Cloud Computing

Airplane flight simulation for competition Air Cargo Challenge 2022

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1. Introduction

When carrying out calculations as a matter of engineering projects, there is often a need to perform a very large number of mathematical operations, which requires high computing power. If large amounts of computing are used once in a while and then, it becomes profitable to use solutions such as computing in a virtual machine on cloud platform services such as Microsoft Azure.

In order to find the best aircraft for the Air Cargo Challenge competition, I had to make many simulations of its flight in accordance to the competition regulations. To use the basic functionalities of the Microsoft Azure platform, in this project, I created a program simulating the course of the aircraft mission with exemplary parameters. The program runs on a virtual machine created on this platform.

2. Project assumptions

2.1. Funcionality

The aim of the program is to simulate the course of the mission of the aircraft participating in the Air Cargo Challenge 2022 competition. Within the mission, the aircraft must perform two tasks:

1. Take off from the runway and climb for the first 60 seconds. If it reaches an altitude of 100 m before that time, it may fly at that altitude up to the 60 second of flight.
2. For the next 120 s, make a cruise at the altitude of not less than 10 m.

After simulating the cruise, the program finishes its operation. It does not simulate a landing.

The program is written in two files:

- symulacja_misji.py
- wyzn_alfa.py

The first file stores the main flight simulation function. The file wyzn_alfa.py allows to calculate the angle of inclination of the plane at any moment in time.

2.2. Environment

I created a Linux based virtual machine (ubuntu 20.04).

I have selected the basic machine properties settings:

- I have indicated the subscription that will include the installation and creation of a new resource group. This is an "Azure for Studensts" subscription
- Name of the resource group: MaszynaTestowa
- Name of the machine: MaszynaTest
- Location: West Europe

Next, I chose the image on which I based my virtual machine's operation:

Ubuntu Server 20.04 LTS – Gen2

I also chose the size of the virtual machine: Standard_B1|s – vcpu: 1, 0.5 GiB pamięci

Podstawowe elementy

Grupa zasobów (Przenieś)
MASZYNATESTOWA_GROUP

Stan
Uruchomione

Lokalizacja
West Europe

Subskrypcja (Przenieś)
Azure for Students

Identyfikator subskrypcji
4b4e8e90-8b1b-4bd3-8635-c20b7dbbf42e

Tagi (Edytuj)
Kliknij tutaj, aby dodać tagi

System operacyjny
Linux (ubuntu 20.04)

Rozmiar
Standard B1ls (1 vcpu, 0.5 GiB pamięci)

Publiczny adres IP
13.69.103.178

Sieć/podsieć wirtualna
MaszynaTestowa_group-vnet/default

Nazwa DNS
Nieskonfigurowano

Właściwości | Monitorowanie | Możliwości (7) | Zalecenia (1) | Samouczki

Maszyna wirtualna

Nazwa komputera	MaszynaTest
Stan kondycji	-
System operacyjny	Linux (ubuntu 20.04)
Wydawca	canonical
Oferta	0001-com-ubuntu-server-focal
Plan	20_04-lts-gen2
Generacja maszyny wirtualnej	V2
Stan agenta	Ready
Wersja agenta	2.6.0.2
Grupa hostów	Brak
Host	-
Grupa umieszczania w pobliżu	-
Stan współwystępowania	Nie dotyczy
Grupa rezerwacji pojemności	-

Dostępność i skalowanie

Strefa dostępności	-
Zestaw skalowania	-

Typ zabezpieczeń

Typ zabezpieczeń	Standardowe

Sieć

Publiczny adres IP	13.69.103.178
Publiczny adres IP (IPv6)	-
Prywatny adres IP	10.0.0.4
Prywatny adres IP (IPv6)	-
Sieć/podsieć wirtualna	MaszynaTestowa_group-vnet/default
Nazwa DNS	Konfiguruj

