

Exercise walk-through

12.2

Structure Charts

A-Level Computer Science

Method — Key knowledge: modules and parameter notation

A **structure chart** shows a program's hierarchical decomposition into modules and the parameters passed between them. Rectangles name modules. An ordinary line connects a caller above to a module it calls below; it is not a parameter arrow.

- An **open circle** marks a data coupling, such as INTEGER, REAL or STRING. A **filled circle** marks a control coupling, such as BOOLEAN.
- A separate labelled arrow points **towards the receiving module**. A downward arrow passes an input; an upward arrow carries a returned value.
- A two-way arrow with a circle represents a parameter passed **BYREF**. A procedure can update the caller's variable this way; this does not make it a function.
- A **function** returns a value and its header includes RETURNS and the type. A **procedure** has no function return value. Parameter names and types go inside parentheses; no parameters means ().

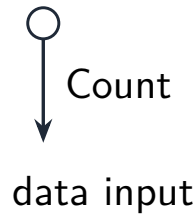
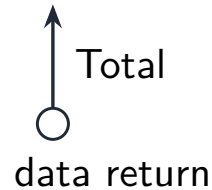
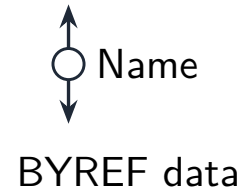
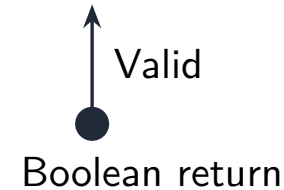
Method — Key knowledge: modules and parameter notation

- A return label belongs to the arrow, not in the function's parameter list. Use the supplied type information: an open circle does not distinguish INTEGER from STRING.

Method — Key knowledge: modules and parameter notation

A structure chart
parameters passed...

shows a program's hierarchical decomposition into modules and the



Exam parameter symbols: data, returns, BYREF and Boolean control

Method — Worked example: chart to headers and iteration

ID is INTEGER and Name is STRING. Read the direction and circle of every coupling:

- 1 Read receives ID and has no return arrow, so it is a procedure with one INTEGER parameter.
- 2 Check receives ID and returns the Boolean Valid, so it is a function returning BOOLEAN.
- 3 Save has a two-way data coupling for Name, so it is a procedure with a BYREF STRING parameter.

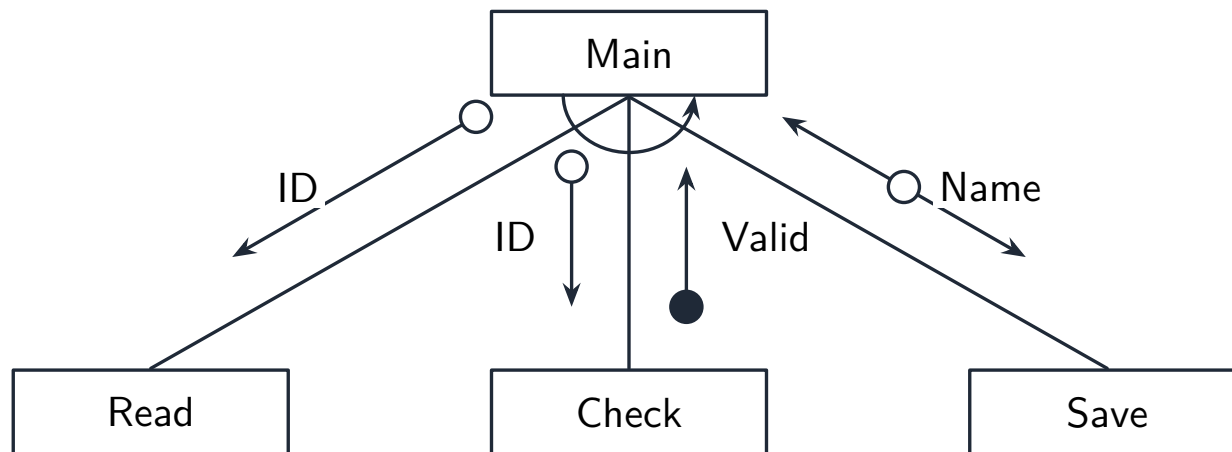
```
PROCEDURE Read(ID : INTEGER)
FUNCTION Check(ID : INTEGER) RETURNS BOOLEAN
PROCEDURE Save(BYREF Name : STRING)
```

Method — Worked example: chart to headers and iteration

The curved arrow means **Main repeatedly calls Read, then Check, then Save, in that order**. An exam explanation needs the caller, the modules, the order and repetition, not just the word 'loop'.

