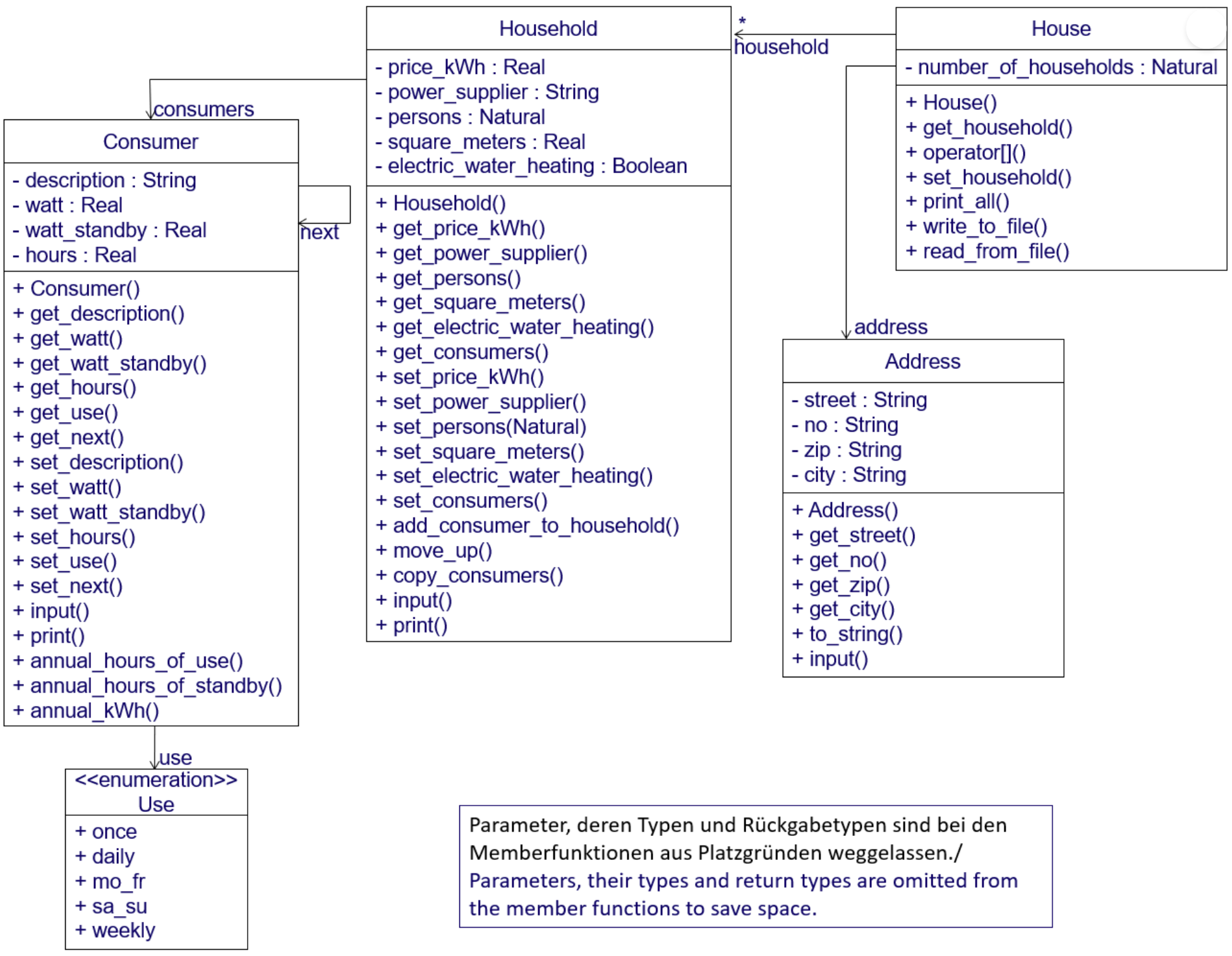
Praktikum Objektorientierte Programmierung in C++ (WS 2023/2024)

A5 Teil 1/Part 1

Nachdem in der Vorlesung Klassen eingeführt sind, soll der C++-Kode aus Aufgabe A4 Teil 1+2 nun mit Objekten und Nachrichten an Objekte statt prozeduraler Funktionsaufrufe umgeändert werden. Damit werden dann Daten und Funktionen in den Klassen zusammengefasst, und es gibt kleinere Änderungen und Ergänzungen wie unten dann beschrieben.
Das nachfolgende UML-Diagramm zeigt die zu implementierenden Klassen mit einer Klasse Haus (**`House`**), die eine bestimmte Anzahl an Haushalten (**`Household`**) über ein Feld von Zeigern auf diese speichert, und einer Liste von Verbrauchern (**`Consumer`**) in jedem Haushalt./
Now that classes have been introduced in the lecture, the C++ code from task A4 part 1+2 is to be modified with objects and messages to objects instead of procedural function calls. Therefore data and functions are combined in the classes, and there are smaller changes and additions as described below.
The following UML diagram shows the classes to be implemented with a class **`House`** storing a certain number of **`Households`** using an array of pointers to them and a list of **`Consumer`**s in each household.



Aufzählung/Enumeration `Use`

Die Aufzählung **`Use`** und zugehörige Funktionen und Operatoren bleiben unverändert./
The enumeration **`Use`** and associated functions and operators remain unchanged.

