# Exercises: Working with Abstraction

This document defines the **exercise assignments** for the ["CSharp OOP" course @ Software University](https://softuni.bg/opencourses/csharp-oop).

You can check your solutions here: [https://judge.softuni.bg/Contests/Working-with-Abstraction-Exercise](https://judge.softuni.bg/Contests/1496/Working-with-Abstraction-Exercise)

Your job is to download [source code](https://softuni.bg/downloads/svn/csharp-fundamentals/2018-Jan/CSharp-OOP-Basics/02.%20CSharp-OOP-Basics-Working-with-Abstraction/02.%20CSharp-OOP-Basics-Working-with-Abstraction-Exercises-Resources.zip) and **refactor** it.

## Raw Data

**You should refactor Pesho’s working code so that it isn’t using just one class.**

You are the owner of a courier company and want to make a system for tracking your cars and their cargo. Define a class **Car** that holds an information about **model, engine, cargo** and a **collection of exactly 4 tires**. The **engine**, **cargo** and **tire** shouldbe **separate classes**. Create a constructor that receives all of the information about the **Car** and creates and initializes its inner components (engine, cargo and tires).

On the first line of input you will receive a number **N** - the amount of cars you have. On each of the next **N** lines you will receive an information about a car in the format “**<Model> <EngineSpeed> <EnginePower> <CargoWeight> <CargoType> <Tire1Pressure> <Tire1Age> <Tire2Pressure> <Tire2Age> <Tire3Pressure> <Tire3Age> <Tire4Pressure> <Tire4Age>”** where the speed, power, weight and tire age are **integers**, tire pressure is a **double.**

After the **N** lines you will receive a single line with one of 2 commands: “**fragile**” or “**flamable**”. If the command is “**fragile**” print all cars whose **Cargo Type is “fragile”** with **a tire** whose **pressure is** **< 1**. If the command is “**flamable**” print all cars whose **Cargo Type is “flamable”** and have **Engine Power > 250**. The cars should be printed in order of appearing in the input.

### Examples

|  |  |
| --- | --- |
| **Input** | **Output** |
| 2  ChevroletAstro 200 180 1000 fragile 1.3 1 1.5 2 1.4 2 1.7 4  Citroen2CV 190 165 1200 fragile 0.9 3 0.85 2 0.95 2 1.1 1  fragile | Citroen2CV |
| 4  ChevroletExpress 215 255 1200 flamable 2.5 1 2.4 2 2.7 1 2.8 1  ChevroletAstro 210 230 1000 flamable 2 1 1.9 2 1.7 3 2.1 1  DaciaDokker 230 275 1400 flamable 2.2 1 2.3 1 2.4 1 2 1  Citroen2CV 190 165 1200 fragile 0.8 3 0.85 2 0.7 5 0.95 2  flamable | ChevroletExpress  DaciaDokker |

## Cars Salesman

**Here Pesho has done pretty well actually. Your job, however, is to show him how to reuse base constructors in his classes.**

Define two classes **Car** and **Engine.** A **Car** has a **model, engine, weight** and **color**. An Engine has a **model**, **power, displacement** and **efficiency**. A Car’s **weight** and **color** and its Engine’s **displacements** and **efficiency** are **optional**.

On the first line you will read a number **N,** which will specify how many lines of engines you will receive. On each of the next **N** lines you will receive an information about an **Engine** in the following format “<**Model> <Power> <Displacement> <Efficiency>**”. After the lines with engines, on the next line you will receive a number **M** – specifying the number of Cars that will follow. On each of the next **M** lines, an information about a **Car** will follow in the format “<**Model> <Engine> <Weight> <Color>**”, where the engine will be the **model of an existing** **Engine**. When creating the object for a **Car**, you should keep a **reference to the real engine** in it, instead of just the engine’s model.  
Note that the optional properties **might be missing** from the formats.

