Week 2

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Assignment 1

From https://www.mathsisfun.com/puzzles/lying-about-their-age.html

Alex, Brook, Cody, Dusty, and Erin recently found out that all of their birthdays were on the same day, though they are different ages.

On their mutual birthday, they were jabbering away, flapping their gums about their recent discovery. And, lucky me, I was there. Some of the things that I overheard were...

- Dusty said to Brook: "I'm nine years older than Erin."
- Erin said to Brook: "I'm seven years older than Alex."
- Alex said to Brook: "Your age is exactly 70% greater than mine."
- Brook said to Cody: "Erin is younger than you."
- Cody said to Dusty: "The difference between our ages is six years."
- Cody said to Alex: "I'm ten years older than you."
- Cody said to Alex: "Brook is younger than Dusty."
- Brook said to Cody: "The difference between your age and Dusty's is the same as the difference between Dusty's and Erin's."

Since I knew these people -- and how old they were, I knew that they were not telling the whole truth.

After thinking about it, I realized that when one of them spoke to someone older, everything they said was true, but when speaking to someone younger, everything they said was false.

The way I approached this assignment is to mark every name with an integer letter representing their age and based on their age and statements write the constraints for z3 to output the result

```
a,b,c,d,e = Ints('a b c d e')

s=Solver()

def abs(x):
    return If(x >= 0,x,-x)

dist= Distinct(a,b,c,d,e)

s.add(a>0,b>0,c>0,d>0,e>0)
s.add(dist)
s.add(If(d<b,d-9==e,Not(d-9==e)))
s.add(If(e<b,e-7==a,Not(e-7==a)))
s.add(If(a<b,10*b==17*a,Not(10*b==17*a)))
s.add(If(b<c,e<c,Not(e<c)))
s.add(If(c<a,c==a+10,Not(c==a+10)))
s.add(If(c<d,abs(c-d)==6,Not(abs(c-d)==6)))
s.add(If(c<a,b<d,Not(b<d)))
s.add(If(b<c,  abs(c-d)==abs(d-e),Not(abs(c-d)==abs(d-e)) ))

print(s.check())
print(s.model())
```

```
sat
[e = 37, b = 51, a = 30, d = 46, c = 55]
```

From the output we can see the following ages:

Alex=30

Brook=51

Cody=55

Dusty=46

Erin=37

Assignment 2

From https://www.mathsisfun.com/puzzles/four-sided-dice.html

The Puzzle:

I have three special four-sided dice.

They have one letter on each side.

When I roll them together I get three random letters which I try to rearrange into a word. In my eight goes so far I have made the words:

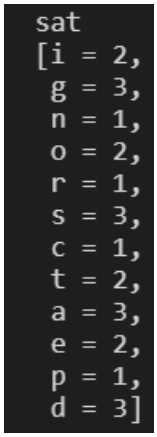
CAT, SON, POD, RIG, PEG, TAP, DIN, APE

What are the letters on each dice?

```
c,n,p,r,a,g,d,s,e,i,o,t=Ints("c n p r a g d s e i o t")
slv=Solver()

#dice are 4 sided so they have 4 letters
#each letter on die 1 will have value 1, each letter from die 2 will have value 2 etc
#that means every word ex:CAT will have value 6 ( 1 letter from each die) and their values will also be distinct

constraint1=c>0,n>0,p>0,r>0,a>0,g>0,d>0,s>0,e>0,i>0,o>0,t>0
constraint2=(c<4,n<4,p<4,r<4,a<4,g<4,d<4,s<4,e<4,i<4,o<4,t<4)

def myfunct(x,y,z):
    slv.add(x+y+z==6)
    slv.add(Distinct(x,y,z))

slv.add(constraint1)
slv.add(constraint2)
myfunct(c,a,t)
myfunct(s,o,n)
myfunct(p,o,d)
myfunct(r,i,g)
myfunct(p,e,g)
myfunct(t,a,p)
myfunct(d,i,n)
myfunct(a,p,e)

print(slv.check())
print(slv.model())
```

Each of the integers declared in the beginning corresponds to a side on a die.

