Online Deviation Detection for Medical Processes

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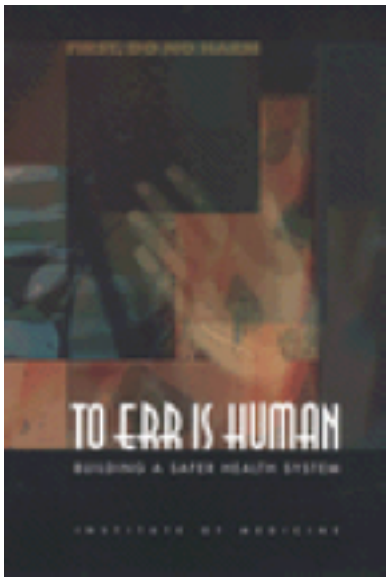
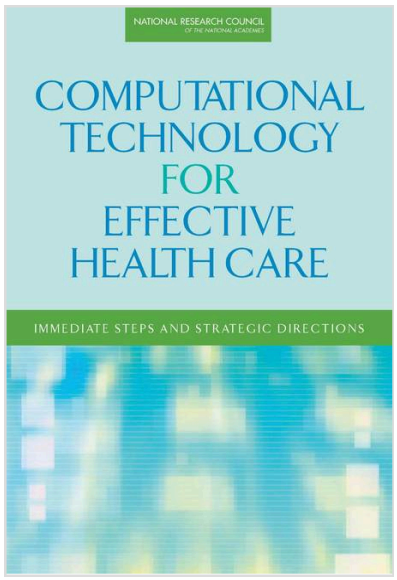
Human Errors Are a Major Concern in Medical Processes