Method — Worked example: chart to headers and iteration

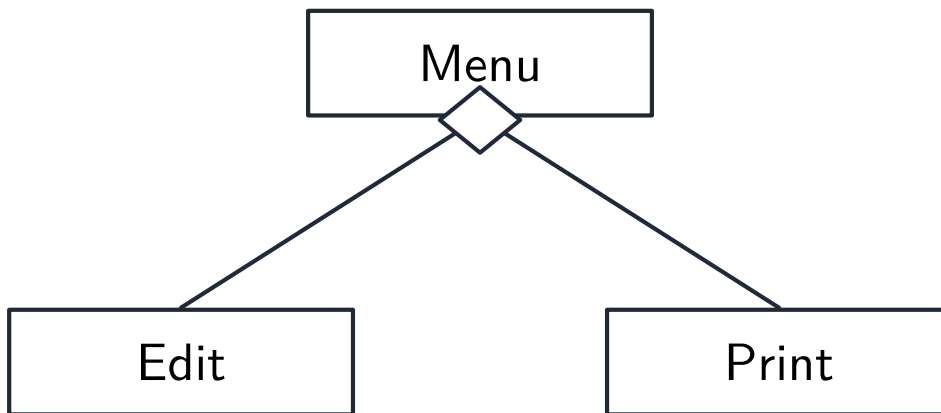
ID is INTEGER and Name is STRING.



Main repeatedly calls Read, Check and Save

Method — Key knowledge: selection and building a chart

The diamond means **Menu calls either Edit or Print**, chosen at run time. It does not mean that both modules are always called.



Menu selects either Edit or Print at run time

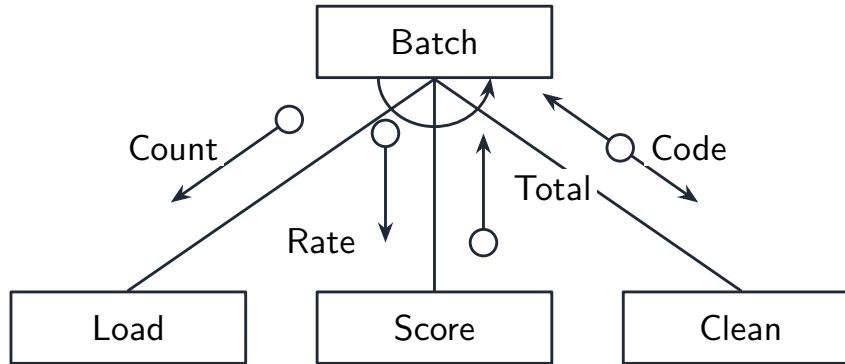
Method — Worked example: headers to a chart

Suppose the notes say Main repeatedly calls Read, then Check, then Save, with the three headers above. First put Main above three rectangles in that order and connect the hierarchy. Add an open-circle ID arrow down to Read. Add ID down to Check and a filled-circle return arrow up. Add a two-way open-circle Name arrow beside Save's link. Finally draw the iteration arc beneath Main across the three child links. This produces the worked chart above.

Before handing in: check every module, caller, parameter, direction, circle, return value, selection and iteration symbol against the notes. Do not add calls that the notes do not specify.

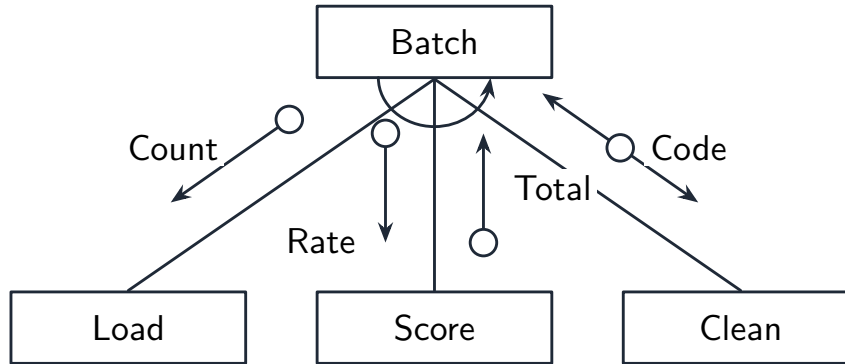
Exercise 2.1

2.1 In the chart, Count is INTEGER, Rate and Total are REAL, and Code is STRING. State what is passed to Load, what Score returns, and how Code is passed to Clean. [3]