Klasse/Class `Consumer`

Die Struktur **`consumer`** wird neu als Klasse **`Consumer`** für Strom-Verbraucher modelliert.
Die bisherigen Komponenten der Struktur werden zu als privat definierten Attributen.
Neben einem Standard-Konstruktor, der nur das Zeiger-Attribut **`next`** auf einen Nullzeiger initialisieren soll, sollen für alle Attribute jeweils eine öffentliche getter- und eine setter-Methode definiert werden.
Die bisherigen Funktionen zur Berechnung der jährlichen Stunden der Nutzung, der jährlichen Stunden Standby-Betrieb, der jährlich insgesamt verbrauchten Kilowattstunden, der Eingabe der Verbraucher-Daten vom Standard-Zeichen-Eingabestrom und deren Ausgabe auf den Standard-Zeichen-Ausgabestrom einschließlich Ausgabe des Wertes von **`this`** sollen zu öffentlichen Member-Funktionen **`annual_hours_of_use`**, **`annual_hours_of_standby`**, **`annual_kWh`**, **`input`** und **`print`** werden.
Definieren Sie keine befreundeten Funktionen oder Klassen!/
The structure **`consumer`** is now modeled as a class **`Consumer`** for power consumers.
The previous components of the structure become attributes defined as private.
In addition to a standard constructor, which should only initialise the pointer attribute **`next`** to a null pointer, a public getter and a setter method should be defined for all attributes.
The previous functions for calculating the annual hours of use, the annual hours of standby, the total annual kilowatt hours consumed, the input of consumer data from the standard character input stream and their output to the standard character output stream including output of the value of **`this`** should become public member functions **`annual_hours_of_use`**, **`annual_hours_of_standby`**, **`annual_kWh`**, **`input`** and **`print`**.
Do not define any **`friend`** functions or classes!

Klasse/Class `Household`

Die Struktur **`household`** wird neu als Klasse **`Household`** für einen Haushalt modelliert.
Die bisherigen Komponenten der Struktur werden zu als privat definierten Attributen; die Komponente/das Attribut **`city`** soll gleichzeitig gelöscht werden, da diese für alle Haushalte gleich ist und redundand.
Neben einem Standard-Konstruktor, der nur das Zeiger-Attribut **`consumers`** auf einen Nullzeiger initialisieren soll, sollen für alle Attribute jeweils eine öffentliche getter- und eine setter-Methode definiert werden.
Die bisherigen Funktionen einen Verbraucher zu einem Haushalt hinzuzufügen, Verbraucher von einem Haushalt in einen anderen hinzu zu kopieren, einen Verbraucher in der Liste der Verbraucher eine Position nach oben zu verschieben, die Eingabe der Daten eines Haushalts vom Standard-Zeichen-Eingabestrom und die Ausgabe aller Daten einschließlich der Ausgabe des Wertes von **`this`** auf den Standard-Zeichen-Ausgabestrom sollen zu öffentlichen Member-Funktionen **`add_consumer_to_household`**, **`copy_consumers`**, **`move_up`**, **`input`** und **`print`** werden.
Definieren Sie keine befreundeten Funktionen oder Klassen!/
The structure **`household`** is now modelled as class **`Household`** for a household.
The previous components of the structure become attributes defined as private; the component/attribute **`city`** is to be deleted at the same time, as it is the same for all households and redundant.
In addition to a standard constructor, which should only initialise the pointer attribute **`consumers`** to a null pointer, and a public getter and a setter method should be defined for all attributes.
The previous functions to add a consumer to a household, to copy consumers from one household to another, to move a consumer up one position in the list of consumers, to input the data of a household from the standard character input stream and to output all data including the output of the value of **`this`** to the standard character output stream should become public member functions **`add_consumer_to_household`**, **`copy_consumers`**, **`move_up`**, **`input`** and **`print`**.
Do not define any **`friend`** functions or classes!

Klasse/Class `Address`

Statt einer Komponente/eines Attributs **`city`** in jedem Haushalt und für ein Haus mit diesen Haushalten soll nur einmal die komplette Adresse eines Hauses gespeichert werden. Hierzu soll die Klasse **`Address`** mit vier privaten Attributen namens **`street`**, **`no`**, **`zip`** und **`city`**, alle vom Typ C++-Zeichenkette, definiert werden.
Definieren Sie einen öffentlichen überladenen Konstruktor mit vier Parametern zur Initialisierung der vier Attribute, die alle vier als Defaultwert die leere Zeichenkette `""` haben sollen.
Weiterhin sollen öffentliche getter-Methoden für die vier Attribute definiert werden, eine Methode **`input`** zur Eingabe der vier Attribute vom Standard-Zeichen-Eingabestrom sowie eine Methode namens **`to_string`**, die die Adresse als eine einzige Zeichenkette in der Form Straße Hausnummer, Postleitzahl Ort zurück gibt (siehe Beispiele unten).
Definieren Sie keine befreundeten Funktionen oder Klassen!/
Instead of a component/attribute **`city`** in each household and for the house with these households, the complete address of a house should be stored once. The class **`Address`** with four private attributes named **`street`**, **`no`**, **`zip`** and **`city`**, all of type C++ **`string`**, shall be defined.
Define a public overloaded constructor with four parameters to initialise the four attributes, all four should have the empty character string `""` as their default value.
Furthermore, define public getter methods for the four attributes, an input method to input the four attributes from the standard character input stream, and a method named **`to_string`** that returns the address as a single string in the form street house number, postcode city (see examples below).
Do not define any **`friend`** functions or classes!