Your task is to print each car (in the order you’ve received them) and its information in the format defined bellow, if any of the optional fields has not been given print “**n/a**” in its place instead:

<CarModel>:  
 <EngineModel>:  
 Power: <EnginePower>  
 Displacement: <EngineDisplacement>  
 Efficiency: <EngineEfficiency>  
 Weight: <CarWeight>  
 Color: <CarColor>

### Bonus\*

Override the classes’ **ToString**() methods to have a reusable way of displaying the objects.

### Examples

|  |  |
| --- | --- |
| **Input** | **Output** |
| 2  V8-101 220 50  V4-33 140 28 B  3  FordFocus V4-33 1300 Silver  FordMustang V8-101  VolkswagenGolf V4-33 Orange | FordFocus:  V4-33:  Power: 140  Displacement: 28  Efficiency: B  Weight: 1300  Color: Silver  FordMustang:  V8-101:  Power: 220  Displacement: 50  Efficiency: n/a  Weight: n/a  Color: n/a  VolkswagenGolf:  V4-33:  Power: 140  Displacement: 28  Efficiency: B  Weight: n/a  Color: Orange |
| 4  DSL-10 280 B  V7-55 200 35  DSL-13 305 55 A+  V7-54 190 30 D  4  FordMondeo DSL-13 Purple  VolkswagenPolo V7-54 1200 Yellow  VolkswagenPassat DSL-10 1375 Blue  FordFusion DSL-13 | FordMondeo:  DSL-13:  Power: 305  Displacement: 55  Efficiency: A+  Weight: n/a  Color: Purple  VolkswagenPolo:  V7-54:  Power: 190  Displacement: 30  Efficiency: D  Weight: 1200  Color: Yellow  VolkswagenPassat:  DSL-10:  Power: 280  Displacement: n/a  Efficiency: B  Weight: 1375  Color: Blue  FordFusion:  DSL-13:  Power: 305  Displacement: 55  Efficiency: A+  Weight: n/a  Color: n/a |

## Jedi Galaxy

**The next four problems are from Pesho’s preparations for the exam. The code is working, but it doesn’t look good. Rework his solutions in order to avoid repeating code, increase readability and improve performance (perhaps).**

Ivo is the illegal son of Darth Vader. But he doesn’t know much about being a powerful Jedi warrior. Meanwhile, Princess Lea just broke up with Han Solo, because he cheated on her. Ivo decided to grab her heart, but he needs your help. He must be powerful enough to impress her and so he starts gathering stars to grow stronger.

His galaxy is represented as a two-dimensional array. Every cell in the matrix is a star that has a value. Ivo starts at the given **col** and **row**. He can move only on the diagonal **from the lowest left to the upper right**, and **adds** to his score all the stars (values) from the cells he **passes through**. Unfortunately, there is always an Evil power that tries to prevent his success.

Evil power starts at the given **row** and **col** and instantly destroys all stars on the opposite diagonal – **From lowest right to the upper left.**

Ivo **adds** the values only of the stars that are **not** **destroyed** by the evil power.

You will receive **two** integers, separated by space, which represent the two dimensional array - the first being the rows and the second being the columns. Then, you must fill the two dimensional array with increasing integers starting from 0, and continuing on every row, like this:   
first row: 0, 1, 2… m  
second row: n+1, n+2, n+3… n + n.   
**Example:**

Ivo starts with coordinates row = 5, col = -1. He must collect all stars with value [20, 16, 12, 8, 4]. Evil starts with coordinates row = 5, col = 5. The Evil destroys all stars in range [24, 18, 12, 6, 0]. The star with value **12** is the cross point for Ivo and The Evil, so Ivo skips the stars and collects only these who are not in the evil range.



You will also receive multiple pairs of commands in the form of 2 integers separated by a single space. The first two integers will represent Ivo’s start coordinates. The second one will represent the Evil Power’s start coordinates.