The output:



Based on this output we see the following values on the dice:

Die1: nrcp

Die2: iote

Die3: gsad

Assignment 3

From https://www.brainzilla.com/logic/self-referential-quiz/

I chose this quiz(medium variant1) : https://www.brainzilla.com/logic/self-referential-quiz/srq-1/

A screenshot with the entire page with the found solution can be found at the end.

Most of the question have a pretty standard format of solving them:

1. Check the constraints of the answer
2. If the constraints would be true then write constraints for the consequences(and negate the consequences if the initial constraints are false)

They key to solving this is taking into account in the code what is implied indirectly. For example:

> 1. The first question whose answer is E is the question
>
> A. 1
> B. 2
> C. 3
> D. 4
> E. 5

If the answer to this question is D then it also means the answer to the questions 1,2,3 cannot be E

```
q1,q2,q3,q4,q5,q6,q7,q8,q9,q10=Ints('q1 q2 q3 q4 q5 q6 q7 q8 q9 q10')
nothing=Int('nothing')
s=Solver()
#q1=2 means the answer to question 1 is 2(B)
constraints=q1>0,q2>0,q3>0,q4>0,q5>0,q6>0,q7>0,q8>0,q9>0,q10>0,  q1<6,q2<6,q3<6,q4<6,q5<6,q6<6,q7<6,q8<6,q9<6,q10<6
s.add(constraints)

def ask(stmt1,stmt2):
     s.add(If(stmt1, stmt2 , Not(stmt2) ))

#for q1
s.add(If(q1==5,q1==1,Not(q1==1)))
s.add(If(q2==5,And(q1==2,q1!=5),Not(And(q1==2,q1!=5))))
s.add(If(q3==5,And(q1==3,q1!=5,q2!=5),Not(And(q1==3,q1!=5,q2!=5))))
s.add(If(q4==5,And(q1==4,q1!=5,q2!=5,q3!=5),Not(And(q1==4,q1!=5,q2!=5,q3!=5))))
s.add(If(q5==5,And(q1==5,q1!=5,q2!=5,q3!=5,q4!=5),Not(And(q1==5,q1!=5,q2!=5,q3!=5,q4!=5))))


#for q2

ask(q9==2,And( q2==1, q7!=2, q5!=2, q3!=2, q1!=2))
ask(q7==2,And( q2==2, q9!=2, q5!=2,q3!=2,q1!=2 ))
ask(q5==2,And( q2==3, q9!=2, q7!=2, q3!=2, q1!=2))
ask(q3==2,And(q2==4,  q9!=2, q7!=2, q5!=2, q1!=2))
ask(q1==2,And(q2==5,  q9!=2, q7!=2, q5!=2,q3!=2 ))

#for q3
# And(q1!=q2,q2!=q3,q3!=q4,q4!=q5,q5!=q6,q6!=q7,q7!=q8,q8!=q9,q9!=q10)   all possibilities here
ask(q3==1,And(q2==q3,  q1!=q2,    q3!=q4,q5!=q6,q6!=q7,q7!=q8,q8!=q9,q9!=q10  ))
ask(q3==2,And( q3==q4,q1!=q2,q2!=q3,   q4!=q5,q5!=q6,q6!=q7,q7!=q8,q8!=q9,q9!=q10  ))
ask(q3==3,And( q4==q5,q1!=q2,q2!=q3,q3!=q4,   q5!=q6,q6!=q7,q7!=q8,q8!=q9,q9!=q10 ))
ask(q3==4,And(q5==q6,  q1!=q2,q2!=q3,q3!=q4,q4!=q5,   q6!=q7,q7!=q8,q8!=q9,q9!=q10 ))
ask(q3==5,And( q6==q7, q1!=q2,q2!=q3,q3!=q4,q4!=q5,q5!=q6,  q7!=q8,q8!=q9,q9!=q10 ))
```

```
#for q4 almost same as q2 but for even numbers
# And(q2!=1,q4!=1,q6!=1,q8!=1,q10!=1)   all possibilities

ask(q2==1,And(q4==1,       q4!=1,q6!=1,q8!=1,q10!=1))
ask(q4==1,And(q4==2, q2!=1,    q6!=1,q8!=1,q10!=1 ))
ask(q6==1,And(q4==3, q2!=1,q4!=1,   q8!=1,q10!=1 ))
ask(q8==1,And(q4==4,  q2!=1,q4!=1,q6!=1,  q10!=1))
ask(q10==1,And(q4==5, q2!=1,q4!=1,q6!=1,q8!=1   ))

#for q5
def countAnsw(v1,v2,v3,v4,v5,v6,v7,v8,v9,v10,target):