Klasse/Class `House`

Die Klasse House hat ein ganzzahliges Attribut **number_of_households** für die Anzahl der Haushalte, ein Zeiger-auf-Zeiger-Attribut **household** auf die Haushalte in diesem Haus (definiert als **Household **household;**) und die Adresse als Attribut **address** vom obigen Typ **Address**.
Definieren Sie einen öffentlichen Konstruktor mit einer ganzen Zahl als ersten und einem Objekt vom Typ **Address** als zweiten Parameter. Allokieren Sie im Rumpf der Funktion ein Feld von **number_of_households** Zeigern (via **household = new Household* [number_of_households];**) und initialisieren alle Zeiger als Nullzeiger.
Definieren Sie eine öffentliche Methode **get_household** mit einer ganzen Zahl **n** als Parameter, die im Rumpf einen Zeiger auf den **n**-ten Haushalt zurück liefert. Definieren Sie einen öffentlichen überladenen unären Operator **[]** mit genau gleicher Funktionalität als Alternative dazu.
Definieren Sie eine öffentliche Methode **set_household** mit einem Zeiger auf einen Haushalt und einer ganzen Zahl **n** als Parameter, die im Rumpf den Haushalt als **n**-ten Haushalt speichert.
Definieren Sie weiterhin die Funktionen zur Ausgabe aller Haushalte in einem Haus einschließlich Ausgabe des Wertes von **this** auf den Standard-Zeichen-Ausgabestrom, das Schreiben aller Daten für ein Haus in eine Datei und das Lesen einer solchen Datei als öffentliche Member-Funktionen **print_all**, **write_to_file** und **read_from_file**.
Ändern Sie beim Schreiben und Lesen der Dateien in der ersten Zeile einer Datei die Kennung von **A4** auf **A5** sowie statt nur der Stadt die komplette Adresse des Hauses.
Erzeugen Sie beim Lesen einer Datei ein neues Objekt vom Typ **House** auf dem Heap (unabhängig vom bestehenden Haus kann das so neu erzeugte Haus eine andere Anzahl an Haushalten haben) und geben einen Zeiger auf dieses am Ende des Einlesens als Funktionswert zurück, im Fehlerfall einen Zeiger auf das vorhandene Objekt.
Löschen Sie bei allen einzelnen Haushalten in den weiteren Zeilen der Datei das Schreiben bzw. das Einlesen der Stadt (siehe separate Datei-Beispiele im Moodle-Kurs dazu).
Definieren Sie keine befreundeten Funktionen oder Klassen!/
The class **House** has an integer attribute **number_of_households** for the number of households, a pointer-to-pointer attribute **household** for the households in this house (defined as **Household **household;**) and the attribute **address** of type **Address** above.
Define a public constructor with an integer as first parameter and an object of type **Address** as second parameter. Allocate an array of **number_of_households** pointers in the body of the function (via **household = new Household*[number_of_households];**) and initialise all pointers as null pointers.
Define a public method **get_household** with an integer **n** as a parameter, which returns a pointer to the **n**-th household in the body.
Define a public overloaded unary **operator[]** with exactly the same functionality as an alternative.
Define a public method **set_household** with a pointer to a household and an integer **n** as a parameter, which saves the household as the **n**-th household in the body.
Further define the functions for outputting all households in a house including outputting the value of **this** to the standard character output stream, writing all data for a house to a file and reading such a file as public member functions **print_all**, **write_to_file** and **read_from_file**.
When writing and reading the files, change the identifier in the first line of a file from **A4** to **A5** and the complete address of the house instead of just the city.
When reading a file, create a new object of type **House** on the heap (regardless of the existing house, the newly created house can have a different number of households) and return a pointer to it at the end of reading, or a pointer to the existing object in the event of an error.
Delete the writing or reading of the city for all individual households in the other lines of the file (see separate file examples in the Moodle course).
Do not define any **friend** functions or classes!

Funktion/Function `main`

Ändern Sie die Funktion so ab, dass Sie einen Zeiger namens **house** vom Typ **House** definieren initialisiert als Nullzeiger und löschen das bisherige Feld von Zeigern auf Haushalte als lokale Variable.
Fügen Sie einen weiteren Menüpunkt **h house initialisation** hinzu, bei dem nach Eingabe der Anzahl der Haushalte in einem Haus und dessen Adresse ein neues Objekt vom Typ **House** auf dem Heap erzeugt wird über einen Konstruktoraufruf.
Die Funktionalitäten für alle Menüpunkte müssen auf Nachrichten an das Objekt vom Typ **House** geändert werden./
Modify the function so that you define a pointer named **house** of type **House** initialised as a null pointer and delete the previous array of pointers to households as local variable.
Add a further menu item **h house initialisation**, where after entering the number of households in a house and its address, a new object of type **House** is created on the heap calling the constructor.
The functionalities of all menu items need to be changed to messages to the object of type **House**.

Hinweise/Notices

Bei den Änderungen im Kode von **main** müssen Sie bei den einzelnen Menüpunkten jeweils entsprechende Nachrichten an das Objekt schicken, auf das der Zeiger **house** zeigt.
Da alle Attribute mit Sichtbarkeit privat definiert sind, müssen Sie mit getter- und setter-Nachrichten statt direkten Zugriffen auf die Attribute arbeiten, bspw. beim Lesen und Schreiben von Daten aus bzw. in Dateien - es sollen wie oben geschrieben keine **friend**-Funktionen oder **friend**-Klassen verwendet werden.
Beachten Sie bei den Parametern der Member-Funktionen, dass ein Parameter entfällt, falls dieser das Objekt ist, an das dieNachricht

gesendet wird./
When making changes to the code of **`main`**, you must send corresponding messages to the object to which pointer **`house`** points for the individual menu items.
As all attributes are defined with visibility privately, you must work with getter and setter messages instead of direct access to the attributes, e.g. when reading and writing data from or to files - as described above, no **`friend`** functions or **`friend`** classes should be used.
Note for the parameters of the member functions that one parameter gets omitted, if it is the object the message is sent to.

