

Criterion A: Planning(~500words)

DEFINING THE PROBLEM:

An owner of a casino is requesting a high-tech LED dice that can display numbers from 0 to 9 with sound queues indicating the number on the dice. This is because the owner wants the casino to be enjoyed by everyone, and to support the casino activity for people who are visually and/or hearing impaired.

RATIONALE FOR PROPOSED SOLUTION :

We will design and make an electronic 3x3 dice for a client who is an owner of a casino in the US. The Arduino board will be made in Mac computer and is constructed using the software C . We will use C because of the three following reasons. First, C compiles and executes much faster than other languages. A casino requires multiple uses of the dice a day, and to keep the casino running smoothly, the dice must be able to process faster. Second, C is a language understood and supported around the world. Because the owner is in the US, it would be better for the user to be able to easily find a programmer that can understand the programming language whenever an urgent problem occurs.

We will use Arduino to develop this product due to the reasons below. First, the Arduino allows us to code functions regarding light bulbs and a speaker. This output is crucial due to solving the problem the client has encountered. Second, we need the product to be able to deal with both input(button) and output(lightbulb/speaker). Finally, it will be most preferred that the product has no other function to keep the cost at the lowest possible. The Arduino has limited functionality, meaning that it is suited for a simple program like this.

We will use Tinkercad to develop our program due to these three reasons. First, it is easy to work on the program as a team. Tinkercad is a website that allows us to share links with our teammates. Working with a team in different locations, it is crucial to make the process smoother virtually. Second, Tinkercad produces immediate results, it allows the casino owner to try out the product, and ask for adjustments before the final product is sent to the owner physically. Finally, the virtual Arduino, allows Tinkercad users to receive immediate results without the physical Arduino, resulting in being friendly for developers in a financially difficult situation.

SUCCESS CRITERIA:

1. The dice uses light and sound to represent numbers from 0 to 9
2. needs to count from 0 to 9 and when it is 1-9
3. needs to be visually similar to the dice below.
4. The dice are to be implemented with an Arduino board.

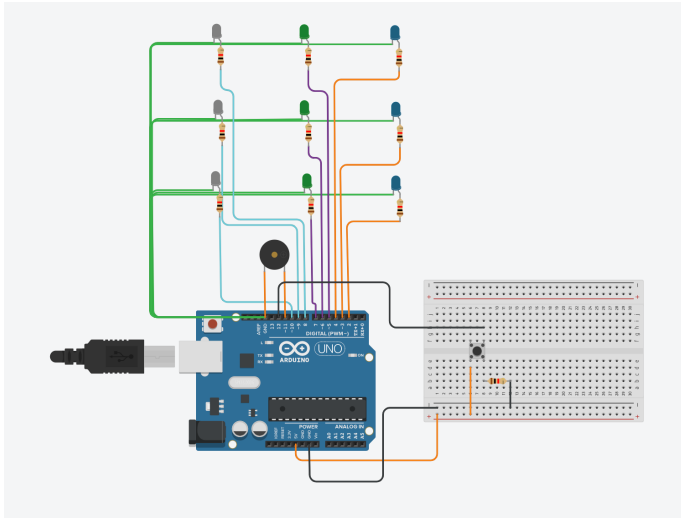
5. When the count is 0 all the lights will blink(repeat on and off process) 4 times and give a long *beep* sound to indicate Jackpot.
6. The dice need to have 3 different LED colors.
7. The button will be used to activate the dice.