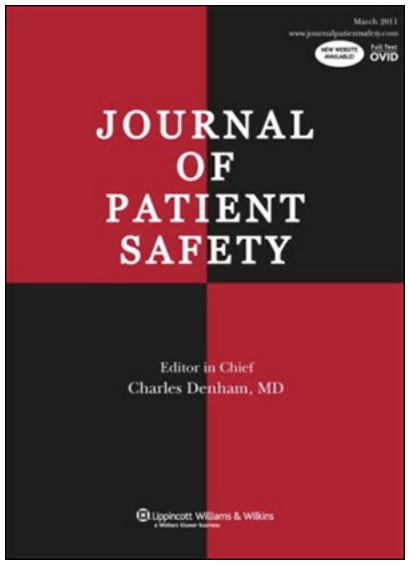
1998



2009

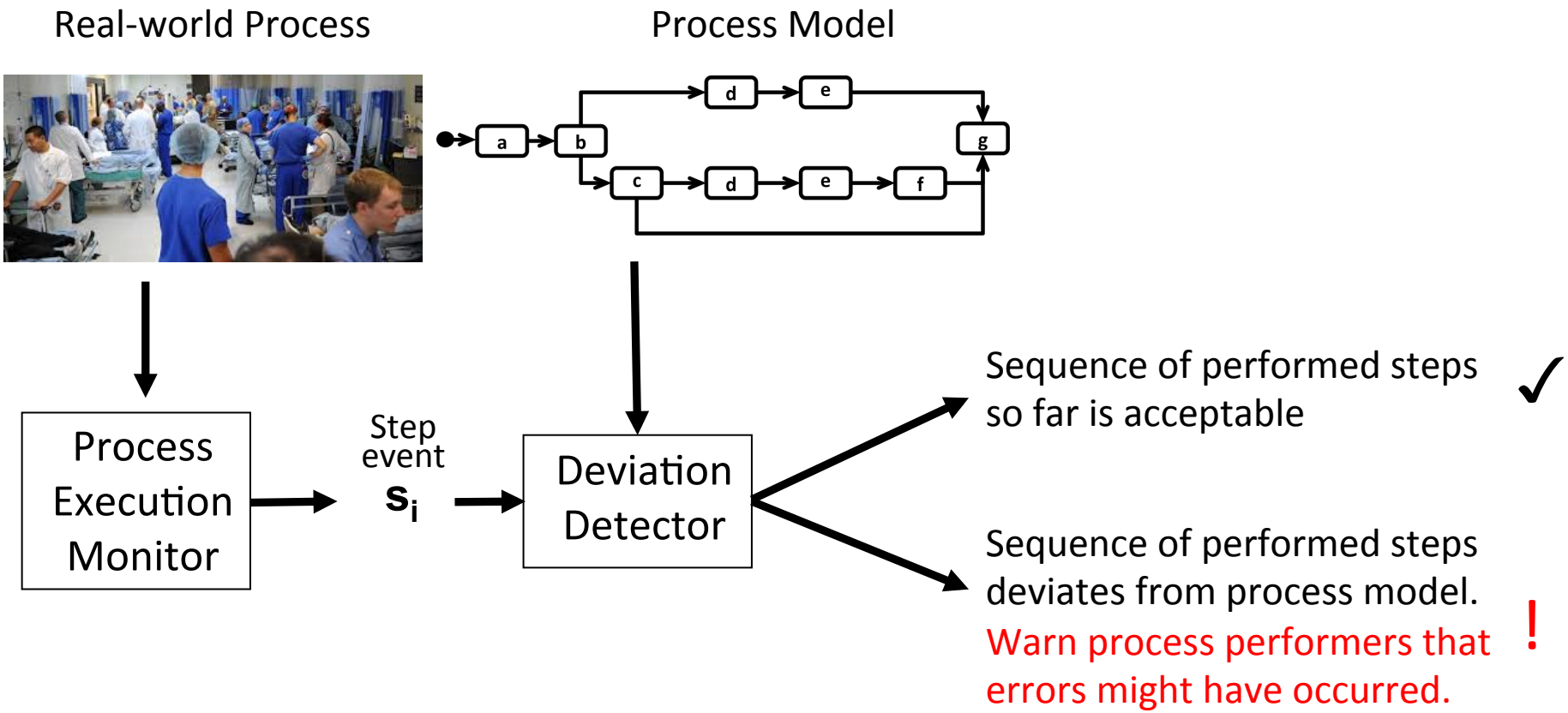


2013



It is estimated that between 98,000 and 400,000 people die each year in the U.S. due to preventable medical errors

