A circuit for majority voting

p	q	r	Movies
T	T	T	T
T	T	F	T
T	F	T	T
T	F	F	F
F	T	T	T
F	T	F	F
F	F	T	F
F	F	F	F

A straigthforward solution:

$$(p \wedge q \wedge r) \vee (p \wedge q \wedge \neg r) \vee (p \wedge \neg q \wedge r) \vee (\neg p \wedge q \wedge r)$$

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p	q	r	Movies		$p \wedge q$	$q \wedge r$	$r \wedge p$	s
T	T	T	T		T	T	T	T
T	T	F	T		T	F	F	T
T	F	T	T		F	F	T	T
T	F	F	F		F	F	F	F
F	T	T	T		F	T	F	T
F	T	F	F		F	F	F	F
F	F	T	F		F	F	F	F
F	F	F	F		F	F	F	F

Proposed solution: $s \equiv (p \wedge q) \vee (q \wedge r) \vee (r \wedge p)$.

An alternative solution was $[(p \vee q) \wedge r] \vee (p \wedge q)$. How to verify it?

It suffices to check if $[(p \vee q) \wedge r] \equiv (q \wedge r) \vee (r \wedge p)$.

But this is true! It follows from the 2nd distributive law (and the commutativity law).

Comparing solutions

Straitforward:
$(p \wedge q \wedge r) \vee (p \wedge q \wedge \neg r) \vee (p \wedge \neg q \wedge r) \vee (\neg p \wedge q \wedge r)$
Pairs of parenthesis: 4
Logic Connectors: 10 AND/OR + 3 INVERTERS

'Symmetric': $(p \wedge q) \vee (q \wedge r) \vee (r \wedge p)$
Pairs of parenthesis: 3
Logic Connectors: 5 AND/OR

Alternative: $[(p \vee q) \wedge r] \vee (p \wedge q)$
Pairs of parenthesis: 3
Logic Connectors: 4 AND/OR

Choose answer according to what is 'cheaper/faster' in problem.

Circuit for the light with 2 swtichers

s_1	s_2	Light
off	off	off
off	on	on
on	off	on
on	on	off

Some solutions:

$$
\begin{aligned}
&(s_1 \wedge \neg s_2) \vee (\neg s_1 \wedge s_2) \\
\equiv &\neg(s_1 \leftrightarrow s_2) \\
\equiv &\neg[(s_1 \wedge s_2) \vee (\neg s_1 \wedge \neg s_2)]
\end{aligned}
$$