The input ends when you receive the command “**Let the Force be with you**”. When that happens, you must print the value of all stars that Ivo has collected successfully.

### Input

* On the first line, you will receive the number N, M -> the dimensions of the matrix. You must then fill the matrix according to these dimensions.
* On the next several lines you will begin receiving 2 integers separated by a single **space**, which represent Ivo’s row and col. On the next line you will receive the Evil Power’s coordinates.
* There will always be **at least 2 lines** of input to represent at least 1 path of Ivo and the Evil force.
* When you receive the command, “**Let the Force be with you**” the input ends.

### Output

* The output is simple. Print the sum of the values from all stars that Ivo has collected.

### Constraints

* The dimensions of the matrix will be integers in the range [5, 2000].
* The given rows will be valid integers in the range [0, 2000].
* The given columns will be valid integers in the range [-231 + 1, 231 - 1].

|  |  |
| --- | --- |
| **Input** | **Output** |
| 5 5  5 -1  5 5  Let the Force be with you | 48 |
| 5 5  4 -1  4 5  Let the Force be with you | 29 |

## Hospital

Your task will be to prepare an electronic register for a hospital. In the hospital we have different departments:

* Cardiology
* [Oncology](https://en.wikipedia.org/wiki/Oncology)
* [Emergency department](https://en.wikipedia.org/wiki/Emergency_department)
* etc.

Each department has **20** rooms for patients and **each room** **has 3 beds**. When a new patient goes in the hospital, he/she is placed on the first free bed in the department. If there are no free beds, the patient should go in another hospital. Of course, in every hospital there are doctors. Each doctor can have patients in a different department. You will receive an information about the patients in the format **{Department} {Doctor} {Patient}**

After the "Output" command you will receive some other commands about what kind of output you need to print. The commands are:

* **{Department}** – You need to **print all patients** in this department in the **order of receiving**
* **{Department} {Room}** – You need to **print all patients** in this room in **alphabetical order**
* **{Doctor}** – you need to **print all patients** for this doctor in **alphabetical order**

The program ends when you receive command "End".

### Input

On the first lines you will receive info for the hospital, department, doctors and patients in the following format:

**{Department} {Doctor} {Patient}**

When you read the "**Output**" line you will get one or more commands telling you what you need to print

Keep reading commands for printing untill you reach the command "**End**"

### Output

* **{Department}** – print all patients in this department in order of receiving on a new line
* **{Department} {Room}** – print all patients in this room in alphabetical order each on new line
* **{Doctor}** – print all patients that are healed from doctor in alphabetical order on new line

### Constraints

* **{Department}** – single word with length **1 < n < 100**
* **{Doctor}** – name and surname, both with length **1 < n < 20**
* **{Patient}** – unique name with length **1 < n < 20**
* **{Room}** – integer **1 <= n <= 20**
* Time limit: 0.3 sec. Memory limit: 16 MB.

### Examples

|  |  |
| --- | --- |
| **Input** | **Output** |
| Cardiology Petar Petrov Ventsi  Oncology Ivaylo Kenov Valio  Emergency Mariq Mircheva Simo  Cardiology Genka Shikerova Simon  Emergency Ivaylo Kenov NuPogodi  Cardiology Gosho Goshov Esmeralda  Oncology Gosho Goshov Cleopatra  Output  Cardiology  End | Ventsi  Simon  Esmeralda |

|  |  |
| --- | --- |
| **Input** | **Output** |
| Cardiology Petar Petrov Ventsi  Oncology Ivaylo Kenov Valio  Emergency Mariq Mircheva Simo  Cardiology Genka Shikerova Simon  Emergency Ivaylo Kenov NuPogodi  Cardiology Gosho Goshov Esmeralda  Oncology Gosho Goshov Cleopatra  Output  Cardiology 1  End | Esmeralda  Simon  Ventsi |

|  |  |
| --- | --- |
| **Input** | **Output** |
| Cardiology Petar Petrov Ventsi  Oncology Ivaylo Kenov Valio  Emergency Mariq Mircheva Simo  Cardiology Genka Shikerova Simon  Emergency Ivaylo Kenov NuPogodi  Cardiology Gosho Goshov Esmeralda  Oncology Gosho Goshov Cleopatra  Output  Ivaylo Kenov  End | NuPogodi  Valio |