Exercise 2.1

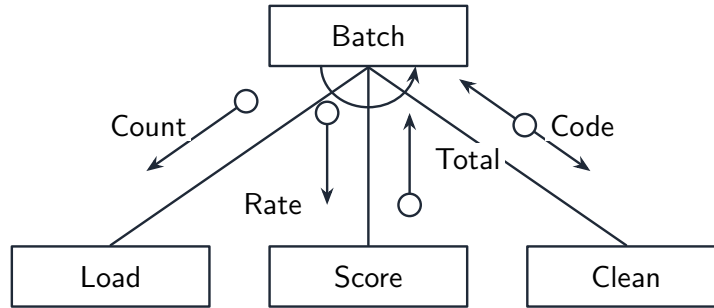
2.1 In the chart, Count is INTEGER, Rate and Total are REAL, and Code is STRING. State what is passed to Load, what Score returns, and how Code is passed to Clean. [3]



2.1 Load receives Count. Score returns Total. Code is passed by reference to Clean, shown by the two-way arrow.

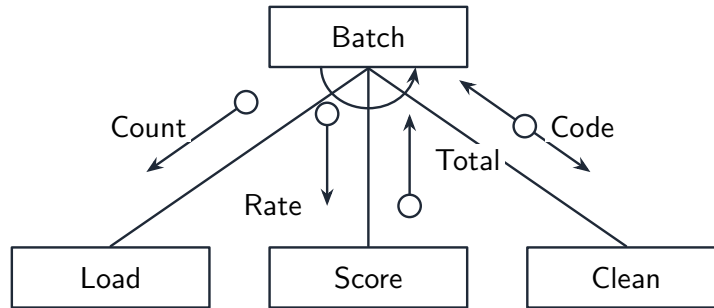
Exercise 2.2

2.2 In the chart below, Count is INTEGER, Rate and Total are REAL, and Code is STRING. Write the complete pseudocode headers for Load, Score and Clean. [3]



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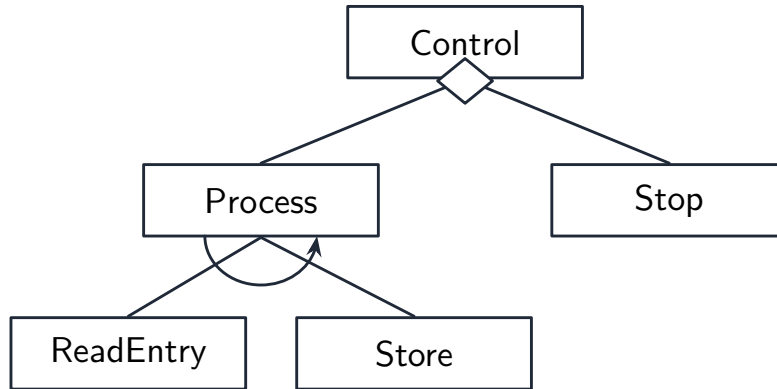
2.2

```
PROCEDURE Load(Count : INTEGER)
FUNCTION Score(Rate : REAL) RETURNS REAL
PROCEDURE Clean(BYREF Code : STRING)
```

One mark per correct complete header. Total is a return value, not a second input parameter.

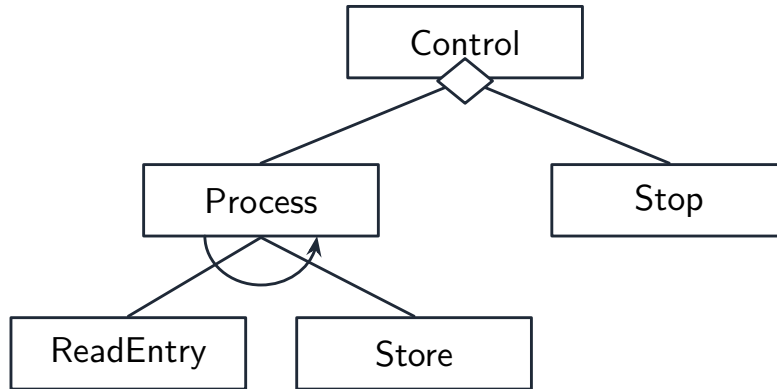
Exercise 2.3

2.3 Explain what the diamond and the curved arrow mean in this chart. Name the affected modules and give their order where relevant. [3]