Beispiel Programmlauf 1/Example Program Run 1

```
CALCULATION OF AVERAGE POWER COSTS FOR A HOUSE - CLASS VERSION
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> a
house is a nullptr, please first choose h to initialise a new house
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> h
how many households does the house have? 6
what is the street name? Lotharstraße
what is house number? 65d
what is zip code? 47057
what is the city name? Duisburg Neudorf
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> a
========================================================================
                              H O U S E
========================================================================
                            (this: 0x1d1a00)
                          address: Lotharstraße 65d, 47057 Duisburg Neudorf
              number of households: 6
========================================================================
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> n
number of household? 2
how many square metres does the household have? 200
how many persons live in this household? 5
is hot water heated using electricity? (y(es) or n(o)) y
what is the price for one kWh in EUR? 0.3
who is the power supplier? Yello Strom
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> a
```

```
==========================================================================
                              H O U S E
==========================================================================
                            (this: 0x1d1a00)
                           address: Lotharstraße 65d, 47057 Duisburg Neudorf
              number of households: 6
H O U S E H O L D   N O   2   P O W E R   C O N S U M P T I O N
--------------------------------------------------------------------------
                            (this: 0x1d17a0)
                 price for one kWh: 30.00 ct/kWh
                    power supplier: Yello Strom
                     square metres: 200.00 qm
                           persons: 5
     water heated using electricity: yes
                 list of consumers
--------------------------------------------------------------------------
--------------------------------------------------------------------------
    power consumption square meters: 1800.0 kWh
      power consumption all persons: 2750.0 kWh
     total annual power consumption: 4550.0 kWh
           total annual power costs: 1365.00 EUR
==========================================================================
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> i
number of household? 2
what is the description of the power consumer? Washing Machine
how many watt it will have? 2000
how many watt standby it will have? 0
how often it will be used?
daily  (d)
mo_fr  (m)
once   (o)
sa_su  (s)
weekly (w)? w
how many hours it will be operating then? 2
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> i
number of household? 2
what is the description of the power consumer? Office PC
how many watt it will have? 200
how many watt standby it will have? 0.5
how often it will be used?
daily  (d)
mo_fr  (m)
once   (o)
sa_su  (s)
weekly (w)? m
how many hours it will be operating then? 8.5
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
```

```
>> a
========================================================================
                              H O U S E
========================================================================
                            (this: 0x1d1a00)
                           address: Lotharstraße 65d, 47057 Duisburg Neudorf
              number of households: 6
H O U S E H O L D   N O   2   P O W E R   C O N S U M P T I O N
------------------------------------------------------------------------
                            (this: 0x1d17a0)
                 price for one kWh: 30.00 ct/kWh
                    power supplier: Yello Strom
                     square metres: 200.00 qm
                           persons: 5
     water heated using electricity: yes
                 list of consumers
------------------------------------------------------------------------
                               1: Office PC
                            (this: 0x1d5d40)
                 power consumption: 200.00 W
          power consumption standby: 0.50 W
                annual hours of use: 2210.00 h
             annual hours of standby: 6550.00 h
                  annual consumption: 445.3 kWh
                        annual costs: 133.58 EUR
                               2: Washing Machine
                            (this: 0x1d5cf0)
                  power consumption: 2000.00 W
          power consumption standby: 0.00 W
                annual hours of use: 104.00 h
             annual hours of standby: 8656.00 h
                  annual consumption: 208.0 kWh
                        annual costs: 62.40 EUR
------------------------------------------------------------------------
    power consumption square meters: 1800.0 kWh
      power consumption all persons: 2750.0 kWh
     total annual power consumption: 5203.3 kWh
           total annual power costs: 1560.98 EUR
========================================================================
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> i
number of household? 2
what is the description of the power consumer? Router
how many watt it will have? 10
how many watt standby it will have? 0
how often it will be used?
daily  (d)
mo_fr  (m)
once   (o)
sa_su  (s)
weekly (w)? d
how many hours it will be operating then? 24
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> a
========================================================================
                              H O U S E
========================================================================
                            (this: 0x1d1a00)
```

```
                          address: Lotharstraße 65d, 47057 Duisburg Neudorf
              number of households: 6
H O U S E H O L D   N O   2   P O W E R   C O N S U M P T I O N
------------------------------------------------------------------------
                             (this: 0x1d17a0)
                 price for one kWh: 30.00 ct/kWh
                    power supplier: Yello Strom
                     square metres: 200.00 qm
                           persons: 5
     water heated using electricity: yes
                 list of consumers
------------------------------------------------------------------------
                                1: Router
                             (this: 0x1d6070)
                  power consumption: 10.00 W
           power consumption standby: 0.00 W
                 annual hours of use: 8760.00 h
             annual hours of standby: 0.00 h
                  annual consumption: 87.6 kWh
                        annual costs: 26.28 EUR
                                2: Office PC
                             (this: 0x1d5d40)
                  power consumption: 200.00 W
           power consumption standby: 0.50 W
                 annual hours of use: 2210.00 h
             annual hours of standby: 6550.00 h
                  annual consumption: 445.3 kWh
                        annual costs: 133.58 EUR
                                   3: Washing Machine
                              (this: 0x1d5cf0)
                   power consumption: 2000.00 W
           power consumption standby: 0.00 W
                 annual hours of use: 104.00 h
             annual hours of standby: 8656.00 h
                  annual consumption: 208.0 kWh
                        annual costs: 62.40 EUR
------------------------------------------------------------------------
     power consumption square meters: 1800.0 kWh
       power consumption all persons: 2750.0 kWh
      total annual power consumption: 5290.9 kWh
            total annual power costs: 1587.26 EUR
========================================================================
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> n
number of household? 3
how many square metres does the household have? 100
how many persons live in this household? 2
is hot water heated using electricity? (y(es) or n(o)) n