    return(
        If(v1==target,1,0)+
        If(v2==target,1,0)+
        If(v3==target,1,0)+
        If(v4==target,1,0)+
        If(v5==target,1,0)+
        If(v6==target,1,0)+
        If(v7==target,1,0)+
        If(v8==target,1,0)+
        If(v9==target,1,0)+
        If(v10==target,1,0)
        )

ask(countAnsw(q1,q2,q3,q4,q5,q6,q7,q8,q9,q10,2)==5,q5==1)
ask(countAnsw(q1,q2,q3,q4,q5,q6,q7,q8,q9,q10,2)==4,q5==2)
ask(countAnsw(q1,q2,q3,q4,q5,q6,q7,q8,q9,q10,2)==3,q5==3)
ask(countAnsw(q1,q2,q3,q4,q5,q6,q7,q8,q9,q10,2)==2,q5==4)
ask(countAnsw(q1,q2,q3,q4,q5,q6,q7,q8,q9,q10,2)==1,q5==5)
```

```
#for q6

ask(q1==q6,And(q6==1 , q3!=q6,q5!=q6,q7!=q6,q9!=q6 ))
ask(q3==q6,And(q6==2 , q1!=q6 ,      q5!=q6,q7!=q6,q9!=q6 ))
ask(q5==q6,And(q6==3 , q1!=q6, q3!=q6,            q7!=q6,q9!=q6 ))
ask(q7==q6,And(q6==4 ,    q1!=q6, q3!=q6,    q5!=q6,                q9!=q6 ))
ask(q9==q6,And(q6==5 ,       q1!=q6, q3!=q6,    q5!=q6,       q7!=q6,                   ))


#for q7
# And(q1!=q7,q2!=q7,q3!=q7,q4!=q7,q5!=q7)  all possibilities
ask(q1==q7,And(q7==1,           q2!=q7,q3!=q7,q4!=q7,q5!=q7))
ask(q2==q7,And(q7==2,     q1!=q7,      q3!=q7,q4!=q7,q5!=q7)  )
ask(q3==q7,And(q7==3,     q1!=q7,q2!=q7,      q4!=q7,q5!=q7)  )
ask(q4==q7,And(q7==4,     q1!=q7,q2!=q7,q3!=q7,      q5!=q7)  )
ask(q5==q7,And(q7==5,     q1!=q7,q2!=q7,q3!=q7,q4!=q7,     )  )

#for q8

def abs(x):
    return If(x >= 0,x,-x)

ask(Or( q8==abs(q9-4),q8==abs(q9+4)  ) ,And(q8==1  , q9==5) )
ask(Or( q8==abs(q9-3),q8==abs(q9+3)  ),And(q8==2  , q9==5) )
ask(Or( q8==abs(q9-2),q8==abs(q9+2)  ),And(q8==3  , Or(q9==5,q9==1) ) )
ask(Or( q8==abs(q9-1),q8==abs(q9+1)  ),And(q8==4  , Or(q9==5,q9==3) ) )
ask(q8==q9,And(q8==5,q9==5))
```

```
#for q9

#there are 10 questions
#count the number of questions whose answer is 2,3 or 4

#primes are 2,3,5,7      A
#squares are 1,4,9       B
#cubes are 1,8           C
#divisible by 5 are 5,10  D
# factorials are  1,2,6    E

def altCount(checker):
    return  (
        countAnsw(q1,q2,q3,q4,q5,q6,q7,q8,q9,q10,2)+
        countAnsw(q1,q2,q3,q4,q5,q6,q7,q8,q9,q10,3)+
        countAnsw(q1,q2,q3,q4,q5,q6,q7,q8,q9,q10,4)
    )==checker

#answer A
ask(
    Or(
        altCount(2),
        altCount(3),
        altCount(5),
        altCount(7)
        ),q9==1
)
```

```
#answer B
ask(
    Or(
        altCount(1),
        altCount(4),
        altCount(9),
        ),q9==2
)

#answer C
ask(
    Or(
        altCount(1),
        altCount(8)
        ),q9==3
)

#answer D
ask(
    Or(
        altCount(5),
        altCount(10)
        ),q9==4
)
#answer E
ask(
    Or(
        altCount(1),
        altCount(2),
        altCount(6)
        ),q9==5
)
```

```
#for q10

ask(q10==1,q10==1)
ask(q10==2,q10==2)
ask(q10==3,q10==3)
ask(q10==4,q10==4)
ask(q10==5,q10==5)


print(s.check())
print(s.model())
```