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2.3 Explain what the diamond and the curved arrow mean in this chart. Name the affected modules and give their order where relevant. [3]



2.3 Control selects either Process or Stop at run time. Process repeatedly calls ReadEntry followed by Store, in that order.

Exercise 2.4

2.4 Main calls ReadValue then Calculate once each. Draw a structure chart from the headers below, including all parameters and the return value. Name the returned value Result. [4]

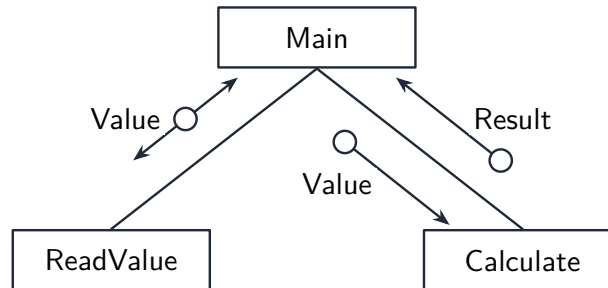
```
PROCEDURE ReadValue(BYREF Value : INTEGER)
FUNCTION Calculate(Value : INTEGER) RETURNS REAL
```

Exercise 2.4

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```
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FUNCTION Calculate(Value : INTEGER) RETURNS REAL
```

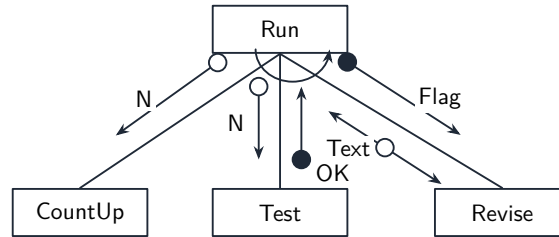
2.4 Main above ReadValue and Calculate with both hierarchy links. ReadValue has a two-way open-circle Value coupling. Calculate has a downward open-circle Value coupling and an upward open-circle Result coupling. No iteration or selection symbol is needed.



Exercise 3.1

3.1 In the chart, N is INTEGER, Text is STRING and Flag is BOOLEAN.

- (a) Write the complete pseudocode headers for CountUp, Test and Revise. [4]

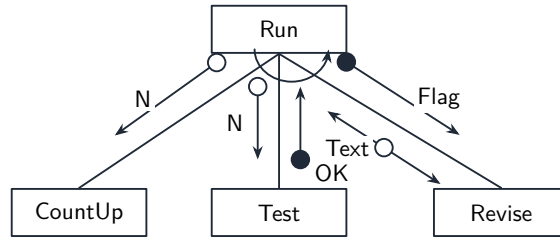


- (b) Explain the curved arrow in the context of this program. [2]

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(b) Explain the curved arrow in the context of this program. [2]

3.1 (a)

