Feedback to HW8

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In this solution, denote `Int1` with i_1 and `Int2` with i_2.

1 Harolds Personal Files

1.1 Least blocks accessed

Fetch inode of root dir $\rightarrow$ content block of root dir
$\rightarrow$ Fetch inode of 1st dir $\rightarrow$ content block of 1st dir
$\rightarrow$ Fetch inode of 2nd dir $\rightarrow$ content block of 2nd dir
...
$\rightarrow$ Fetch inode of $i_1 \mod 3 + 2$-th dir $\rightarrow$ content block of $i_1 \mod 3 + 2$-th dir
$\rightarrow$ Fetch inode of file $\rightarrow$ first block of file

\# Total blocks $= (i_1 \mod 3 + 4) \cdot 2$

1.2 Most blocks accessed

\# Total blocks $= (i_1 \mod 3 + 3) \cdot 5 + 2$

2 Fat Fast File System

2.1 Largest file with direct pointers

$12 + i_1 \mod 3$ direct pointer: $12 + i_1 \mod 3$ blocks;
File size:

$$(12 + i_1 \mod 3) \cdot (8 + (i_2 \mod 4))\text{K}$$

2.2 Max file size supported

$12 + i_1 \mod 3$ direct pointer: $12 + i_1 \mod 3$ blocks;
2 indirect pointer: $2 \cdot (8 + (i_2 \mod 4)) \cdot 1024/8 = 2^8 \cdot (8 + (i_2 \mod 4))$ blocks
2 double indirect pointer: $2 \cdot ((8 + (i_2 \mod 4)) \cdot 1024/8)^2 = 2^{15} \cdot (8 + (i_2 \mod 4))^2$ blocks
2 triple indirect pointer: $2 \cdot ((8 + (i_2 \mod 4)) \cdot 1024/8)^3 = 2^{22} \cdot (8 + (i_2 \mod 4))^3$ blocks
1 quadruple indirect pointer: $((8 + (i_2 \mod 4)) \cdot 1024/8)^4 = 2^{28} \cdot (8 + (i_2 \mod 4))^4$ blocks
Total number of blocks:

$$12 + i_1 \mod 3 + 2^8 \cdot (8 + (i_2 \mod 4)) + 2^{15} \cdot (8 + (i_2 \mod 4))^2$$
$$+ 2^{22} \cdot (8 + (i_2 \mod 4))^3 + 2^{28} \cdot (8 + (i_2 \mod 4))^4$$

"within %1": $((8 + (i_2 \mod 4)) \cdot 1024/8)^4 = 2^{28} \cdot (8 + (i_2 \mod 4))^4$ blocks

Total size of file: $2^{28} \cdot (8 + (i_2 \mod 4))^5$ KB $= 256 \cdot (8 + (i_2 \mod 4))^5$ GB

Approximation:

$i_2 \mod 4 = 0$: $2^8 \cdot 8^5 = 8$ PB

$i_2 \mod 4 = 1$: $2^8 \cdot 9^5 = 14.4$ PB

$i_2 \mod 4 = 2$: $2^8 \cdot 10^5 = 24.4$ PB

$i_2 \mod 4 = 3$: $2^8 \cdot 11^5 = 39.3$ PB

3 Wasted Space

3.1 Internal fragmentation

folder name	#entries
`animal`	3
`felidae`	1
`rodent`	2
`primate`	2
`hominidate`	1
`code-monkey`	2
`hacker`	1
`unknown`	1

Exp. $i_2 = 2$, then block size is 10K bytes.

Then fragmentation of folder:

$$\begin{aligned}\texttt{fragFolder} &= \sum_{\text{folders}} (10 \cdot 1024)\text{B} - \text{number of entries in folder} \cdot 16\text{B} \\ &= 8 \cdot 10 \cdot 1024 - 16 \cdot (3 + 1 + 2 + 2 + 1 + 2 + 1 + 1) \\ &= 81712\text{B}\end{aligned}$$

Fragmentation of file:

$$\begin{aligned}\texttt{fragFile} &= \sum_{\text{files}} \text{internal fragmentation of each file} \\ &= 8\text{K} + 0 + 0 + 0 + 0 + 0 \\ &= 8192\text{B}\end{aligned}$$

Total fragmentation: (bytes)

$$81712 + 8192 = 89904$$

3.2 Internal fragmentation with double block size

Exp. $i_2 = 2$, then block size is 20K bytes.

Then fragmentation of folder:

$$\begin{aligned}\texttt{fragFolder} &= \sum_{\text{folders}} (10 \cdot 1024)\text{B} - \text{number of entries in folder} \cdot 16\text{B} \\ &= 8 \cdot 20 \cdot 1024 - 16 \cdot (3 + 1 + 2 + 2 + 1 + 2 + 1 + 1) \\ &= 163632\text{B}\end{aligned}$$

Fragmentation of file:

$$\begin{aligned}\texttt{fragFile} &= \sum_{\text{files}} \text{internal fragmentation of each file} \\ &= 8\text{K} + 10\text{K} + 0 + 10\text{K} + 0 + 0 \\ &= 28672\text{B}\end{aligned}$$

Total fragmentation: (bytes)

$$163632 + 28672 = 192304$$