Criteria B: Solution Overview

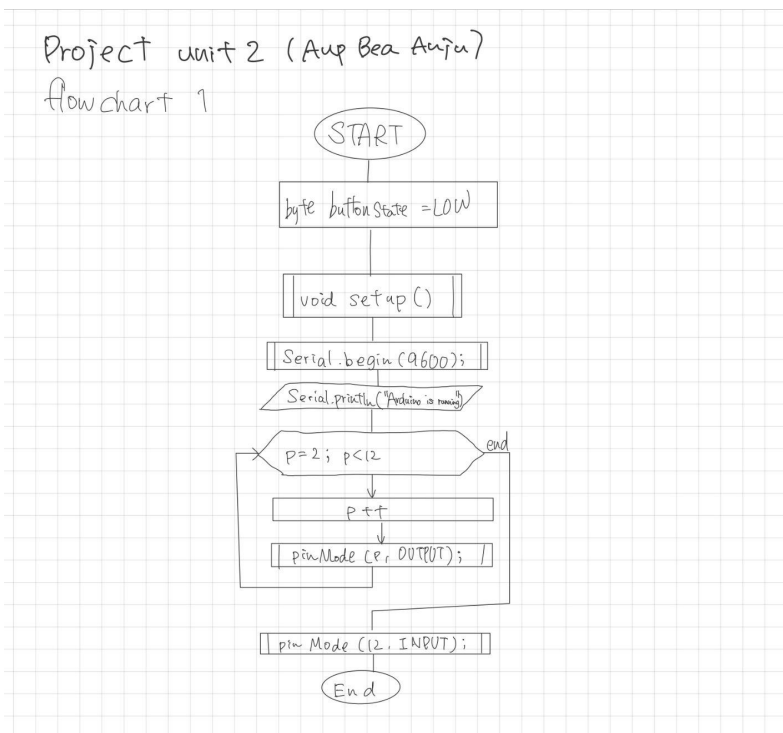
TEST PLAN:

Description	Type	Inputs	Expected Outputs
Testing function dice	Unit test	<ol style="list-style-type: none"> 1. Run the program 2. Press the button once 	No error is found and the LED is turned on with a buzzer sound as many times as the numbers of LEDs on
Dice test	Integration test	<ol style="list-style-type: none"> 1. Upload the program to the Arduino board connected to circuit 2. Run the program 3. Press buttons a few times 	The program has no error which can be seen by the light at pin 13 switch on and off. After that, the LED will be on with a buzzer sound when the button is pressed. After a few times, there will give randomly number which mean that the project is successful
Review the void setup/loop code	Code review	<p>Check for variables.</p> <p>Pin numbers</p> <p>Functions</p> <p>If/else statements</p> <p>For loops</p>	The variables are easy to understand and use. The pin number matches its use on the circuit which is on the left side of the code. The instructions are clear and easy to understand from comments made at the beginning

SYSTEM DIAGRAM: Showing the prototype of Arduino on the Tinkercad website which connect to 9 LEDs light (3x3) as the client's requirement stated. The LED lights will have 3 colors and this Arduino also connect to piezo buzzer which is the tool to create sound as this is multisensorial dice. The dice will be activated by the switch on the bread board (on the right side of the Arduino board) connected to Arduino.