what is the price for one kWh in EUR? 0.4
who is the power supplier? Stadtwerke
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> c
number of household from which to copy consumers? 3
number of household to copy to? 4
q quit
h house initialisation
i input power consumer
u move up power consumer
```

```
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> a
========================================================================
                              H O U S E
========================================================================
                            (this: 0x1d1a00)
                           address: Lotharstraße 65d, 47057 Duisburg Neudorf
              number of households: 6
H O U S E H O L D   N O   2   P O W E R   C O N S U M P T I O N
------------------------------------------------------------------------
                            (this: 0x1d17a0)
                price for one kWh: 30.00 ct/kWh
                   power supplier: Yello Strom
                    square metres: 200.00 qm
                          persons: 5
    water heated using electricity: yes
                list of consumers
------------------------------------------------------------------------
                               1: Router
                            (this: 0x1d6070)
                power consumption: 10.00 W
        power consumption standby: 0.00 W
              annual hours of use: 8760.00 h
          annual hours of standby: 0.00 h
               annual consumption: 87.6 kWh
                     annual costs: 26.28 EUR
                               2: Office PC
                            (this: 0x1d5d40)
                power consumption: 200.00 W
        power consumption standby: 0.50 W
              annual hours of use: 2210.00 h
          annual hours of standby: 6550.00 h
               annual consumption: 445.3 kWh
                     annual costs: 133.58 EUR
                               3: Washing Machine
                            (this: 0x1d5cf0)
                power consumption: 2000.00 W
        power consumption standby: 0.00 W
              annual hours of use: 104.00 h
          annual hours of standby: 8656.00 h
               annual consumption: 208.0 kWh
                     annual costs: 62.40 EUR
------------------------------------------------------------------------
   power consumption square meters: 1800.0 kWh
     power consumption all persons: 2750.0 kWh
    total annual power consumption: 5290.9 kWh
          total annual power costs: 1587.26 EUR
H O U S E H O L D   N O   3   P O W E R   C O N S U M P T I O N
------------------------------------------------------------------------
                            (this: 0x1d6bc0)
                price for one kWh: 40.00 ct/kWh
                   power supplier: Stadtwerke
                    square metres: 100.00 qm
                          persons: 2
    water heated using electricity: no
                list of consumers
------------------------------------------------------------------------
------------------------------------------------------------------------
   power consumption square meters: 900.0 kWh
     power consumption all persons: 400.0 kWh
    total annual power consumption: 1300.0 kWh
          total annual power costs: 520.00 EUR
========================================================================
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
```

```
r read data from file
w write data into file
>> i
number of household? 3
what is the description of the power consumer? LED TV
how many watt it will have? 70
how many watt standby it will have? 0.5
how often it will be used?
daily  (d)
mo_fr  (m)
once   (o)
sa_su  (s)
weekly (w)? s
how many hours it will be operating then? 2
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> i
number of household? 3
what is the description of the power consumer? Dish Washer
how many watt it will have? 250
how many watt standby it will have? 0
how often it will be used?
daily  (d)
mo_fr  (m)
once   (o)
sa_su  (s)
weekly (w)? d
how many hours it will be operating then? 3.5
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> a
========================================================================
                              H O U S E
========================================================================
                            (this: 0x1d1a00)
                         address: Lotharstraße 65d, 47057 Duisburg Neudorf
                number of households: 6
H O U S E H O L D   N O   2   P O W E R   C O N S U M P T I O N
------------------------------------------------------------------------
                            (this: 0x1d17a0)
                  price for one kWh: 30.00 ct/kWh
                     power supplier: Yello Strom
                      square metres: 200.00 qm
                            persons: 5
     water heated using electricity: yes
                  list of consumers
------------------------------------------------------------------------
                               1: Router
                            (this: 0x1d6070)
                  power consumption: 10.00 W
           power consumption standby: 0.00 W
                 annual hours of use: 8760.00 h
             annual hours of standby: 0.00 h
                  annual consumption: 87.6 kWh
                        annual costs: 26.28 EUR
                               2: Office PC
                            (this: 0x1d5d40)
                  power consumption: 200.00 W
           power consumption standby: 0.50 W
                 annual hours of use: 2210.00 h
```

```
            annual hours of standby: 6550.00 h
                 annual consumption: 445.3 kWh
                       annual costs: 133.58 EUR
                                  3: Washing Machine
                             (this: 0x1d5cf0)
                   power consumption: 2000.00 W
           power consumption standby: 0.00 W
                 annual hours of use: 104.00 h
            annual hours of standby: 8656.00 h
                 annual consumption: 208.0 kWh
                       annual costs: 62.40 EUR
-------------------------------------------------------------------
    power consumption square meters: 1800.0 kWh
      power consumption all persons: 2750.0 kWh
     total annual power consumption: 5290.9 kWh
           total annual power costs: 1587.26 EUR
H O U S E H O L D   N O   3   P O W E R   C O N S U M P T I O N
-------------------------------------------------------------------
                             (this: 0x1d6bc0)
                 price for one kWh: 40.00 ct/kWh
                    power supplier: Stadtwerke
                     square metres: 100.00 qm
                           persons: 2
    water heated using electricity: no
                 list of consumers
-------------------------------------------------------------------
                                1: Dish Washer
                             (this: 0x1d5f50)
                   power consumption: 250.00 W
           power consumption standby: 0.00 W
                 annual hours of use: 1277.50 h
            annual hours of standby: 7482.50 h
                 annual consumption: 319.4 kWh
                       annual costs: 127.75 EUR
                                  2: LED TV
                             (this: 0x1d5f00)
                   power consumption: 70.00 W
           power consumption standby: 0.50 W
                 annual hours of use: 208.00 h
            annual hours of standby: 8552.00 h
                 annual consumption: 18.8 kWh
                       annual costs: 7.53 EUR
-------------------------------------------------------------------
    power consumption square meters: 900.0 kWh
      power consumption all persons: 400.0 kWh
     total annual power consumption: 1638.2 kWh
           total annual power costs: 655.28 EUR
===================================================================
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> w
input file name: h1.csv
input separator character: ;
output file "h1.csv" opened...
output file "h1.csv" closed
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> q
```