## Greedy Times

Finally, you have unlocked the safe and reached the treasure! Inside there are all kinds of gems, cash in different currencies and gold bullions. Next to you there is a bag which unfortunately has a limited space. You don’t have much time so you need to take as much wealth as possible! But in order to get a bigger amount of the most valuable items, you need to keep the following rules:

* The **gold amount** in your bag should **always** **be** **more** than **or equal** to the **gem** **amount** at **any** time
* The **gem amount** should **always** **be** **more** than **or** **equal** to the **cash** **amount** at **any** time

If you read an **item** which **breaks** one of **these rules** you **should not put** it in the **bag**. You should **always** be careful **not** to **exceed** the overall **bag’s capacity,** because it will tear down and you will lose everything! You will receive the **content** **of** the **safe** on a **single line** in the **format** of **item - quantity** pairs, separated by **whitespace**. You need to gather **only** **three** **types** of items:

* Cash - All **three letter** items
* Gem - All **items** which **end** on “**Gem**” (at least 4 symbols)
* Gold - this type has **only one item** with the name - “**Gold**”

Each **item** which **does not** fall **in** one of the **above categories** is **useless** and you should **skip it**. Reading item’s **names** should be **CASE-INSENSITIVE**. You should **aggregate** **item’s quantities** which have the **same** **name**.

If you’ve kept the rules you should escape successfully with a bag full of wealth. Now it’s time to review what you have managed to get out of the safe. **Print all** the **types** ordered by **total amount** in **descending order**. Inside a type, **order** the **items** first **alphabetically** in **descending** order and **then by** their **amount** in **ascending** order. Use the following format for each type:

**“<{type}> ${total amount}”**

**“##{item} - {amount}”** - each item from this type on new line

### Input

* On the **first line**, you will receive a **number** which represents the **capacity** of the **bag**
* On the **second line**, you will receive a **sequence** of **item - quantity** pairs

### Output

Print **only** the **types** from which you **have items in the bag** ordered by **Total Amount** descending. Inside a type order the **items** **first** **alphabetically** in **descending** order and **then** by **amount** in **ascending** **order**. Use the following format for each type:

**“<{type}> ${total amount}”**

**“##{item} - {amount}”** - each item on new line

### Constraints

* Bag’s **max capacity** will **always** be a **positive number**
* All **quantities** will be **positive** **integer** in the range [0 … 2100000000]
* Each item of type **gem** willhave a **name** - **at** **least 4** symbols
* Time limit: 0.1 sec. Memory limit: 16 MB

### Examples

|  |  |
| --- | --- |
| **Input** | **Output** |
| 150  Gold 28 Rubygem 16 USD 9 GBP 8 | <Gold> $28  ##Gold - 28  <Gem> $16  ##Rubygem - 16  <Cash> $9  ##USD - 9 |
| 24000010  USD 1030 Gold 300000 EmeraldGem 900000 Topazgem 290000 CHF 280000 Gold 10000000 JPN 10000 Rubygem 10000000 KLM 3120010 | <Gold> $10300000  ##Gold - 10300000  <Gem> $10290000  ##Topazgem - 290000  ##Rubygem - 10000000  <Cash> $3410010  ##KLM - 3120010  ##JPN - 10000  ##CHF - 280000 |
| 80345  RubyGem 70000 JAV 10960 Bau 60000 Gold 80000 | <Gold> $80000  ##Gold - 80000 |

## Sneaking

After our hero Sam got the recipe from the first problem, there is another thing he needs to check off from his to-do list. In order to make the recipe even more valuable, he needs to “eliminate” anyone who possesses the knowledge of it. That person is Sam’s sworn enemy - **Nikoladze**. Sam needs to get through a rectangular room of **patrolling** **enemies** until he finally **reaches Nikoladze**.