FLOW CHART1: pre-conditions and connect each tools to their pin number

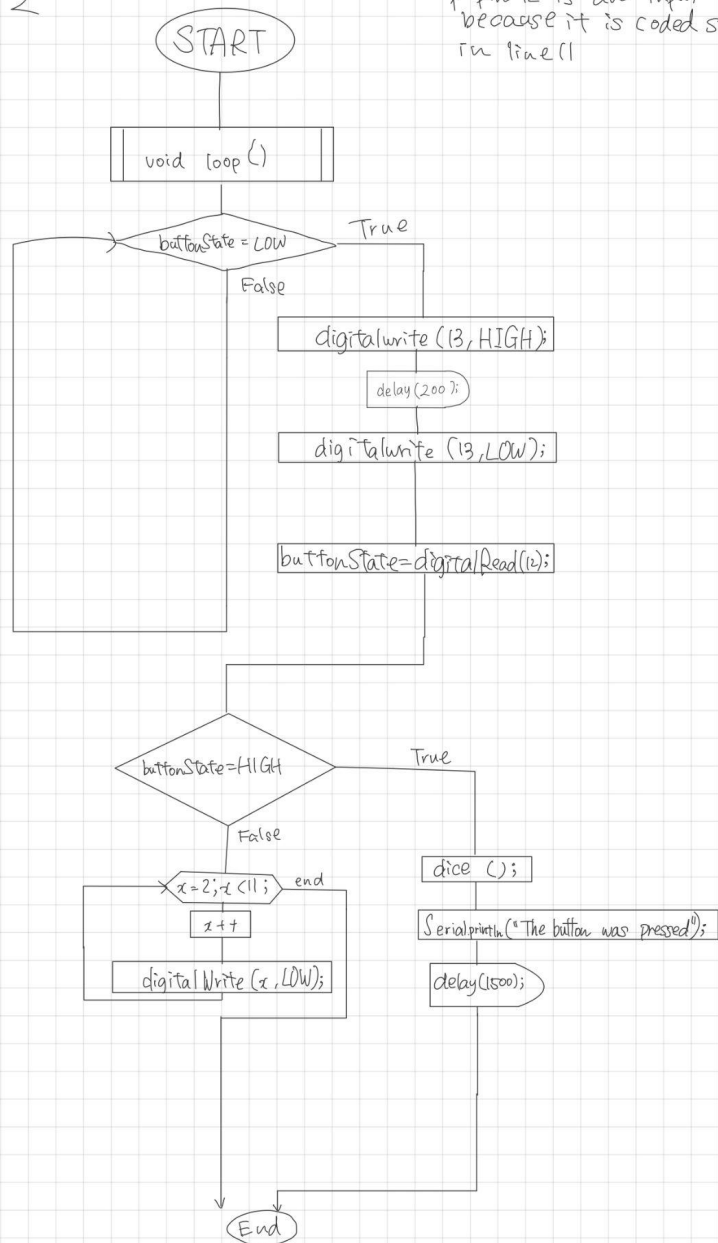


FLOW CHART 2: void loop() for the activation of function

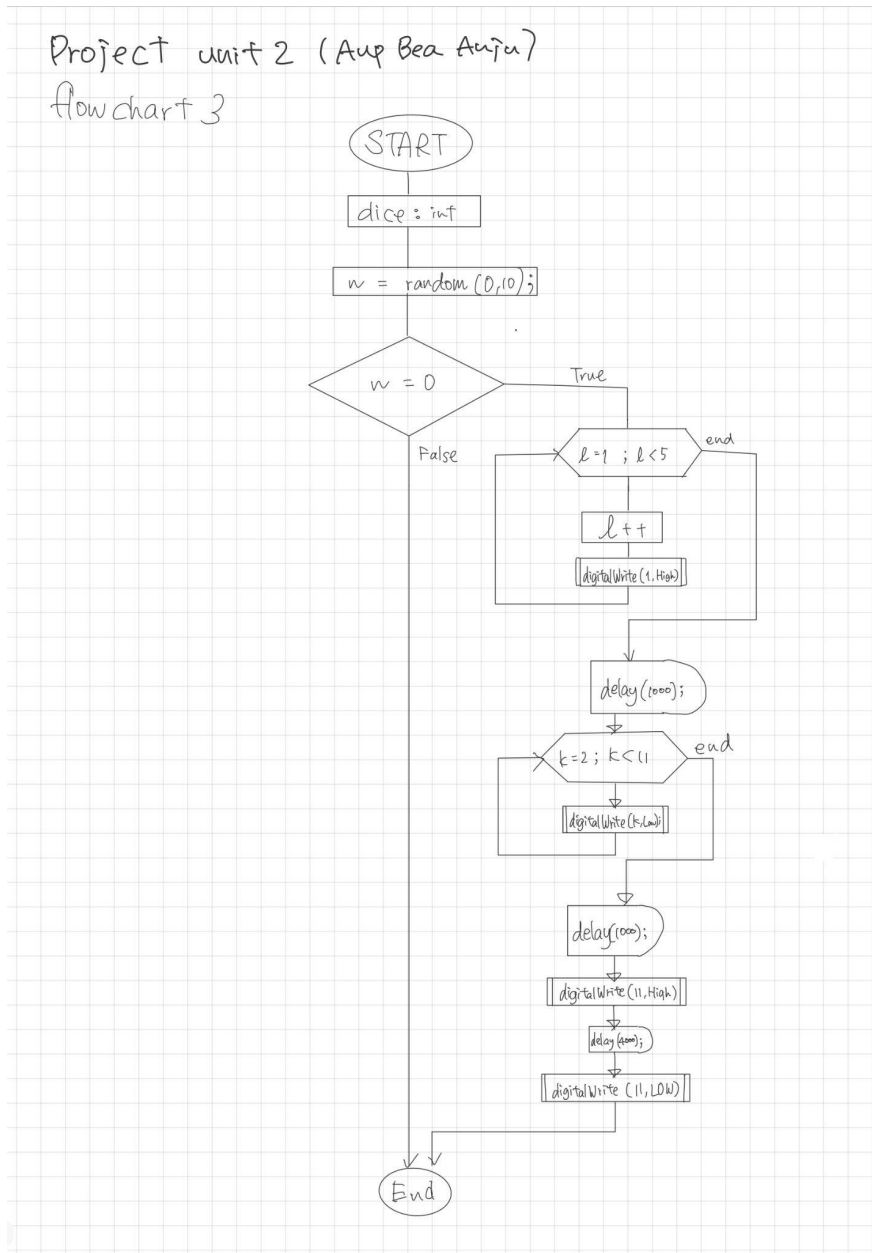
Project unit 2 (Aup Bea Anju)

