Name: Hasen Yahya
Class: BSE-4D
Roll no: 22L-7471

Question-01:

→ (Size-Metrics:)

→ Number of attributes per class (NOA):

Animal: 3
Dog: 2 | Total: 8 |
Cat: 2
Bird: 1

→ Number of methods per class (NOM):

Animal: 2   ~~(Excluding constructor)~~
                   (excluding constructor)
Dog: 3
Cat: 3 | Total: 10 |
Bird: 2

→ Weighted method per class (WMC):

$$WMC = \sum_{i=1}^{n} C_i$$ (excluding constructor).

C here is cyclometic complexity. Since there are no if-else or while in this code, so the cyclometic complexity of each function (no constructor included) is 1.

Animal: 2
Dog: 3
Cat: 3

if we include constructors, then both NOM & WMC increase by 1 for each function, so +4 & +4 for both.

Bird: 2

Total is 10.

.> Response for a class (RFC): (including the constructors).
    Animal: 3 unique
    Dog= 6 (4 unique + 2 inherited).
    Cat: 6 (4 unique + 2 inherited).
    Bird: 5 (3 unique + 2 inherited).
  → Total is 20.

.> Lines of Code (LOC):
    Animal: 19
    Dog: 19   Total: 71
    Cat: 19
    Bird: 14

.>→ (Coupling Metrics:)

.> Coupling b/w objects (CBO):
    Animal : 0
    Dog: 1
    Cat: 1
    Bird: 1

-> Data abstraction coupling (DAC):

No abstract data-types available, so all are zero.

$$DAC = 0.$$

-> Message passing coupling (MPC):

It is zero, because while species, age, isPet is being used by 3 inherited classes, but inheritance isn't allowed in MPC. So,

$$MPC = 0. \text{ (for all)}.$$

-> Coupling Factor (CF):

Coupling due to inheritance is not included in CF, so it is zero.

$$CF = \frac{\sum_{i=0}^{TC} \sum_{j=0}^{TC} [IS\text{-}Client (c_i, c_j)]}{TC^2 - TC}$$

$$CF = 0.$$

⟶ (Cohesion Metrix)

·) Lack of cohesion methods (LCOM):

LCOM = disjoint - similar.
(P is disjoint pairs) & (M is similar pairs).

→ Animal: I = {species, age, isPet}
            M = {makeSound(), PrintInfo()}.
            P = 0
            Q = 1
Hence, LCOM = max $(0, |P|, |Q|)$ = max$(0, 0-1)$ = -1
        = -1 (but it can't be negative)
      So, LCOM = 0.

→ Dog : I = {breed, color},
          M = {makeSound(), printBreed(), printColor()}
          P = 3
          Q = 0
     LCOM = max $(0, |P|-|Q|)$ = max $(0, 3-0)$
                                = 3.

→ Cat: I = {furType, isOutdoor}
         M = {makeSound(), printFurType(),
                printOutdoorStatus()}.
         P = 3
         Q = 0
     So, LCOM = max $(0, |P|-|Q|)$ = max $(0, 3-0)$ = 3.

$\rightarrow$ Bird $\Rightarrow$ I $\Rightarrow$ {can Fly?}.

M $\Rightarrow$ {make Sound (), print Flight Capability()}.

$P = 1$

$Q = 0$

LCOM $\Rightarrow$ max $(0, |P| - |Q|) \Rightarrow$ max $(0, 1) \Rightarrow 1$.

-) Tight class Cohesion (TCC):

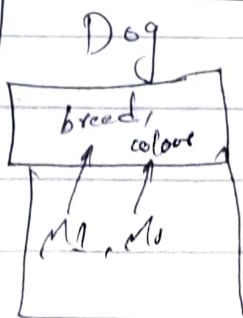$$TCC \Rightarrow \frac{\text{Number of connected methods}}{\text{Total possible cohesion}} \times 100$$

Animal $\rightarrow$ $\Rightarrow$ $\frac{1}{1} \times 100$ $\Rightarrow$ 100%.

Dog $\rightarrow$ $\Rightarrow$ $\frac{0}{3} \times 100$ $\Rightarrow$ 0%.

Cat $\rightarrow$ $=$ $\frac{0}{3} \times 100$ $\Rightarrow$ 0%.