Output

```
sat
[q5 = 4,
 q7 = 3,
 q3 = 3,
 q8 = 1,
 q2 = 5,
 q4 = 4,
 q10 = 2,
 q6 = 5,
 q1 = 2,
 q9 = 5]
```

which corresponds to the screenshot below

1. The first question whose answer is E is the question

A. ✖ ~~1~~
B. ✔ 2
C. ✖ ~~3~~
D. ✖ ~~4~~
E. ✖ ~~5~~

2. The only odd numbered question whose answer is B is the question

A. ✖ ~~9~~
B. ✖ ~~7~~
C. ✖ ~~5~~
D. ✖ ~~3~~
E. ✔ 1

3. The only two consecutive questions with identical answers are the questions

A. ✖ ~~2 and 3~~
B. ✖ ~~3 and 4~~
C. ✔ 4 and 5
D. ✖ ~~5 and 6~~
E. ✖ ~~6 and 7~~

4. The only even numbered question whose answer is A is the question

A. ✖ ~~2~~
B. ✖ ~~4~~
C. ✖ ~~6~~
D. ✔ 8
E. ✖ ~~10~~

5. The number of questions with the answer B is

A. ✖ ~~6~~
B. ✖ ~~4~~
C. ✖ ~~3~~
D. ✔ 2
E. ✖ ~~1~~

6. The last odd question with the same answer as this one is the question

A. ✖ ~~1~~
B. ✖ ~~3~~
C. ✖ ~~5~~
D. ✖ ~~7~~
E. ✔ 9

7. The answer to this question is the same as the answer to the question

A. ✖ ~~1~~
B. ✖ ~~2~~
C. ✔ 3
D. ✖ ~~4~~
E. ✖ ~~5~~

8. Alphabetically, the answer to this question and the answer to the following question are

A. ✔ 4 apart
B. ✖ ~~3 apart~~
C. ✖ ~~2 apart~~
D. ✖ ~~1 apart~~
E. ✖ ~~the same~~

9. The number of questions whose answer is a consonant is

A. ✖ ~~a prime~~
B. ✖ ~~a square~~
C. ✖ ~~a cube~~
D. ✖ ~~divisible by 5~~
E. ✔ a factorial

10. The answer to this question is

A. ✖ ~~A~~
B. ✔ B
C. ✖ ~~C~~
D. ✖ ~~D~~
E. ✖ ~~E~~