flowchart 2

* pin 12 is an input
because it is coded so
in line 11



FLOW CHART3: Example for the light and sound in the dice function when dice roll 0.



RECORD OF TASK:

Task no.	Planned Action	Planned Outcome	Time estimate	Target completion date	Criterion
1	Problem definition	Define the problem and client of the project	30 minutes	Nov 30, 2021	A
2	Success Criteria	Have at least 3 success criteria.	15 minutes	Nov 30, 2021	A
3	Make rubric for a designer role	Marking rubric from 0-6 points for designer	10 minutes	Dec 2, 2021	-
4	Create a record of the task	Make a record of task and continue development	-	Jan 21, 2022	B
5	Make system diagram	First system diagram that can show the detail of software, computer's hardware spec, etc.	1 hour	Dec 12, 2021	B
6	Proposed solution	Make the proposed solution and justification of tools and structure for our project which need to meet all the client's requirements	1 day	Dec 6, 2021	A
7	Arduino board prototype	Make the prototype of our final product	1 hour	Dec 6, 2021	B
8	Equipment and research	Prepare Arduino board and research	1 hour 20 minutes	Dec 12, 2021	C
9	Arduino coding rough plan	Research and code the basic components	2 days	Dec 12, 2021	C
10	Arduino code rough draft	Share program information, and a brief explanation of how the code works	1 day	Dec 15, 2021	-
11	Arduino physical circuit	Make a physical circuit for the Arduino to ensure that the code can be used physically and practically	2hr	Dec 17, 2021	B
12	Arduino digital circuit	Identical circuit of the physical circuit to ensure that the results shown on Tinkercad would be the same as the physical circuit	1hr	Dec 21, 2021	B

13	Arduino coding in C	Code the program for the dice which need to fulfill all of the client's requirements	4 days	Jan 2, 2022	C
14	Flow chart	Making 3 flow charts that correspond with the code	2hr	Jan 13, 2022	B
15	Final adjustments of code	Adjust code to make it simple and easier to make flowcharts	2hr	Jan 19, 2022	C
16	Final adjustments of the Flow chart	Make adjustments according to the code	30min	Jan 20, 2022	B
17	Fill Criteria A	Fill criteria A according to the problem definition and success criteria.	2 hr	Jan 19, 2022	A
18	Fill Criteria B	Fill criteria B and verbally explain parts that are not enough.	2hr	Jan 19, 2022	B
19	Fill Criteria C	Verbalize the coding process and research. Documentation	4hr	Jan 20, 2022	C
20	Final meeting	Group meeting to correct any errors, miswording, misunderstanding in the group or document	2 hr	Jan 21, 2022	-

Criteria C: Development (~1,000 words)

a. List of the techniques used

1. For loops
2. If statement
3. Functions
4. Variables
5. Random integers
6. Pushbutton (input)

b. Development

1. Circuit

In order to meet our client's first requirement we designed the 3x3 dice that can display the sound using Arduino board, Arduino's piezo buzzer and 9 LED lights to display the visual light as you can see from **figure 1**.

Figure 1: Arduino circuit showing the multisensorial counting dice with 3x3 light for visual display and buzzer for audio/sound display.