A standard room looks like this:

|  |  |
| --- | --- |
| **Room** | **Legend** |
| ......N... b......... ..d....... ......d... .....S.... | S 🡺 **Sam**, the player character  b/d 🡺 **left/right-facing** **patrolling enemy**  N 🡺 **Nikoladze**  . 🡺 **Empty space** |

Each turn proceeds as follows:

* **Enemies** move either **left** or **right**, depending on which **direction** they are **facing** (b goes **right**, d goes **left**)
  + If an enemy is standing on the **edge** of the room, he flips his **direction** (from d to b or from b to d)
* After that, Sam moves in the **direction** he is instructed to (either U/D/L/R or W, which means **wait**).
* If **Sam** moves **onto an enemy** (**same row** and **column**), Sam **kills** the enemy and **leaves no trace of him**.
* Otherwise, if an enemy is on the **same row** as Sam, and also **facing** **Sam** (eg. .b.S.), the **enemy** **kills Sam**.
* If Sam is reaches the **same row** as **Nikoladze**, **Sam** kills **Nikoladze** (replacing him with an **X**)

### Input

* On the **first line** of input, you will receive n – the **number of rows** the **room** will consist of
* On the next **n lines**, you will receive the **room**, which Sam will have to navigate.
* On the **final line** of input, you will receive a sequence of **directions** – one of (U, D, L, R, W)

### Output

* If Sam is **killed**, print “Sam died at {row}, {col}”
* If Nikoladze is **killed**, print “Nikoladze killed!”
* Then, in both cases, **print** the **final state of the room** on the **console**, with either **Sam** or **Nikoladze’s** **symbols** replaced by an X.

### Constraints

* The room will always be **rectangular**.
* There will **always** be enough moves for **Sam** to reach **Nikoladze**
* There will be **no case** where **Sam** is instructed to move **out of the bounds of the room**.
* There will be **no case** with **two enemies on the same row**.
* There will be **no case** with an **enemy and Nikoladze** standing on the **same row**.
* There will be **no case** where Sam reaches the same **row and column** as **Nikoladze**.

### Examples

|  |  |  |
| --- | --- | --- |
| **Input** | **Output** | **Comments** |
| 5  ......N...  b.........  ..d.......  ......d...  .....S....  UUUUR | Sam died at 2, 5  ......N...  ...b......  b....X....  ..........  .......... | Turn 1: Enemies move, then Sam steps on the enemy on the 4th row.  Turn 2: Enemies move, then Sam moves.  Turn 3: Enemy 2 turns around, Sam goes on the same row as him.  Turn 4: Enemy sees Sam and kills him. |
| 3  N......  .b.....  ..dS...  WUUU | Nikoladze killed!  X..S...  .......  b...... | Turn 1: Enemies move, Sam waits.  Turn 2: Enemies move, Sam goes up, steps on an enemy.  Turn 3: Enemies move, Sam goes up, kills Nikoladze. |
| 6  .............  ....S........  .b...........  ...........d.  .............  ....N........  WWWDWWWDDRD | Nikoladze killed!  .............  .............  ............b  d............  .............  ....XS....... | Turn 1/2/3: Enemies move, Sam waits.  Turn 4: Enemies move, Sam goes down.  Turn 5/6/7: Enemies move, Sam waits.  Turn 8/9: Enemies move, Sam goes down.  Turn 10: Enemies move, Sam goes right.  Turn 11: Enemies move, Sam goes down and kills Nikoladze. |

## Family Tree

**Pesho is done with C# Advanced and is now working with classes. He waited until the last day the exercise is due and wrote some really bad code in a hurry. This time, his code doesn’t even work well and he needs help to refactor and fix it to get max points in Judge.**

You want to build your family tree, so you went to ask your grandmother. Sadly, your grandmother keeps remembering information about your predecessors in pieces, so it falls to you to group the information and build the family tree.

