20-1

State - ISWIM

$M ::= X \mid \lambda X.M \mid (M\ N) \mid b \mid o^n\ M \ldots$
$\quad \mid \sigma \mid (\text{set!}\ X\ M)$
$P ::= (\text{with}\ ([\cancel{X}\sigma\ V] \ldots)\ M)$
$V ::= b \mid \lambda X.M$

LS :: live slots $\quad : M \to P(\sigma)$

$LS(X) = \emptyset \qquad LS(\lambda X.M) = LS(M) \qquad LS(M\ N) = LS(M) \cup LS(N)$

$LS(b) = \emptyset \qquad LS(o^n\ M_1 \ldots M_n) = \bigcup_{i=1}^{n} LS(M_i)$

$LS(\sigma) = \{\sigma\} \qquad LS(\text{set!}\ X\ M) = LS(M)$

$LS : P \to P(\sigma)$

$LS(\text{with}\ ([\sigma_1\ V_1] \ldots [\sigma_n\ V_n])\ M) =$
$\quad LS(M) \cup LS(V_1) \cup \ldots \cup LS(V_n)$

$N = (\text{with}\ ([\sigma_1\ V_1] \ldots [\sigma_n\ V_n] \ldots [\sigma_{n+m}\ V_{n+m}])\ M)$
$\quad \mapsto (\text{with}\ ([\sigma_1\ V_1] \ldots [\sigma_n\ V_n])\ M)$
$\quad \text{iff} \quad \{\sigma_{n+1} \ldots \sigma_{n+m}\} \cap LS(N) = \emptyset$

20-2

CESK + gc

$LS : K \rightarrow P(\sigma)$

$LS(\text{ret}) = \emptyset$

$LS(\text{fun}(N, E, k)) = LS(N) \cup LS(E) \cup LS(k)$

$LS(\text{arg}(V, k)) = LS(V) \cup LS(k)$

$LS(\text{set}(\sigma, k)) = LS(k) \cup \{\sigma\}$

$LS(\text{op}(o^n, E, V\ldots, N\ldots, k)) = LS(E) \cup LS(V)\ldots \cup LS(N)\ldots \cup LS(k)$

$LS : V \rightarrow P(\sigma)$

$LS(b) = \emptyset \qquad LS(\text{clo}(\lambda X.M, E)) = LS(M) \cup LS(E)$

$LS : S \rightarrow P(\sigma) ::= LS(\bullet) = \emptyset \qquad LS(S[\sigma \mapsto V]) = LS(S) \cup LS(V)$

$LS : E \rightarrow P(\sigma) ::= LS(\bullet) = \emptyset \qquad LS(E[X \mapsto \sigma]) = LS(E) \cup \{\sigma\}$

$$\langle M, E, S[\sigma_1 \mapsto V_1]\ldots[\sigma_n \mapsto V_n], K \rangle$$
$$\mapsto \langle M, E, S, K \rangle$$
$$\text{iff } (LS(M) \cup LS(E) \cup LS(K) \cup LS(S)) \cap \{\sigma_1 \ldots \sigma_n\} = \emptyset$$

$$MS = \langle \underbrace{P(\sigma)}_{\text{white ptrs}}, \overbrace{P(\sigma)}^{\text{black ptrs}}, \underbrace{S}_{\text{store}} \rangle$$

$$\langle \{\sigma_0\} \cup \Sigma, \Sigma', S[\sigma_0 \mapsto V] \rangle$$
$$\mapsto_{gc} \langle \Sigma \cup (LS(V) - \{\sigma_0\} \cup \Sigma'), \{\sigma_0\} \cup \Sigma', S[\sigma_0 \mapsto V] \rangle$$

$$\langle M, E, S, K \rangle \mapsto_{cesk} \langle M, E, \bullet[\sigma_1 \mapsto V_1]\ldots[\sigma_n \mapsto V_n], K \rangle$$
$$\text{if } \langle LS(M) \cup LS(E) \cup LS(K), \emptyset, S \rangle$$
$$\mapsto^*_{gc} \langle \emptyset, \{\sigma_1 \ldots \sigma_n\}, S'[\sigma_1 \mapsto V_1]\ldots[\sigma_n \mapsto V_n] \rangle$$