Computational Management Science 1
Final

registration number: ....

(Do not write your name on the test - just the 7 digit student id number.)

1. (6 points) Writing Code

   (a) (3 points, ≤5 minutes) Functions

   Write a function `sumproduct(first_iterable, second_iterable)` in Python that takes a two sequences of numbers with equal length and returns the sum of the product of the numbers. [e.g. `sumproduct((1, 3, 4), (9, 2, 3))` ⇒ 27; `sumproduct([3, 5], [2, 4])` ⇒ 26]. Add a proper docstring to receive full points.

   (b) (3 points, ≤5 minutes) Classes and Data Structures

   Implement a simple data structure in Python. The data structure must be capable of storing a node of a binary tree (i.e. a data field and a link to each child). Write a **minimalistic** class. You don't need to implement any functionality, just a class that stores the required data. Don't forget to write docstrings in order to receive full points.

2. (6 points, ≤10 minutes) Correct Mistakes
   The following code contains 6 syntax errors/ typos. Clearly mark and correct the mistakes.
   (*hint: you don't need to understand what the function does to correct the mistakes as there are no
   logical errors; assume that all required classes are available → just look for syntax errors*)

```
def __objective_function(index, p: Problem, milp**,
                         x_ns, y_sm, **kwargs)
    """"The objective function."
    milp ++= (lpSum(x_ns[n][] * s.unit_costs[n]
                    for n in p.fulfillment_centers
                    for s in p.sortation_centers) +
              lpSum(y_sm[s][m] * s.shipping_costs[m]
                    for s in p.sortation_centers
                    for m element p.customers),
              '({}) objective function'.format(index))
```

3. (6 points, ≤10 minutes) Scripting vs. compiled languages
   Name (in total) three advantages and/or disadvantages of scripting languages vs. compiled
   programming languages (3p). Give at least one example for each of them (1p).
   Also, name one thing you like about this course and one thing that should be improved in
   the future (be honest!) (2p).

4. (12 points) Reading and Understanding Code

What do the following code snippets print to stdout? Write exactly what the output of each snippet is if **the snippet is the only content of a Python file**. If the output is an error message, it is enough to write "ERROR". If there is no output, write "None"

(a) Simple calculation

```python
print(3 ** 2 * 2 ** 3)
```

(b) Loop

```python
prices = (4.2, 5.8, 2.9)
total = 0.0
for price in prices:
    total += price
print(prices)
```

(c) Functions

```python
def calc_squares(iterable):
    print('calculating squares')
    return [x ** 2 for x in iterable]
calc_squares(range(3))
```

(d) Geometry

```python
l = [5, 3, 2]
print(math.hypot(l[0], l[1]))
```

(e) Lists

```python
l1 = [5, 3]
l2 = [3, 5]
l1.extend(l2)
print(sum(l1))
```

(f) Sorting

```python
l = [2, 4, 3]
print(l.sort())
```

5. (5 points, ≤5 minutes) Assignment

   (a) (3 points)
       Briefly explain the difference between copy assignment and reference assignment.

   (b) (1 points)
       How can you convince C++ to use call by value?

   (c) (1 points)
       How can you convince C++ to use call by reference?

6. (6 points, ≤5 minutes) Reading and Writing Files
   Write a Python function `read_json(filename: str) => str` that takes a filename string
   pointing to an existing, readable json file. The function should read the contents of the file
   and return the contents as Python dictionary. Write a second function `write_json(filename:
   str, data: dict) => None`. This function takes a filename string and a Python dictio-
   nary that can be automatically converted to json. The function should save the passed data
   in a json file with the given name. It does not return anything. Don't forget to document
   the functions in order to receive full points.

7. (7 points) Tools

   (a) (3 points)
       What is git and what can it do for you? Name some of the key features. Give examples
       of file types that work well with git and examples of file types that are not ideal.

   (b) (3 points)
       Name the three types of UI and give a pro and a contra for each approach.

   (c) (1 points)
       If you want to use Python to solve a mixed integer linear program, what else do you
       need?