Rozmiar

Rozmiar	Standard B1ls
Procesory wirtualne vCPU	1
Pamięć RAM	0.5 GiB

Dysk

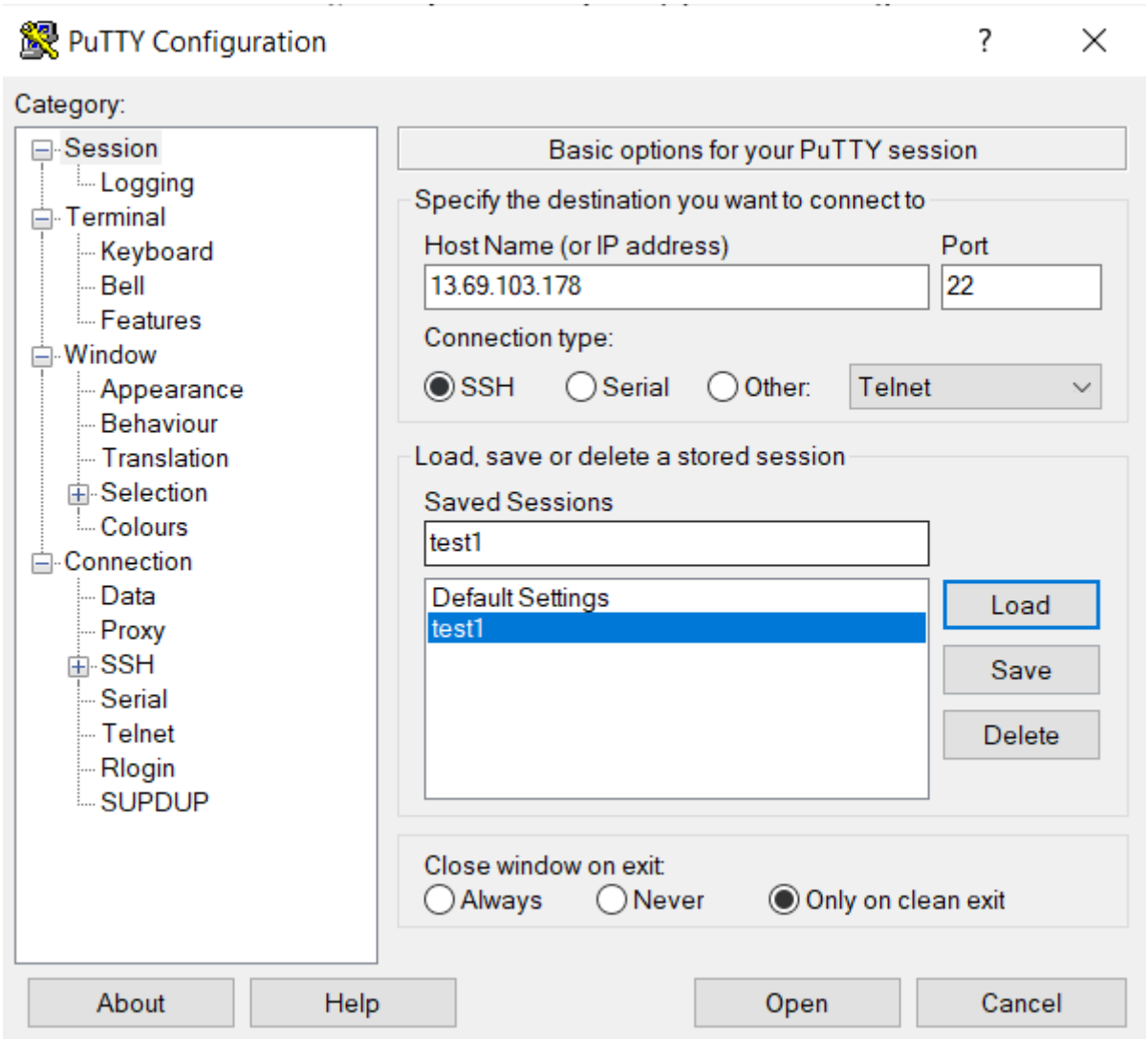
Dysk systemu operacyjnego	MaszynaTest_OsDisk_1_0200f4baca3d4575aad4deedec00147d
Szyfrowanie dysków platformy Azure	Niewłączone
Efemeryczny dysk systemu operacyjnego	Nie dotyczy
Dyski z danymi	0