Beispiel Programmlauf 2/Example Program Run 2

```
CALCULATION OF AVERAGE POWER COSTS FOR A HOUSE - CLASS VERSION
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> h
how many households does the house have? 1
what is the street name? Test Street
what is house number? 2a
what is zip code? 54321
what is the city name? Test City
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> a
=============================================================================
                               H O U S E
=============================================================================
                            (this: 0x6e1a00)
                          address: Test Street 2a, 54321 Test City
              number of households: 1
=============================================================================
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> r
input file name: h1.csv
input separator character: ;
input file "h1.csv" opened...
input file "h1.csv" closed
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> a
=============================================================================
                               H O U S E
=============================================================================
                            (this: 0x6e5fa0)
                          address: Lotharstraße 65d, 47057 Duisburg Neudorf
              number of households: 6
H O U S E H O L D   N O   2   P O W E R   C O N S U M P T I O N
-----------------------------------------------------------------------------
                            (this: 0x6e60a0)
                price for one kWh: 30.00 ct/kWh
                   power supplier: Yello Strom
                    square metres: 200.00 qm
                          persons: 5
    water heated using electricity: yes
                list of consumers
```

```
--------------------------------------------------------------------
                                1: Router
                           (this: 0x6e60f0)
                  power consumption: 10.00 W
           power consumption standby: 0.00 W
                 annual hours of use: 8760.00 h
            annual hours of standby: 0.00 h
                 annual consumption: 87.6 kWh
                       annual costs: 26.28 EUR
                                2: Office PC
                           (this: 0x6e6140)
                  power consumption: 200.00 W
           power consumption standby: 0.50 W
                 annual hours of use: 2210.00 h
            annual hours of standby: 6550.00 h
                 annual consumption: 445.3 kWh
                       annual costs: 133.58 EUR
                                3: Washing Machine
                           (this: 0x6e61c0)
                  power consumption: 2000.00 W
           power consumption standby: 0.00 W
                 annual hours of use: 104.00 h
            annual hours of standby: 8656.00 h
                 annual consumption: 208.0 kWh
                       annual costs: 62.40 EUR
--------------------------------------------------------------------
    power consumption square meters: 1800.0 kWh
      power consumption all persons: 2750.0 kWh
     total annual power consumption: 5290.9 kWh
           total annual power costs: 1587.26 EUR
H O U S E H O L D   N O   3   P O W E R   C O N S U M P T I O N
--------------------------------------------------------------------
                           (this: 0x6e6210)
                price for one kWh: 40.00 ct/kWh
                   power supplier: Stadtwerke
                    square metres: 100.00 qm
                          persons: 2
    water heated using electricity: no
                list of consumers
--------------------------------------------------------------------
                                1: Dish Washer
                           (this: 0x6e6260)
                  power consumption: 250.00 W
           power consumption standby: 0.00 W
                 annual hours of use: 1277.50 h
            annual hours of standby: 7482.50 h
                 annual consumption: 319.4 kWh
                       annual costs: 127.75 EUR
                                2: LED TV
                           (this: 0x6e62b0)
                  power consumption: 70.00 W
           power consumption standby: 0.50 W
                 annual hours of use: 208.00 h
            annual hours of standby: 8552.00 h
                 annual consumption: 18.8 kWh
                       annual costs: 7.53 EUR
--------------------------------------------------------------------
    power consumption square meters: 900.0 kWh
      power consumption all persons: 400.0 kWh
     total annual power consumption: 1638.2 kWh
           total annual power costs: 655.28 EUR
====================================================================
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> n
number of household? 4
how many square metres does the household have? 50
how many persons live in this household? 3
```

```
is hot water heated using electricity? (y(es) or n(o)) y
what is the price for one kWh in EUR? 0.5
who is the power supplier? RWE
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> a
========================================================================
                              H O U S E
========================================================================
                            (this: 0x6e5fa0)
                          address: Lotharstraße 65d, 47057 Duisburg Neudorf
              number of households: 6
H O U S E H O L D   N O   2   P O W E R   C O N S U M P T I O N
------------------------------------------------------------------------
                            (this: 0x6e60a0)
                price for one kWh: 30.00 ct/kWh
                   power supplier: Yello Strom
                    square metres: 200.00 qm
                          persons: 5
    water heated using electricity: yes
                list of consumers
------------------------------------------------------------------------
                                1: Router
                              (this: 0x6e60f0)
                  power consumption: 10.00 W
          power consumption standby: 0.00 W
                annual hours of use: 8760.00 h
            annual hours of standby: 0.00 h
                 annual consumption: 87.6 kWh
                       annual costs: 26.28 EUR
                                2: Office PC
                              (this: 0x6e6140)
                  power consumption: 200.00 W
          power consumption standby: 0.50 W
                annual hours of use: 2210.00 h
            annual hours of standby: 6550.00 h
                 annual consumption: 445.3 kWh
                       annual costs: 133.58 EUR
                                3: Washing Machine
                              (this: 0x6e61c0)
                  power consumption: 2000.00 W
          power consumption standby: 0.00 W
                annual hours of use: 104.00 h
            annual hours of standby: 8656.00 h
                 annual consumption: 208.0 kWh
                       annual costs: 62.40 EUR
------------------------------------------------------------------------
    power consumption square meters: 1800.0 kWh
      power consumption all persons: 2750.0 kWh
     total annual power consumption: 5290.9 kWh
           total annual power costs: 1587.26 EUR
H O U S E H O L D   N O   3   P O W E R   C O N S U M P T I O N
------------------------------------------------------------------------
                              (this: 0x6e6210)
                price for one kWh: 40.00 ct/kWh
                   power supplier: Stadtwerke
                    square metres: 100.00 qm
                          persons: 2
    water heated using electricity: no
                list of consumers