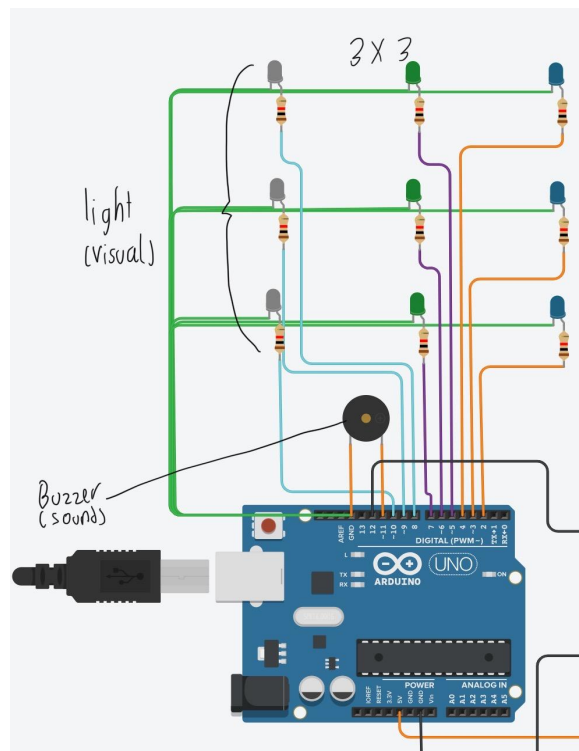


Figure 1 also shows how the LED light in this circuit is in 3 different colors which is one of the requirements. To meet the client's requirements, the LED displayed has to be the same as the dice shown in **figure 2**.



Figure 2: Sample dice from 1 to 9

In addition, the buzzer needs to create sound as many times as the number shown on the dice. The dice is also designed to roll for number 0 which all the LEDs should be switch on and off 4 times followed by the long sound. The display for each number from 0-9 is displayed in **figure 3** below.

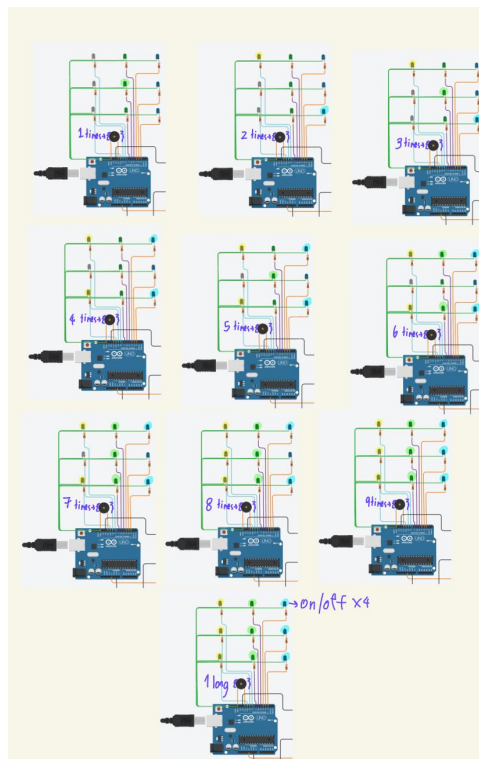


Figure 3: Model shows the display for both LED and sound from buzzer for each counting from 1-9 (starting from top left to bottom right) in the Arduino circuit and last one is for 0 (last row).

We identified that if statement is one of the technique needed in this process to give condition to the program. Variable is another technique being applied. Variable is used to store information to be referenced or used later on in the program. In our program, the variable called “n” will be used to store the integer for the later use as the condition for if statements.

```

byte dice(){
  int n = random(0,10);|
  if(n==1){
    digitalWrite(11,HIGH);
    digitalWrite(6,HIGH);
    delay(1000);
    digitalWrite(11,LOW);
  }

  if(n==2){
    digitalWrite(8,HIGH);
    digitalWrite(2,HIGH);
    for(int l=1;l<3;l++){
      digitalWrite(11,HIGH);
      delay(500);
      digitalWrite(11,LOW);
      delay(500);
    }
  }
}

```

Figure 4: The code above show the if statement when the dice roll 1 and 2.

From the code above, we can see the example of how the information get from the random integer is store in variable n. After that, the program will move forward to the next part which are the if statement examples which are for $n = 1/2$. The program will see if n meet any condition of the “if” or not and the program in that “if” will be execute.

2. Random integer

As stated in the problem statement, the client want to use this with their new game in casino. Therefore, this dice should display random number. The function random integer (**figure 4 second line**) has been implemented in this stage to fulfill it. This function will use pseudo randomness to random an integer by using the program “random(range of integer: minimum, maximum+1)”. This function will randomly pick number between the first inputed number (0) and the second inputed number -1($10-1 = 9$) and store it in the variable “n”.