Azure Spot

Azure Spot	-
Zasady eksmisji usługi Azure Spot	-

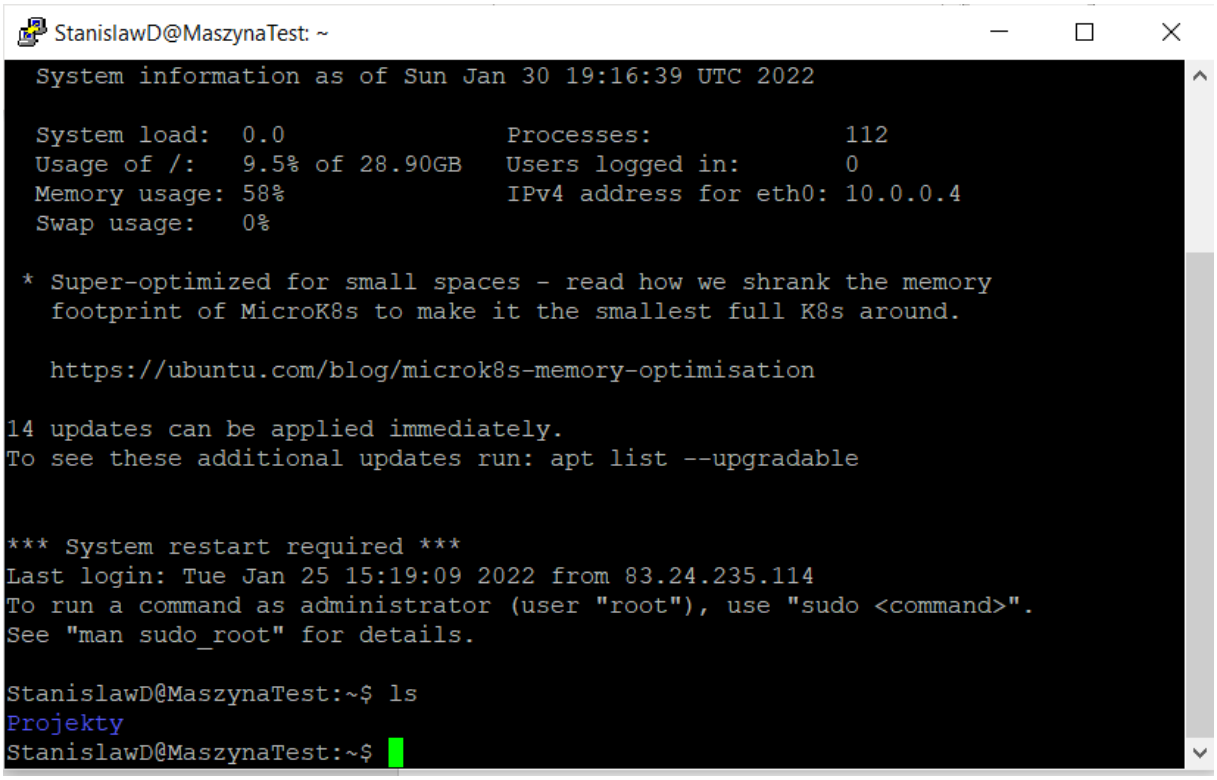
Then, using the Puttygen application, I generated an SSH public key. The public key has been pasted into the appropriate place in the virtual machine configurator. The private key has been saved in the appropriate place on the computer.

The connection to the virtual machine was done using the Putty application.



The SSH protocol was used to connect to the virtual machine.

After connecting to the virtual machine, the Projects folder was created, in which there are stored files with the flight simulation program.



2.3. GitHub

To be able to transfer the program code to a virtual machine, I created an account on the GitHub website. There I created the repository "obliczebnia_w_chmmurze" and there I put the program code.

The repository has been cloned to a virtual machine with the command:

```
git clone https://github.com/StanislawDul/obliczenia_w_chmmurze
```

The repository was cloned to the Projects folder.

3. Computational project

3.1. Flight simulation program

The aircraft whose flight was simulated has the following parameters:

- Take-off weight = 3 kg
- Airfoil Surface area = 0.35 m^2
- Minimum drag coefficient = 0,07
- Wing elongation = 10,
- Maximum lift coefficient CLmax = 1,75
- The angle of climb = 0,1396 rad
- The angle of inclination during the cruise = -0,01745 rad

The program was written in Python. It calculates all relevant flight parameters:

- Time
- The angle of inclination

- Velocity
- Lift coefficient
- Drag coefficient
- Lift Force
- Trust
- Aerodynamic drag
- Rolling force
- Altitude
- Traveled distance
- Run-up

These parameters are saved for each moment of time in a text file dane_lotu.txt.