------------------------------------------------------------------------
                                1: Dish Washer
                              (this: 0x6e6260)
                  power consumption: 250.00 W
          power consumption standby: 0.00 W
                annual hours of use: 1277.50 h
            annual hours of standby: 7482.50 h
                 annual consumption: 319.4 kWh
```

```
                      annual costs: 127.75 EUR
                                 2: LED TV
                             (this: 0x6e62b0)
                   power consumption: 70.00 W
           power consumption standby: 0.50 W
                 annual hours of use: 208.00 h
             annual hours of standby: 8552.00 h
                  annual consumption: 18.8 kWh
                       annual costs: 7.53 EUR
-----------------------------------------------------------------------
    power consumption square meters: 900.0 kWh
      power consumption all persons: 400.0 kWh
     total annual power consumption: 1638.2 kWh
           total annual power costs: 655.28 EUR
H O U S E H O L D   N O   4   P O W E R   C O N S U M P T I O N
-----------------------------------------------------------------------
                             (this: 0x6e5ce0)
                  price for one kWh: 50.00 ct/kWh
                     power supplier: RWE
                      square metres: 50.00 qm
                            persons: 3
    water heated using electricity: yes
                  list of consumers
-----------------------------------------------------------------------
-----------------------------------------------------------------------
    power consumption square meters: 450.0 kWh
      power consumption all persons: 1650.0 kWh
     total annual power consumption: 2100.0 kWh
           total annual power costs: 1050.00 EUR
=======================================================================
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> c
number of household from which to copy consumers? 2
number of household to copy to? 4
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> c
number of household from which to copy consumers? 3
number of household to copy to? 4
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> a
=======================================================================
                              H O U S E
=======================================================================
                            (this: 0x6e5fa0)
                          address: Lotharstraße 65d, 47057 Duisburg Neudorf
              number of households: 6
H O U S E H O L D   N O   2   P O W E R   C O N S U M P T I O N
-----------------------------------------------------------------------
                            (this: 0x6e60a0)
```

```
                 price for one kWh: 30.00 ct/kWh
                    power supplier: Yello Strom
                     square metres: 200.00 qm
                           persons: 5
    water heated using electricity: yes
                 list of consumers
-----------------------------------------------------------------------
                               1: Router
                           (this: 0x6e60f0)
                 power consumption: 10.00 W
          power consumption standby: 0.00 W
                annual hours of use: 8760.00 h
              annual hours of standby: 0.00 h
                   annual consumption: 87.6 kWh
                         annual costs: 26.28 EUR
                               2: Office PC
                           (this: 0x6e6140)
                 power consumption: 200.00 W
          power consumption standby: 0.50 W
                annual hours of use: 2210.00 h
              annual hours of standby: 6550.00 h
                   annual consumption: 445.3 kWh
                         annual costs: 133.58 EUR
                               3: Washing Machine
                           (this: 0x6e61c0)
                 power consumption: 2000.00 W
          power consumption standby: 0.00 W
                annual hours of use: 104.00 h
              annual hours of standby: 8656.00 h
                   annual consumption: 208.0 kWh
                         annual costs: 62.40 EUR
-----------------------------------------------------------------------
    power consumption square meters: 1800.0 kWh
      power consumption all persons: 2750.0 kWh
     total annual power consumption: 5290.9 kWh
           total annual power costs: 1587.26 EUR
H O U S E H O L D   N O   3   P O W E R   C O N S U M P T I O N
-----------------------------------------------------------------------
                           (this: 0x6e6210)
                 price for one kWh: 40.00 ct/kWh
                    power supplier: Stadtwerke
                     square metres: 100.00 qm
                           persons: 2
    water heated using electricity: no
                 list of consumers
-----------------------------------------------------------------------
                               1: Dish Washer
                           (this: 0x6e6260)
                 power consumption: 250.00 W
          power consumption standby: 0.00 W
                annual hours of use: 1277.50 h
              annual hours of standby: 7482.50 h
                   annual consumption: 319.4 kWh
                         annual costs: 127.75 EUR
                               2: LED TV
                           (this: 0x6e62b0)
                 power consumption: 70.00 W
          power consumption standby: 0.50 W
                annual hours of use: 208.00 h
              annual hours of standby: 8552.00 h
                   annual consumption: 18.8 kWh
                         annual costs: 7.53 EUR
-----------------------------------------------------------------------
    power consumption square meters: 900.0 kWh
      power consumption all persons: 400.0 kWh
     total annual power consumption: 1638.2 kWh
           total annual power costs: 655.28 EUR
H O U S E H O L D   N O   4   P O W E R   C O N S U M P T I O N
-----------------------------------------------------------------------
                           (this: 0x6e5ce0)
                 price for one kWh: 50.00 ct/kWh
                    power supplier: RWE
                     square metres: 50.00 qm
                           persons: 3
    water heated using electricity: yes
                 list of consumers
```

```
--------------------------------------------------------------------
                              1: Dish Washer
                           (this: 0x6e5e20)
                  power consumption: 250.00 W
          power consumption standby: 0.00 W
                annual hours of use: 1277.50 h
            annual hours of standby: 7482.50 h
                 annual consumption: 319.4 kWh
                       annual costs: 159.69 EUR
                              2: LED TV
                           (this: 0x6e5e70)
                  power consumption: 70.00 W
          power consumption standby: 0.50 W
                annual hours of use: 208.00 h
            annual hours of standby: 8552.00 h
                 annual consumption: 18.8 kWh
                       annual costs: 9.42 EUR
                              3: Router
                           (this: 0x6e5d30)
                  power consumption: 10.00 W
          power consumption standby: 0.00 W
                annual hours of use: 8760.00 h
            annual hours of standby: 0.00 h
                 annual consumption: 87.6 kWh
                       annual costs: 43.80 EUR
                              4: Office PC
                           (this: 0x6e5d80)
                  power consumption: 200.00 W
          power consumption standby: 0.50 W
                annual hours of use: 2210.00 h
            annual hours of standby: 6550.00 h
                 annual consumption: 445.3 kWh