3. Activate lighting and sounds

The activation of light and sound use a few techniques. First, function is where piece of is store for it to be excutede later. In **figure 4**, the function call “dice()” is define and in front of the function and variable the information type is labelled. In this function, the information output will be in byte and I chose byte because it is the type that use the least information as the function will only output on and off. After the function is being defined to activate the function the button (input of this program) is being used to execute the function (shown in **figure 5**).

```
// C++ code
//define state for button that it is pressed or not
byte buttonState = LOW;
void setup() {
  Serial.begin(9600);
  Serial.println("Arduino is running");
  //setup the pin for output(light and buzzer)
  for(int p=2;p<12;p++){
    pinMode(p,OUTPUT);
  }
  //setup pin for input(pushbutton)
  pinMode(12, INPUT);
}
void loop() {
  // turn on the LED
  digitalWrite(13,HIGH);
  //wait 1 sec
  delay(200);
  //turn off the LED
  digitalWrite(13,LOW);
  buttonState = digitalRead(12);

  // check if the pushbutton is pressed. If it is, the buttonState
  if (buttonState == HIGH) {
    //activate the function dice
    dice();
    Serial.println("the button was pressed");
    delay(1500);
  }else {
    // turn off all the light when the button is not pressed
    for(int x=2;x<11;x++){
      digitalWrite(x,LOW);
    }
  }
}
```

Figure 5: Coding for setup and the execution of program

The above code is the setup from define the push button state (High = pressed/ Low = not). After that each output and input will be accordingly to the pin it connected to in void setup. Then, in the void loop buttonstate will be connected to the button in pin 12 and will work with if statement that activate the “dice()” when button is pressed(buttonState = HIGH) and if the button is not pressed (in the else statement), all the light (pin 2 to 10 will turned off). In this process of turning off, we used for loops technique which is “for(int x =2; x<11; x++)” this mean that x will start from 2 and will replace the x in digitalWrite and x will increase by 1 until it reach 10(<11). This technique is to repeat code with same pattern several times which help us better organize the code. Next, We will focus on the activation of light and sound. For 1 to 9 will have similar format (use reference from **figure 4** which shows how 1 and 2 work) the only thing that change is the number and position of LED turning on. We also have buzzer which use for loops to create sound as seen in **figure 6**.

```
for(int l=1;l<8;l++){
    digitalWrite(11,HIGH);
    delay(500);
    digitalWrite(11,LOW);
    delay(500);
}
```

Figure 6: The code above show the example code to activate the buzzer.

From **figure 6**, we can see that for loop is being used again to repeat the sound 7 times which this is for $n = 7$. The buzzer which is connected to pin 11 will ring for 500 ms because of the delay 500 and will stop for 500 ms (LOW and delay 500) and will repeat this 7 times.

```
if(n==0){
    for(int l=1;l<5;l++){
        for(int l=2;l<11;l++){
            digitalWrite(l,HIGH);

        }
        delay(1000);
        for(int k=2;k<11;k++){
            digitalWrite(k, LOW);
        }
        delay(1000);
    }
    digitalWrite(11,HIGH);
    delay(4000);
    digitalWrite(11,LOW);
}
```

Figure 7: the code for light and sound for $n=0$

Code above show the special case which is when dice roll a zero. The client's requirement is to have all light switch on and off for 4 times which we use 3 for loops the first one (second line) is repeating the whole process of turn on and off the light for 4 times and second is to set all the light to HIGH and third is for LOW. Then after all the lights are off the long sound from buzzer will ring for 4 second(4000 ms from delay).

References:

1. James, Michael. "What is Arduino?" *Programming Electronics Academy* 22,6,2021 <https://www.programmingelectronics.com/what-is-arduino/#:~:text=So%20the%20Arduino%20hardware%20is,%2Dthe%2Dshelf%20microcontroller>
2. "Random()" *Arduino* <https://www.arduino.cc/reference/en/language/functions/random-numbers/random/>
3. "Roll the Dice, Click the Button to Roll!" https://www.antoniasapps.com/products_rollthedice.php
4. "What Is a Variable in Computer Programming?" <https://launchschool.com/books/ruby/read/variables>
5. "Why C is the Best Programming Language for Beginners" *NIIT* <https://www.niit.com/india/knowledge-centre/reasons-to-learn-C-programming-language#:~:text=The%20programs%20that%20you%20write,to%20most%20other%20programming%20languages>