلية التقنية الصناعية_مصراتة
The College Of Industrial Technology_Misurata

UNC CHARLOTTE
Energy Production and Infrastructure Center (EPIC)