                       annual costs: 222.64 EUR
                              5: Washing Machine
                           (this: 0x6e5dd0)
                  power consumption: 2000.00 W
          power consumption standby: 0.00 W
                annual hours of use: 104.00 h
            annual hours of standby: 8656.00 h
                 annual consumption: 208.0 kWh
                       annual costs: 104.00 EUR
--------------------------------------------------------------------
    power consumption square meters: 450.0 kWh
      power consumption all persons: 1650.0 kWh
     total annual power consumption: 3179.1 kWh
           total annual power costs: 1589.54 EUR
====================================================================
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> u
number of household? 4
which one? 5
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> u
number of household? 4
which one? 4
q quit
h house initialisation
i input power consumer
```

```
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> a
======================================================================
                              H O U S E
======================================================================
                           (this: 0x6e5fa0)
                        address: Lotharstraße 65d, 47057 Duisburg Neudorf
              number of households: 6
H O U S E H O L D   N O   2   P O W E R   C O N S U M P T I O N
----------------------------------------------------------------------
                           (this: 0x6e60a0)
                price for one kWh: 30.00 ct/kWh
                   power supplier: Yello Strom
                    square metres: 200.00 qm
                          persons: 5
    water heated using electricity: yes
                list of consumers
----------------------------------------------------------------------
                              1: Router
                           (this: 0x6e60f0)
                 power consumption: 10.00 W
        power consumption standby: 0.00 W
              annual hours of use: 8760.00 h
          annual hours of standby: 0.00 h
               annual consumption: 87.6 kWh
                     annual costs: 26.28 EUR
                              2: Office PC
                           (this: 0x6e6140)
                 power consumption: 200.00 W
        power consumption standby: 0.50 W
              annual hours of use: 2210.00 h
          annual hours of standby: 6550.00 h
               annual consumption: 445.3 kWh
                     annual costs: 133.58 EUR
                              3: Washing Machine
                           (this: 0x6e61c0)
                 power consumption: 2000.00 W
        power consumption standby: 0.00 W
              annual hours of use: 104.00 h
          annual hours of standby: 8656.00 h
               annual consumption: 208.0 kWh
                     annual costs: 62.40 EUR
----------------------------------------------------------------------
   power consumption square meters: 1800.0 kWh
     power consumption all persons: 2750.0 kWh
    total annual power consumption: 5290.9 kWh
          total annual power costs: 1587.26 EUR
H O U S E H O L D   N O   3   P O W E R   C O N S U M P T I O N
----------------------------------------------------------------------
                           (this: 0x6e6210)
                price for one kWh: 40.00 ct/kWh
                   power supplier: Stadtwerke
                    square metres: 100.00 qm
                          persons: 2
    water heated using electricity: no
                list of consumers
----------------------------------------------------------------------
                              1: Dish Washer
                           (this: 0x6e6260)
                 power consumption: 250.00 W
        power consumption standby: 0.00 W
              annual hours of use: 1277.50 h
          annual hours of standby: 7482.50 h
               annual consumption: 319.4 kWh
                     annual costs: 127.75 EUR
                              2: LED TV
                           (this: 0x6e62b0)
                 power consumption: 70.00 W
        power consumption standby: 0.50 W
              annual hours of use: 208.00 h
```

```
           annual hours of standby: 8552.00 h
                annual consumption: 18.8 kWh
                      annual costs: 7.53 EUR
-----------------------------------------------------------------------
    power consumption square meters: 900.0 kWh
      power consumption all persons: 400.0 kWh
     total annual power consumption: 1638.2 kWh
           total annual power costs: 655.28 EUR
H O U S E H O L D   N O   4   P O W E R   C O N S U M P T I O N
-----------------------------------------------------------------------
                             (this: 0x6e5ce0)
                 price for one kWh: 50.00 ct/kWh
                    power supplier: RWE
                     square metres: 50.00 qm
                           persons: 3
    water heated using electricity: yes
                 list of consumers
-----------------------------------------------------------------------
                                1: Dish Washer
                             (this: 0x6e5e20)
                 power consumption: 250.00 W
          power consumption standby: 0.00 W
                annual hours of use: 1277.50 h
           annual hours of standby: 7482.50 h
                annual consumption: 319.4 kWh
                      annual costs: 159.69 EUR
                                2: LED TV
                           (this: 0x6e5e70)
                 power consumption: 70.00 W
          power consumption standby: 0.50 W
                annual hours of use: 208.00 h
           annual hours of standby: 8552.00 h
                annual consumption: 18.8 kWh
                      annual costs: 9.42 EUR
                                3: Washing Machine
                           (this: 0x6e5dd0)
                 power consumption: 2000.00 W
          power consumption standby: 0.00 W
                annual hours of use: 104.00 h
           annual hours of standby: 8656.00 h
                annual consumption: 208.0 kWh
                      annual costs: 104.00 EUR
                                4: Router
                           (this: 0x6e5d30)
                 power consumption: 10.00 W
          power consumption standby: 0.00 W
                annual hours of use: 8760.00 h
           annual hours of standby: 0.00 h
                annual consumption: 87.6 kWh
                      annual costs: 43.80 EUR
                                5: Office PC
                           (this: 0x6e5d80)
                 power consumption: 200.00 W
          power consumption standby: 0.50 W
                annual hours of use: 2210.00 h
           annual hours of standby: 6550.00 h
                annual consumption: 445.3 kWh
                      annual costs: 222.64 EUR
-----------------------------------------------------------------------
    power consumption square meters: 450.0 kWh
      power consumption all persons: 1650.0 kWh
     total annual power consumption: 3179.1 kWh
           total annual power costs: 1589.54 EUR
=======================================================================
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> w
input file name: h2.csv
```

```
input separator character: #
output file "h2.csv" opened...
output file "h2.csv" closed
q quit
h house initialisation
i input power consumer
u move up power consumer
p print household
a print all households
n new household
c copy all consumers (added to already existing ones)
r read data from file
w write data into file
>> q
```

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◄ A4 Upload Teil 1/Part 1

Jump to...

h1.csv ►