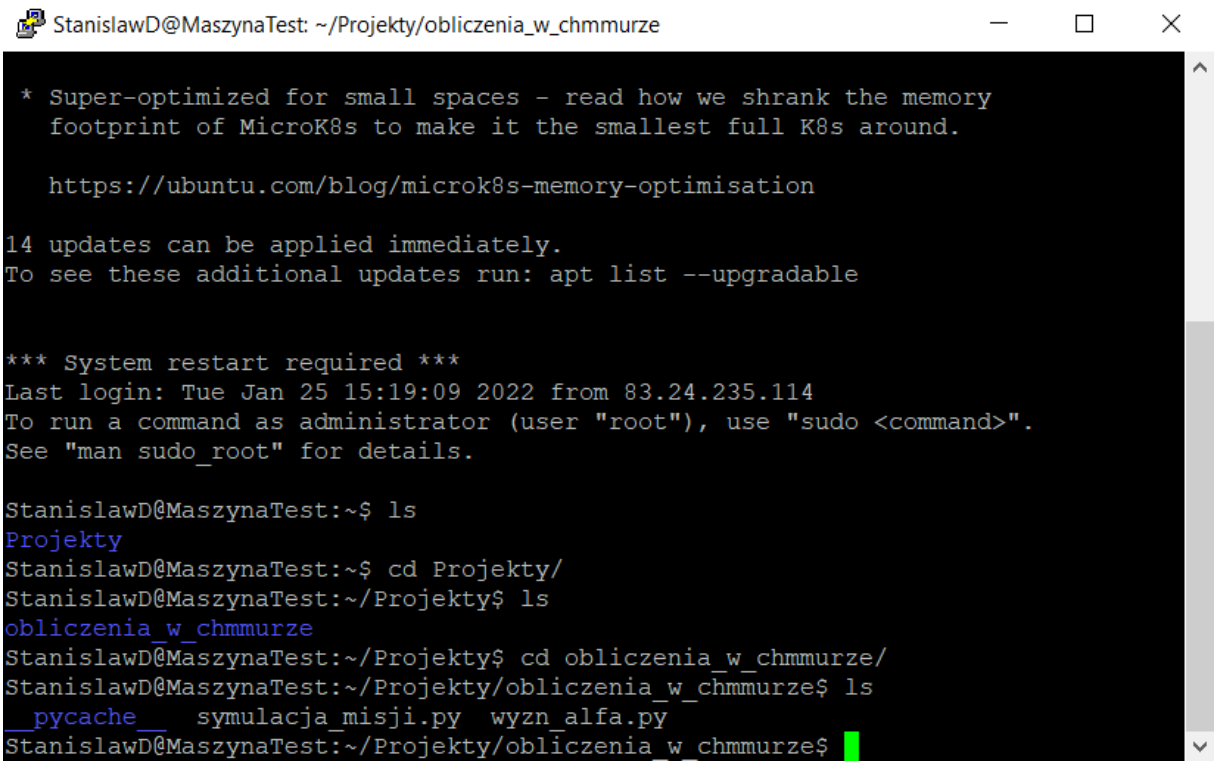
In this file, information about the parameters of the aircraft for which the calculations are performed is also saved.

Additionally, the following flight information is saved in the flight wyniki_lotu.txt:

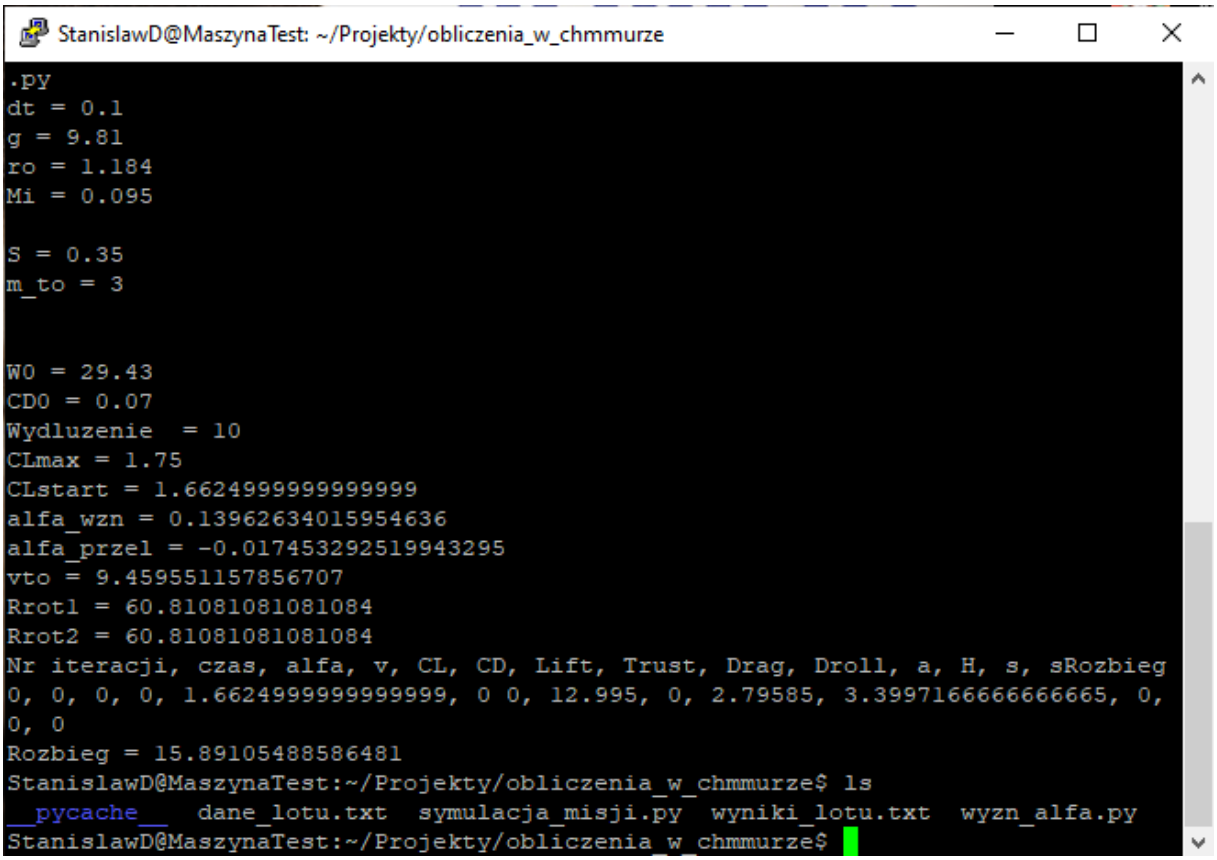
- Run-up
- Altitude at the time t=60 s.
- Distance traveled in the last 120 s of the simulation

3.2. Code implementation in the virtual machine

After cloning the repository to the virtual machine, it was possible to use the files contained in the repository.

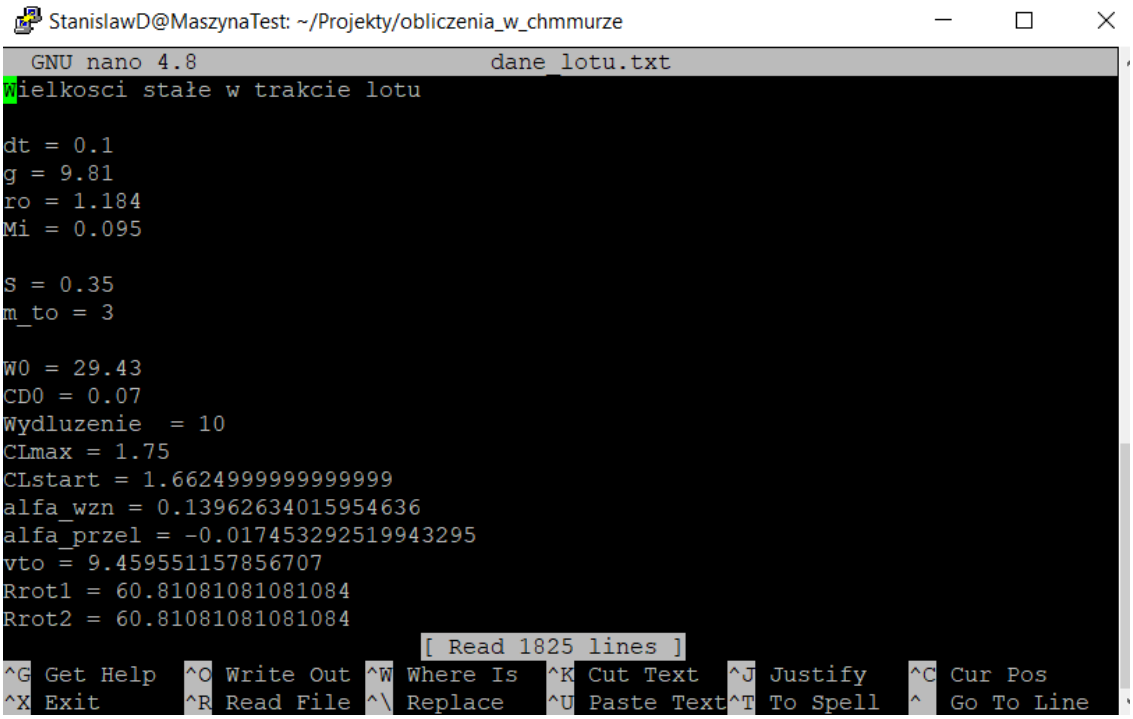


Code was runned in python3 program. After that text fiels dane_lotu.txt i wyniki_lotu.txt appeared.



