Iowa State University

Department of Electrical and Computer Engineering

Deep Machine Learning: Theory and Practice

EE 526X

Homework 1

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Homework 1   **Vishal Deep**
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Note: Problems are completed using 5th edition of the text book.

1   Problem 1.1

(a) Die yield can be determined by the following formula:

$$Die\,Yield = Wafer\,Yield \times \frac{1}{(1 + (Defects\,per\,unit\,area \times Die\,area)/N)^N}$$

Let us assume wafer yield is 100% and process complexity 'N' = 10.

$$Die\,Yield = \frac{1}{(1 + ((0.30 \times 3.89)/10)^{10}} = 0.33$$

(b) The manufacturing size of IBM Power5 is 130nm which is larger than Niagra (90nm) and Opteron (90nm). This implies that Power5 is older hence more matured process. Therefore defects per unit area is small.

2   Problem 1.2

(a) We know that

$$Dies\,per\,wafer = \frac{\pi \times (Wafer\,diameter/2)^2}{Die\,area} - \frac{\pi \times Wafer\,diameter}{\sqrt{2 \times Die\,area}}$$

$$Dies\,per\,wafer = \frac{\pi \times (30/2)^2}{1.5} - \frac{\pi \times 30}{\sqrt{2 \times 1.5}}$$

$$= 471.24 - 54.48 = 416.76$$

Therefore 416 dies can be made from this wafer. To find defect free die, we need to find die yield.

$$Die\,Yield = \frac{1}{(1 + ((0.30 \times 1.5)/10)^{10}} = 0.64$$

$$Profit = 416 \times 0.64 \times \$20 = \$5324.8$$

(b)

$$Dies\,per\,wafer = \frac{\pi \times (30/2)^2}{2.5} - \frac{\pi \times 30}{\sqrt{2 \times 2.5}}$$

$$= 282.74 - 42.08 = 240.66$$

Therefore 240 dies can be made from this wafer. To find defect free die, we need to find die yield.

$$Die\, Yield = \frac{1}{(1 + ((0.30 \times 2.5)/10)^{10}} = 0.49$$

$$Profit = 240 \times 0.49 \times \$25 = \$2940$$

(c) Wood chips generate more profits. Therefore wood ships should be produced in this facility.

(d) For 50000 wood chips, I need $50000/416 = 120.19$ wafers per month. While for 25000 Markon chips, I need $25000/240 = 104.17$ wafers per month. By looking at demand and maximum profit, I would make 120 wafers of wood chips and 30 wafers of Markon chips per month.

Problem 1.3

(a) First we need to find yield of a single core chip

$$Die\, Yield = \frac{1}{(1 + ((0.75 \times 1.99)/10)^{10}} = 0.25$$

Probability of both core work $= 0.25 \times 0.25 = 0.06$
Probability that one core is faulty $=$ 1st faulty $\times$ 2nd good $+$ 1st good $\times$ 2nd faulty $= 0.75 \times 0.25 + 0.25 \times 0.75 = 0.38$
Now, probability that a defect will occur on no more than one of the two processor cores $= 0.06 + 0.38 = 0.44$

(b)
$$Cost\, of\, die = \frac{Cost\, of\, wafer}{Dies\, per\, wafer \times Die\, yield}$$

$$\$20 \times 0.25 = \frac{Cost\, of\, wafer}{Dies\, per\, wafer}$$

$$Dies\, per\, wafer = Wafer\, area/Die\, area$$

For the new chip:

$$Cost\, of\, die(new) = \frac{Cost\, of\, wafer}{1/2 \times Dies\, per\, wafer \times 0.44}$$

$$= \frac{20 \times 0.25}{1/2 \times 0.44} = \$22.73$$

Problem 1.4

(a) Total power consumed by the system on maximum load will be maximum power consumed by Intel Pentium 4 chip, 2 GB 240-pin Kingston DRAM, and one 7200 rpm hard drive. Also, the power supply efficiency of system is 80%. Therefore,

$$0.80 \times Power = 66 + (2 \times 2.3) + 7.9$$

$$Power = 98.12 \, Watts$$

(b) From the table, we know that power consumed by disk drive is 7.9 W read/seek, 4.0 W idle. And it is idle 60% times.

$$0.6 \times 4 + 0.4 \times 7.9 = 5.56W$$

(c) Given that
$$read7200 = 0.75 \times read5400$$

Power consumption of disk drives will be equal when

$$read7200 \times 7.9 + idle7200 \times 4 = read5400 \times 7 + idle5400 \times 2.9$$

and we also know that
$$read7200 + idle7200 = 1$$
$$read5400 + idle5400 = 1$$

Solving these equations for idle7200

$$(1 - idle7200) \times 7.9 + idle7200 \times 4 = \frac{1 - idle7200}{0.75} \times 7 + (1 - (\frac{1 - idle7200}{0.75})) \times 2.9$$

$$idle7200 = 0.29$$

Problem 3

(a) I logged into 'linux-5.ece.iastate.edu'.

(b) The system used 40 shared CPUs. To find information about CPU, I used following command:

```
$ cat /proc/cpuinfo
```

The CPU is Intel Xeon(R) E5-2660 V3 @ 2.60 GHz. It is a 10 core CPU.

(c) The execution time for the native input and minimum 4 number of threads is 1 min 22.8 sec as shown in figure below.

```
[PARSEC] [---------- Beginning of output ----------]
PARSEC Benchmark Suite Version 3.0-beta-20150206
yuv4mpeg: 1920x1080@25/1fps, 0:0

encoded 512 frames, 23.53 fps, 30265.17 kb/s

real    0m22.559s
user    1m22.800s
sys     0m0.900s
[PARSEC] [----------    End of output    ----------]
[PARSEC]
[PARSEC] BIBLIOGRAPHY
[PARSEC]
[PARSEC] [1] Bienia. Benchmarking Modern Multiprocessors. Ph.D. Thesis, 2011.
[PARSEC]
[PARSEC] Done.
-bash-4.1$ 
```

Transcript to run x264 benchmark on PARSEC

This procedure is taken from the PARSEC tutorial [1].

1. Remote login into server
   Open terminal and type in

   ```
   $ ssh linux-5.ece.iastate.edu
   ```

   then enter your credentials to log in.

2. Download PARSEC 3.0

   Download the PARSEC 3.0 full package using the following command:

   ```
   $ wget http://parsec.cs.princeton.edu/download/3.0/parsec-3.0.tar.gz
   ```

3. Unpack downloaded package

   Unpack the downloaded package using following command:

   ```
   $ tar -xzf parsec-3.0.tar.gz
   ```

   Change directory to parsec-3.0

   ```
   $ cd parsec-3.0
   ```

4. Setup environmental variables
   Setup environmental variables using following command:

   ```
   $ source env.sh
   ```

5. Build Benchmark Build x264 benchmark using following command:

4

```
      $ parsecmgmt -a build -p x264
```

where '-a' flag denotes desired action and '-p' flag specify package.

6. Run Benchmark Run x264 benchmark with 'native' input and 4 threads:

```
      $ parsecmgmt -a run -p x264 -i native -n 4
```

where '-i' flag denotes desired input and '-n' flag specify minimum number of threads.

References

[1] C. B. a. K. Li, "The PARSEC Benchmark Suite Tutorial - PARSEC 2.0." (http://parsec.cs.princeton.edu/download/tutorial/2.0/parsec-2.0-tutorial.pdf).