Bird $\rightarrow$ $\Rightarrow$ $\frac{0}{1} \times 100$ $\Rightarrow$ 0%.

Ref Work

Dog

breed,
colour

M1, M2

$\Rightarrow$ no
common
$\Rightarrow 0 \%$.

Cat

AT, 20

9

M1, M2
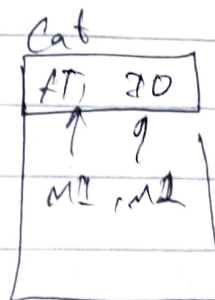
$\Rightarrow 0 \%$

→ Loose class Cohesion (LCC):

Same as TCC. as no method is one class is directly involving a method in other class. ~~Moreover~~

So,

Animal = 100%.   Cat = 0%.
Dog = 0%.   Bird = 0%.

→ Information flow base cohesion (ICH):

No, method involves any other method so,
$$ICH = 0.$$

→→ (Inheritance Metrics:)

→ Depth of tree (DIT):

Animal = 0   (it is root).
Dog = 1
Cat = 1
Bird = 1

[Maximum depth is thus 1.]

·) Number of children (NOC):

Animal = 3.

Dog = Cat = Bird = 0.

·) Method Inheritance Factor (MIF):
   Methods inherited by:
      Animal = 0,
      Dog = 3, Cat = 3, Bird = 0.
   Methods declared in class: (concluding constructor).
      Animal = 5, Dog = 7, Cat = 7
      Bird = 5.

   Total no of classes = 4.

   So, MIF = $\frac{(3+3+3)}{(5+7+7+5)}$ = $\frac{9}{24}$ = 0.375

         or   37%.

·) Attribute inheritance factor:
      All subclasses inherit 3
   attributes, while animal is 0.
   & number of attributes inherited
      in Animal is 3.

   Ai: (Attributes inherited)
   ＝
      Animal = 0
      Dog = Cat = Bird = 3.

AJ: (Attributes desired)

Animal = 3.

Dog = 5
Cat = 5
Bird = 1

Sol   AJF = $\dfrac{(3+3+3)}{(3+5+5+4)}$, $\dfrac{9}{17}$

= 0.529   or   52%.

Question - 02:

→ (Size metrics):

• NOA:
   Engine = 2
   Car = 3
   Motorcycles = 3

• NOM: (including constructor):
   Engine = 3
   Car = 3
   Motorcycle = 3

• WMC: (using cyclometric complexity &
   Engine = 3   including constructor)
   Car = 3
   Motorcycle = 3

•) RFC (irelwdy constructor)

      Engine = 3

      Car = 3

      Motorcycle = 3

•) LOC:

      Engine = 16 -

      Car = 18

      Motorcycle = 18

>>> (Coupling Metrics)

•) CBO:

      Engine = 0 -

      Car = 1 .

      Motorcycle = 1 .

•) DAC:

      All are zero.

•) MPC:

      Engine = 0

      Car = 2

      Motorcycle = 2 .

•) CF:

$$\text{Is\_Client (Car, Engine)} = 1$$
$$\text{Is\_Client (M, E)} = 1$$
$$\text{//} (E, C) = 0$$
$$\text{//} (E, M) = 0$$
$$\text{//} (G, M) = 0$$
$$\text{//} (M, C) = 0$$

Sum = 2.

Total classes = 3.

$$CF = \frac{2}{(3^2 - 3)} = \frac{2}{9 - 3}$$

$$= \frac{2}{6} = 0.33$$

66 33%.

-)) ⟶ (Cohesion Matrix)

•) LCOM:

Engine = 0
Car = 0
Motorcycle = 0

Because all variables are being used by methods.

•) TCC:

Engine = 0%.
Car = 100%.
Motorcycle = 100%.

Engine = 0+
Cars = 7St.
Motorcycle = 7St.

`>` ICH:
$\approx$
　　Engine = 0+.
　　Car = 0+.
　　Motorcycle = 0+.

`>>→` (Inheritance Metrices)
$\approx$

`>` DIT:
$\approx$
　　0　as no inheritance is
　　done.

`>` NOC
$\approx$
　　0 for all.

`>` MIF:
$\approx$
$$\approx \frac{0}{no\ of\ methods} \geq 0.$$

`>` AIF:
$\approx$
$$\frac{0}{no\ of\ attributes}$$

$$\geq 0.$$