More Fault Tolerant Consensus

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1. TurpinCoan Sync Multi

2. BenOr Async Stop

TurpinCoan Sync Multi

TurpinCoan Init aka Round 0 (Process #i)

- Initial choice: $x \in V$

- Proposal: $y \in V \cup \perp = \perp$
- Candidate: $z \in V \cup \perp = \perp$

- Vote: $\hat{v} \in \{0, 1\} = 0$

TurpinCoan Round 1 (Process #i)

- Send x to all processes
- Let $W \subseteq V \cup \perp$ = multiset of all received messages
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- Else, keep $y = \perp$
- $y \in V \cup \perp$ is our proposal
- Note: all non-faulty processes select the same $y \in V \cup \perp$
  - $aaa\underline{b} \Rightarrow y = a$, $aaa\underline{c} \Rightarrow y = a$
  - $aa\underline{a}b \Rightarrow y = a$, $aa\underline{c}b \Rightarrow y = \perp$

TurpinCoan Round 2 (Process #i)

- Send $y \in V \cup \perp$ to all processes
- Let $W \subseteq V \cup \perp$ ≡ multiset of all received messages
- $W = N$: sync,
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- Else if $\exists v \in V$, $\arg\max_v |W|_v$, arbi ($\hat{v} = 0$)
  - We do NOT vote for candidate $z \in V$, but this may be the final decision
- Else i.e. $|W| \cap V = \emptyset$. $(z = \perp, \hat{v} = 0)$
  - No candidate, no vote

TurpinCoan Round 3, ... (Process #i)

- decision z
- Else, final decision $v_0 \in V$

TurpinCoan Other Agreement Examples

The three loyal processes start with aab, $a, b \in V$, the last process is faulty

- Variant agreement: $z = a \quad V$

  - $aab\underline{b} \Rightarrow y = \perp$, $aa \perp \underline{b} \Rightarrow z = a$

- Variant agreement $z = v_0 \in V$
  - $aab\underline{a} \Rightarrow y = a$, $aa \perp \underline{a} \Rightarrow z = a$, $\hat{v} = 1$, $1100 \Rightarrow 0$
  - $aab\underline{a} \Rightarrow y = a$, $aa \perp \underline{a} \Rightarrow z = a$, $\hat{v} = 1$, $1100 \Rightarrow 0$
  - $aab\underline{b} \Rightarrow y = \perp$, $aa \perp \underline{b} \Rightarrow z = a$, $\hat{v} = 0$, $1100 \Rightarrow 0$

TurpinCoan Other Agreement Examples

The three loyal processes start with abc, $a, b, c \in V$, the last process is faulty

- Agreement: $z = v_0 \in V$
  - $abc\underline{b} \Rightarrow y = \perp,\ \perp\perp\perp\ \underline{e} \Rightarrow z = f, \hat{v} = 0,\ 000\_\quad 0$
- Agreement may be impossible with just one round
  - $aab\underline{a}\cdots \Rightarrow z = a, \hat{v} = 1,\ 110\underline{1} \Rightarrow 1$
  - $aab\underline{a}\cdots \Rightarrow z = a, \hat{v} = 1,\ 110\underline{1} \Rightarrow 1$
  - $aab\underline{b}\cdots \Rightarrow z = b, \hat{v} = 0,\ 110\underline{1} \Rightarrow 1$

BenOr Async Stop

- FLP: no agreement in the async model, even if one single
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- Way around: stronger model, and weaker termination
- Stronger model: processes use randomis
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- Weaker termination: eventual terminat

BenOr Init aka Round 0 (Process #i)

- Initial choice: $x \in \{0, 1\}$

- Proposal: $y \in \{0, 1, \perp\} = \perp$
- Step: $s \in \mathbb{N} = 0$, unbounded
- Each step has two rounds

BenOr Step s, Round 1 (Process $\#i$)

- Send (I, s, x) to all processes
- ges
- If all $m \in M$ have same value $v \in$
- Else, $y = \bot$

BenOr Step s, Round 2 (Process #i)

- Send (I, s, v) to all processes
- ges
- https://eduassistpro.github.i
- ecide v (if not already), and continue
- If at least $N - 2F = F + 1$ $m \in v \in \{0, 1\}$, then $x = v$, but do not deci
- Else i.e. $x =$ random $\in \{0, 1\}$.