3.3. Calculation results

All necessary information is stored in the dane_lotu.txt and wyniki_lotu.txt. On their basis, the future analysis of the simulation can be performed.



StanislawD@MaszynaTest: ~/Projekty/obliczenia_w_chmmurze

```
  GNU nano 4.8                        dane_lotu.txt

Symulacja misji
Nr iteracji, czas, alfa, v, CL, CD, Lift, Trust, Drag, Droll, a, H, s, sRozbieg
0, 0, 0, 0, 1.6624999999999999, 0, 0, 12.995, 0, 2.79585, 3.3997166666666665, 0
1, 0.1, 0, 0.33997166666666667, 1.6624999999999999, 0.17997233548252095, 0.0398
2, 0.2, 0, 0.6786161754474241, 1.6624999999999999, 0.17997233548252095, 0.15863
3, 0.30000000000000004, 0, 1.0158347902165474, 1.6624999999999999, 0.1799723354
4, 0.4, 0, 1.3515304551935525, 1.6624999999999999, 0.17997233548252095, 0.62922
5, 0.5, 0, 1.6856079017646006, 1.6624999999999999, 0.17997233548252095, 0.97873
6, 0.6, 0, 2.0179737508847575, 1.6624999999999999, 0.17997233548252095, 1.40275
7, 0.7, 0, 2.348536610844067, 1.6624999999999999, 0.17997233548252095, 1.899967
8, 0.7999999999999999, 0, 2.677207170199652, 1.6624999999999999, 0.179972335482
9, 0.8999999999999999, 0, 3.003898285695893, 1.6624999999999999, 0.179972335482
10, 0.9999999999999999, 0, 3.328525065015031, 1.6624999999999999, 0.17997233548
11, 1.0999999999999999, 0, 3.651004944221172, 1.6624999999999999, 0.17997233548
12, 1.2, 0, 3.9712577597815253, 1.6624999999999999, 0.17997233548252095, 5.4325
13, 1.3, 0, 4.289205815069651, 1.6624999999999999, 0.17997233548252095, 6.33731
14, 1.4000000000000001, 0, 4.6047739412764015, 1.6624999999999999, 0.1799723354
15, 1.5000000000000002, 0, 4.917889552675043, 1.6624999999999999, 0.17997233548
16, 1.6000000000000003, 0, 5.228482696207552, 1.6624999999999999, 0.17997233548
17, 1.7000000000000004, 0, 5.536486095379266, 1.6624999999999999, 0.17997233548
18, 1.8000000000000005, 0, 5.841835188468794, 1.6624999999999999, 0.17997233548
19, 1.9000000000000006, 0, 6.144468161079222, 1.6624999999999999, 0.17997233548

^G Get Help  ^O Write Out ^W Where Is  ^K Cut Text  ^J Justify   ^C Cur Pos
^X Exit      ^R Read File ^\ Replace   ^U Paste Text^T To Spell  ^_ Go To Line
```

StanislawD@MaszynaTest: ~/Projekty/obliczenia_w_chmmurze

```
  GNU nano 4.8                        wyniki_lotu.txt
Rozbieg = 15.89105488586481 m
Pulap w chwili t=60s = 100.18987549590788 m
Przebyty dystans = 2506.9725182041293 m

                          [ Read 3 lines ]
^G Get Help  ^O Write Out ^W Where Is  ^K Cut Text  ^J Justify   ^C Cur Pos
^X Exit      ^R Read File ^\ Replace   ^U Paste Text^T To Spell  ^_ Go To Line
```

4. Summary

By using virtual machines from the Microsoft Azure platform, it is possible to perform much more complex flight simulations. Thanks to this tool, it is possible to perform complex engineering calculations without having very expensive equipment that would enable to perform these tasks on the spot.