On the first line of input you will receive either a name or a birthdate in the format “<**FirstName> <LastName>”** or **“day/month/year**” – your task is to find the person’s information in the family tree. On the next lines until the command “**End**” is received, you will receive information about your predecessors and use it to build the family tree.

The information will be in one of the following formats:

* “**FirstName LastName - FirstName LastName**”
* “**FirstName LastName - day/month/year**”
* “**day/month/year - FirstName LastName**”
* “**day/month/year - day/month/year**”
* “**FirstName LastName day/month/year**”

The first 4 formats reveal a family tie – **the person on the left is parent to the person on the right** (as you can see the format does not need to contain names, for example the 4th format means the person born on the left date is parent to the person born on the right date). The last format ties different information together – i.e. **the person with that name was born on that date**. **Names** and **birthdates** are **unique** – there won’t be 2 people with the same name or birthdate, there will **always** be enough entries to construct the family tree (all people’s names and birthdates are known and they have atleast one connection to another person in the tree).

After the command “**End**” is received you should print all information about the person whose name or birthdate you received on the first line – his **name, birthday, parents and children** (check the examples for the format). The people in the parents and childrens lists should be ordered by their first appearance in the input (regardless if they appeared as a birthdate or a name, for example in the first input Stamat is before Penka because he has appeared first on the second line, while she appears on the third one).

### Examples

|  |  |
| --- | --- |
| **Input** | **Output** |
| Pesho Peshev  11/11/1951 - 23/5/1980  Penka Pesheva - 23/5/1980  Penka Pesheva 9/2/1953  Pesho Peshev - Gancho Peshev  Gancho Peshev 1/1/2005  Stamat Peshev 11/11/1951  Pesho Peshev 23/5/1980  End | Pesho Peshev 23/5/1980  Parents:  Stamat Peshev 11/11/1951  Penka Pesheva 9/2/1953  Children:  Gancho Peshev 1/1/2005 |
| 13/12/1993  25/3/1934 - 4/4/1961  Poncho Tonchev 25/3/1934  4/4/1961 - Moncho Tonchev  Toncho Tonchev - Lomcho Tonchev  Moncho Tonchev 13/12/1993  Lomcho Tonchev 7/7/1995  Toncho Tonchev 4/4/1961  End | Moncho Tonchev 13/12/1993  Parents:  Toncho Tonchev 4/4/1961  Children: |
| Asen Peshev  3/10/1927 - 23/10/1951  Gosho Peshev 3/10/1927  3/4/1923 - Maxim Peshev  Maxim Peshev 26/8/1951  3/10/1927 - Stamat Peshev  Stamat Peshev 24/6/1948  Dragomir Peshev - 5/2/1998  Goran Peshev 5/2/1998  Maxim Peshev - 4/3/1977  Dragomir Peshev 4/3/1977  3/10/1927 - Karamfil Peshev  Karamfil Peshev 6/3/1951  Dragomir Peshev - 16/12/1998  Dimitrichka Pesheva 16/12/1998  3/4/1923 - Kalin Peshev  Kalin Peshev 23/10/1951  Dragomir Peshev - 10/2/1999  Pesho8 Peshev 10/2/1999  Dragomir Peshev - 23/11/2001  Todor Peshev 23/11/2001  Dragomir Peshev - 18/8/2000  Kamen Peshev 18/8/2000  Dragomir Peshev - 21/6/2002  Trendafil Peshev 21/6/2002  Asen Peshev 3/4/1923  4/3/1977 - Stefan Peshev  Stefan Peshev 2/6/2001  End | Asen Peshev 3/4/1923  Parents:  Children:  Maxim Peshev 26/8/1951  Kalin Peshev 23/10/1951 |