

**Concurrency:
Theory, Languages and Programming
– Pi Calculus Examples –
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Unbounded Buffers

$$\begin{aligned} B(i, o) &\stackrel{\text{def}}{=} i(x).C\langle x, i, o \rangle \\ C(x, i, o) &\stackrel{\text{def}}{=} \bar{o}\langle x \rangle.B\langle i, o \rangle \\ &\quad + i(y).(C\langle y, i, o \rangle \frown C\langle x, i, o \rangle) \end{aligned}$$

where

$$\begin{aligned} X\langle i, o \rangle \frown Y\langle i, o \rangle &\stackrel{\text{def}}{=} \\ &(\nu m) (X\langle i, o \rangle[m/o] \mid Y\langle i, o \rangle[m/i]) \end{aligned}$$

- Follow the sequence $\xrightarrow{i1} \xrightarrow{i2} \xrightarrow{\bar{o}2} \xrightarrow{\dots}$ to convince yourself that the buffer process is indeed a buffer (FIFO) and that it can grow unboundedly.
- Note the “type” of the stored values ...
- Note the behavior of empty cells inside a buffer “chain”.

Elastic Buffers

Make the buffer elastic,
i.e., make empty cells disappear!

Several design decisions to be taken concern the question *when* an empty cell should cut itself out of a chain and die.

- if empty cell is next to a full/empty cell?
- if empty cell is left/right to a cell?
- should it be *allowed* (suicide)
or *forced* (murder) to die?

One goal of this exercise is to make you think about how to argue for or against that the various design decisions above lead to equivalent solutions.

Elastic Buffers: Setup

$$B(i, l, o, r) \stackrel{\text{def}}{=} i(x).C_x\langle i, l, o, r \rangle$$

+ ...

$$C_x(i, l, o, r) \stackrel{\text{def}}{=} \bar{o}\langle x \rangle.B\langle i, l, o, r \rangle$$

$$+ i(y).(C_y\langle i, l, o, r \rangle \frown C_x\langle i, l, o, r \rangle)$$

+ ...

where

$$(X \frown Y)\langle i, l, o, r \rangle \stackrel{\text{def}}{=}$$

$$X\langle i, l, o, r \rangle \frown Y\langle i, l, o, r \rangle \stackrel{\text{def}}{=}$$

...

Elastic Buffers: cut-when-left

$$B \stackrel{\text{def}}{=} (i, l, o, r). \\ i(x).C_x \langle i, l, o, r \rangle \\ + \dots$$

$$C_x \stackrel{\text{def}}{=} (i, l, o, r). \\ \bar{o} \langle x \rangle . B \langle i, l, o, r \rangle \\ + i(y). \left((C_y \frown C_x) \langle i, l, o, r \rangle \right) \\ + \dots$$

Elastic Buffers: cut-when-right

$$B \stackrel{\text{def}}{=} (i, l, o, r). \\ i(x).C_x \langle i, l, o, r \rangle \\ + \dots$$

$$C_x \stackrel{\text{def}}{=} (i, l, o, r). \\ \bar{o} \langle x \rangle . B \langle i, l, o, r \rangle \\ + i(y). \left((C_y \frown C_x) \langle i, l, o, r \rangle \right) \\ + \dots$$