```
PROCEDURE CountUp(N : INTEGER)
FUNCTION Test(N : INTEGER) RETURNS BOOLEAN
PROCEDURE Revise(BYREF Text : STRING, Flag : BOOLEAN)
```

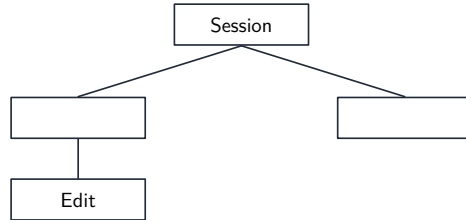
CountUp header; Test's input and function return type; Revise's two inputs including BYREF Text. OK is the Boolean return label and is not an input.

(b) Run repeatedly calls CountUp, then Test, then Revise in that order.

Exercise 3.2

3.2 Session calls either Lookup or SetFlag, decided at run time. Lookup calls Edit once. Complete the chart using the headers below. Label Lookup's return value Index. You may redraw the chart in the space below. [5]

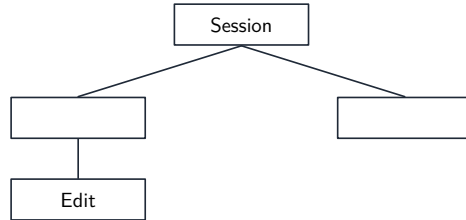
```
FUNCTION Lookup(Key : STRING) RETURNS INTEGER  
PROCEDURE SetFlag(Enabled : BOOLEAN)  
PROCEDURE Edit(BYREF Name : STRING)
```



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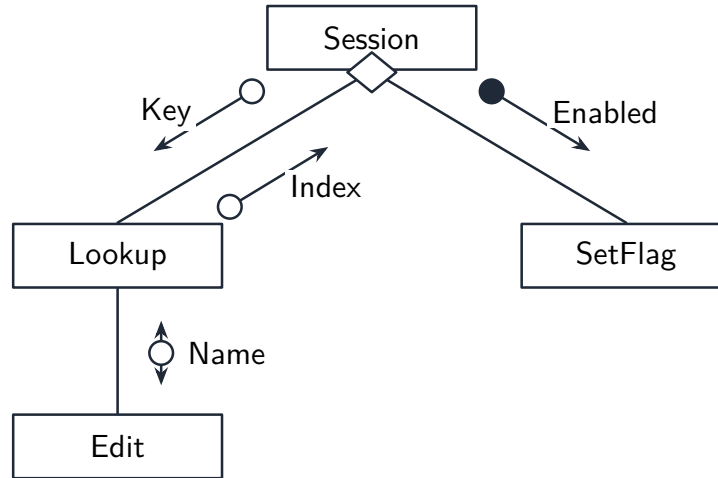
```
FUNCTION Lookup(Key : STRING) RETURNS INTEGER  
PROCEDURE SetFlag(Enabled : BOOLEAN)  
PROCEDURE Edit(BYREF Name : STRING)
```



3.2

Full solution 3.2

3.2



Both missing module names; selection diamond beneath Session; open-circle Key input and Index return at Lookup; filled-circle Enabled input at SetFlag; two-way open-circle Name at Edit. Copy these additions onto the given chart; redrawing it consistently is also acceptable.

Exercise 3.3

3.3 Draw a complete structure chart from these program notes. Choose suitable names for the two return values. [6]

- Manage calls either Amend or Find, chosen at run time.
- Amend takes a STRING parameter Label passed by reference.
- Find takes a STRING parameter Search and returns an INTEGER.
- Amend repeatedly calls Write followed by Ready.
- Write takes a STRING parameter Label; Ready has no parameters and returns a BOOLEAN.

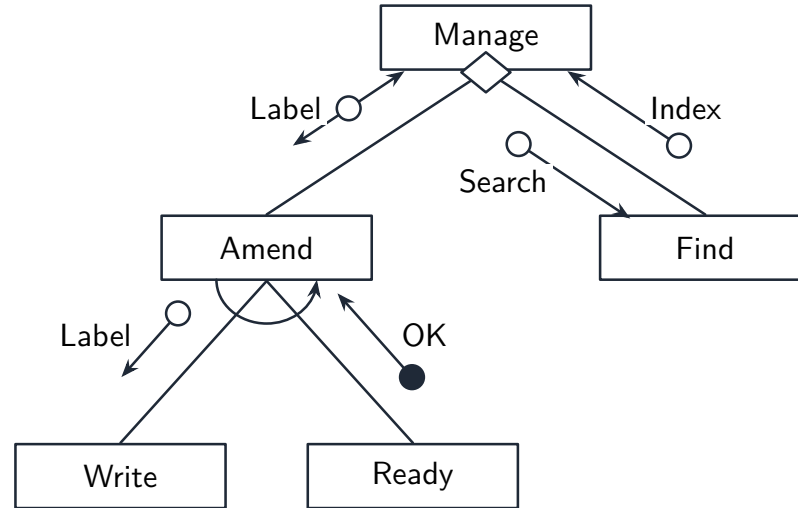
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Full solution 3.3

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Five modules in the correct hierarchy; diamond at Manage; iteration arc at Amend; two-way open-circle Label coupling to Amend; open-circle Search input and INTEGER return at Find; open-circle Label input at Write and filled-circle BOOLEAN return at Ready. Return labels such as Index and OK are acceptable; they are not input parameters.