Deviation Detection to Catch Errors Before Harm Is Done

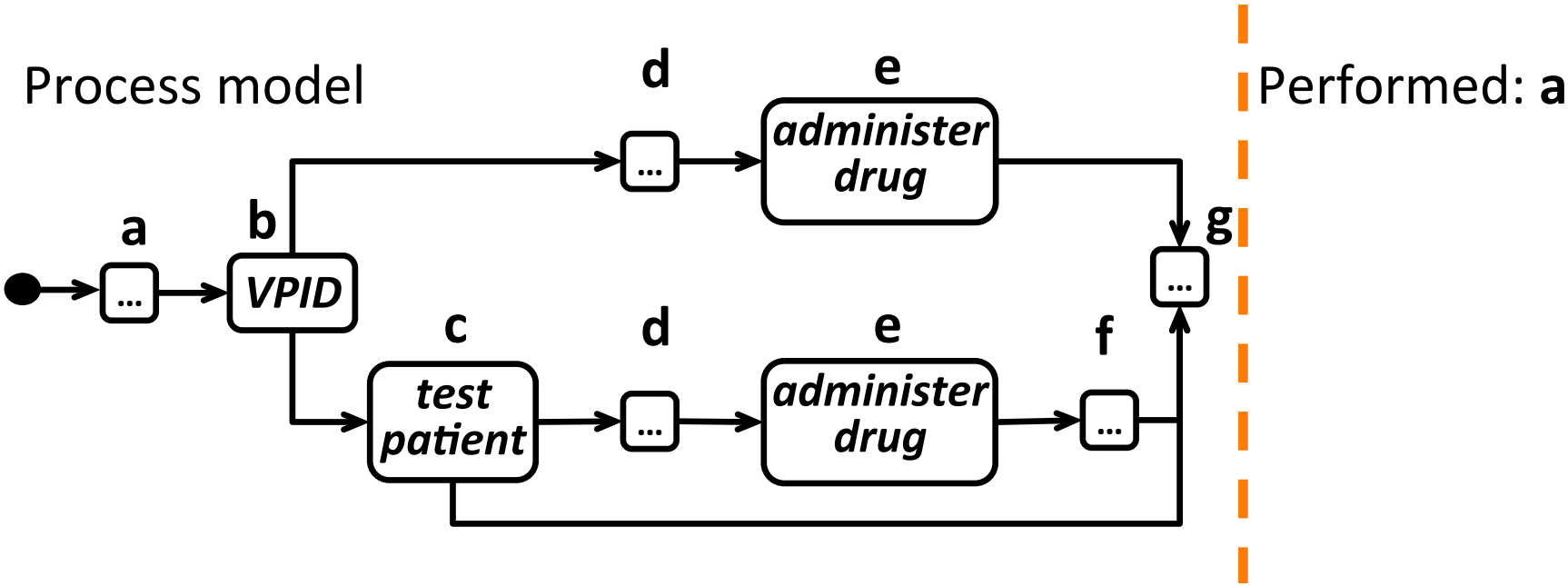


Approach targets *sequencing errors*—the use of a wrong sequence of steps

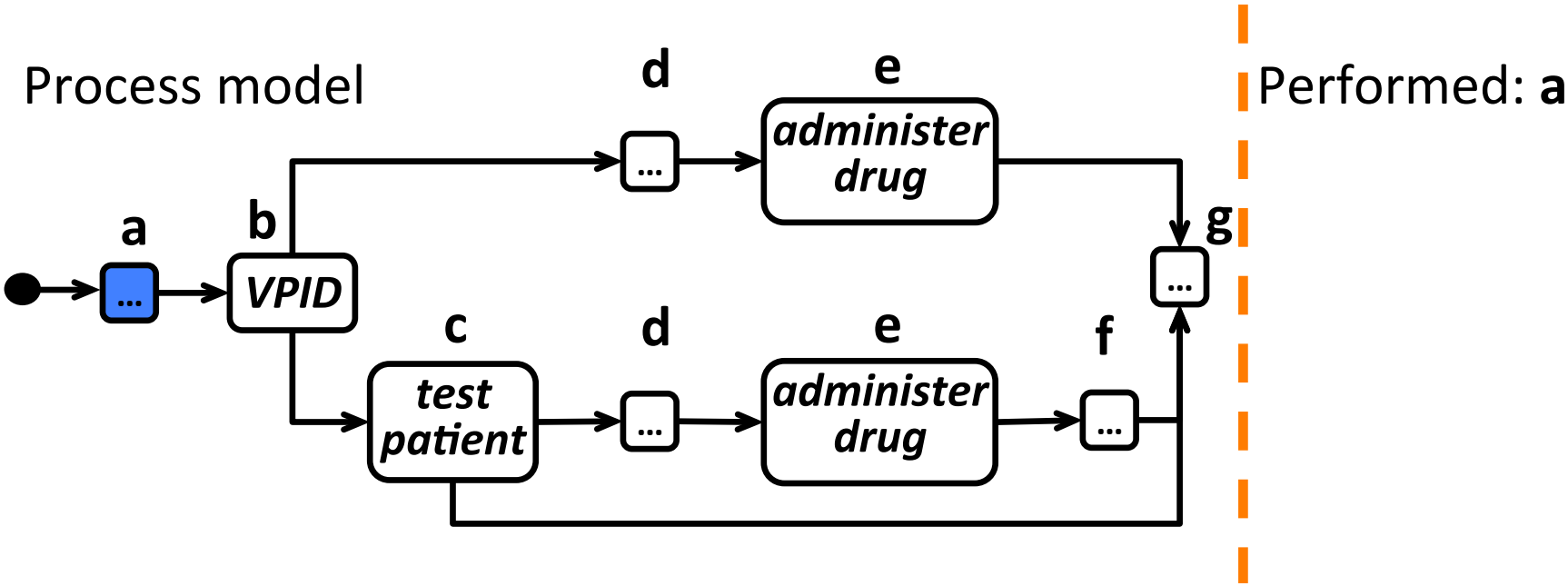
Outside of scope for now:

- Performing the right step, but doing it poorly/incorrectly
- Real-time errors

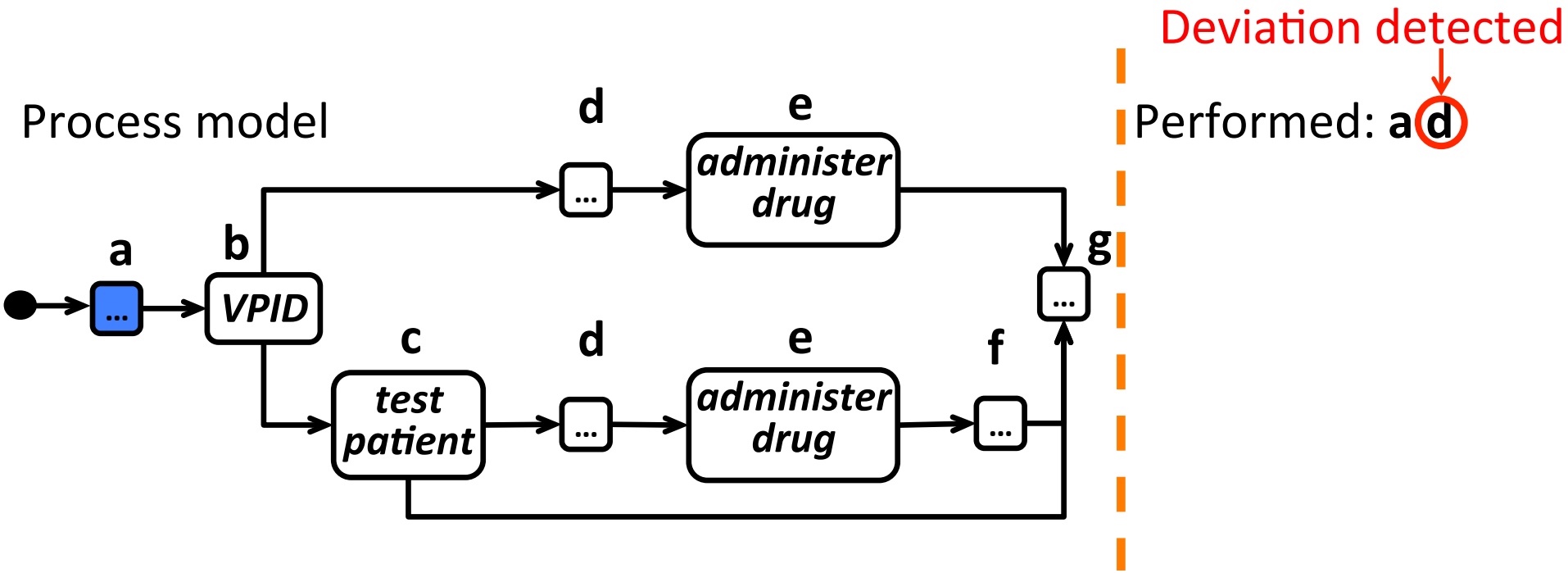
Deviation Detection



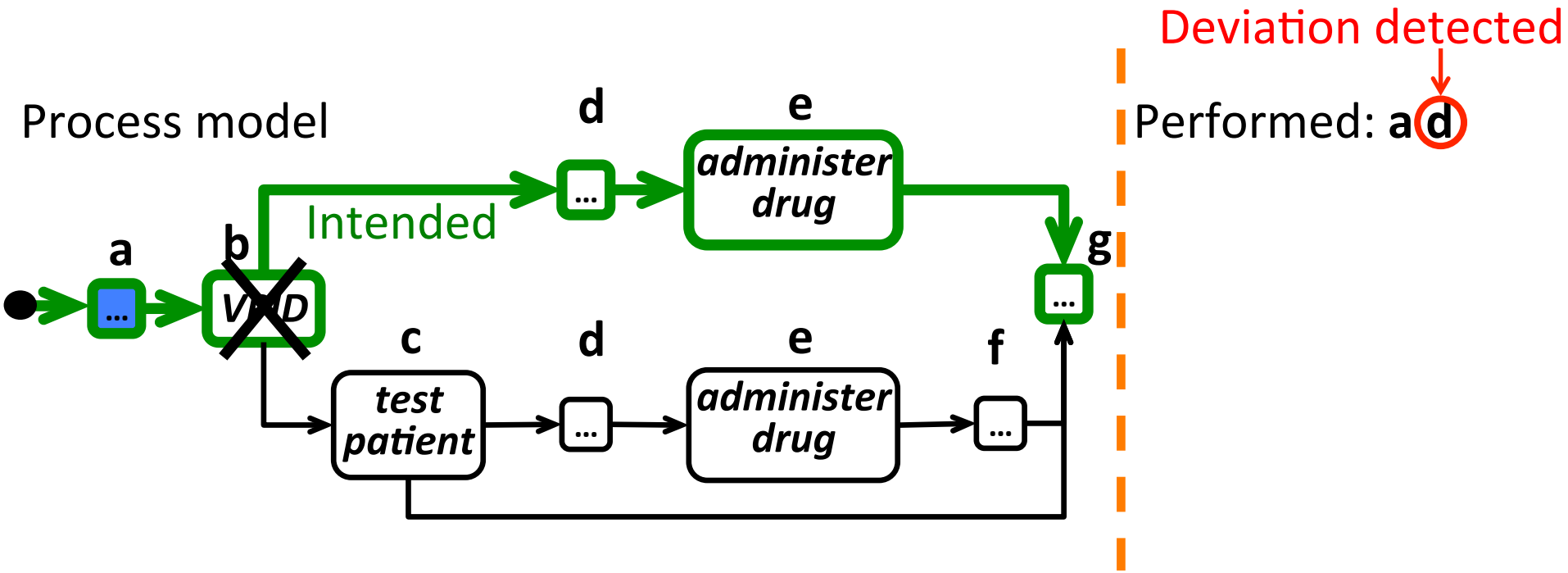
Deviation Detection



Deviation Detection



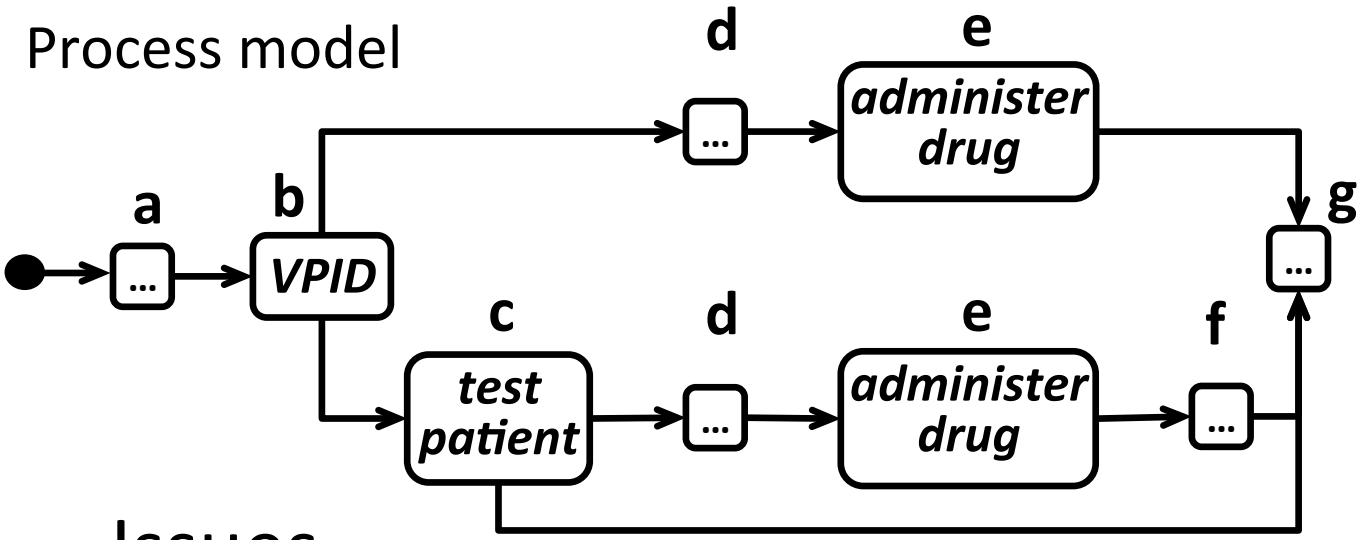
Deviation Detection



Error can be caught before harm is done

Deviation Detection

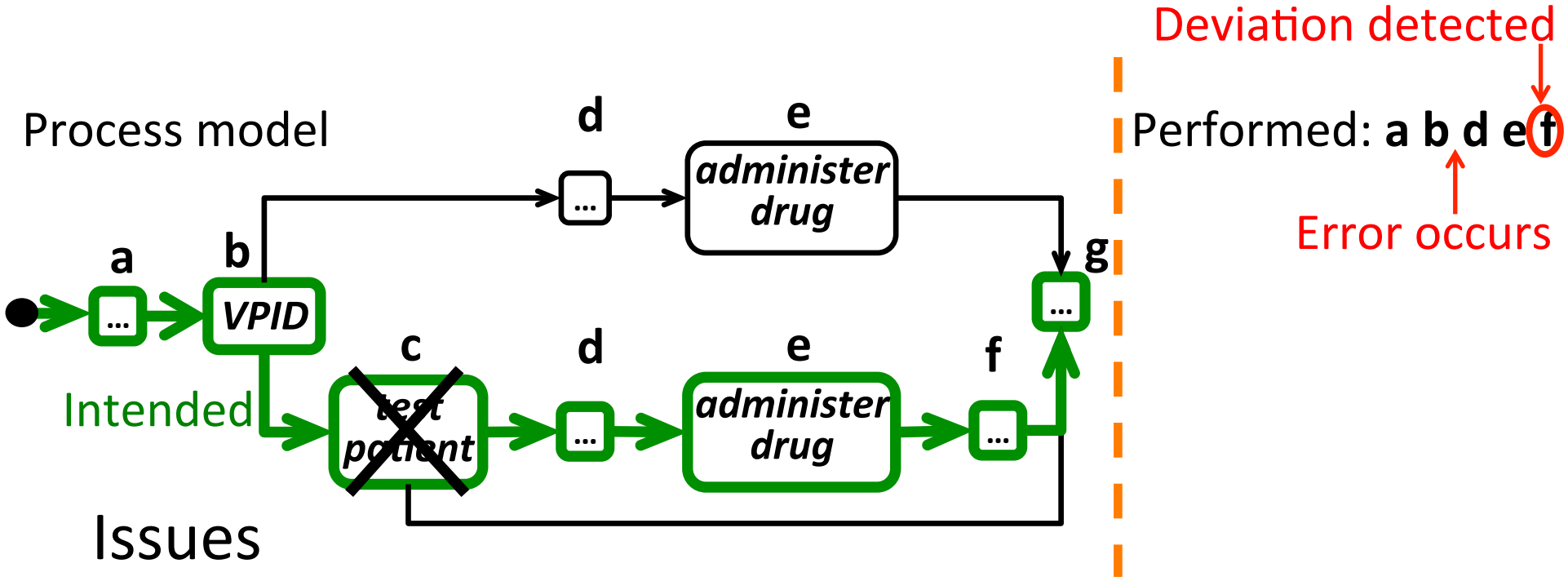
Process model



Issues

- Often do not know intent of process performers

Deviation Detection



Issues

- Often do not know intent of process performers
- Errors might occur before the deviation is detected (delayed deviation detection)
- Harm could be done before deviation is even detected

Research Questions

- **Characteristics of deviation detection delays**
  - How often do deviation detection delays occur?
  - How long are deviation detection delays?
  - How often do deviation detection delays result in harm?
- **Performance of deviation detection approach**
  - What is the running time?
  - What is the memory usage?

Applying the Deviation Detection Approach to Realistic Medical Scenarios

- **Used realistic models of two medical processes**
  - Chemotherapy preparation and administration
  - Blood transfusion
- **Created process executions**
  - Domain experts proposed likely step sequences with errors based on their experience and medical literature
  - Automatically generated step sequences with seeded errors using the process models
    - Seeded errors:
      - omission, insertion, substitution of a single step
      - omission of a subprocess
- **Identified sets of potentially harmful steps**
- **Applied deviation detection approach to each sequence**
  - Measured detection delay, harm, computation time and space

Results

- Characteristics of deviation detection delays
  - How often do deviation detection delays occur?
    - **Infrequently (observed delay in less than 1% of sequences with errors)**
  - How long are deviation detection delays?
    - **Short (observed delays were close to 1 step on average)**
  - How harmful are such deviation detection delays?
    - **Not harmful (did not observe cases where delay could result in harm)**

Results

- Performance of the deviation detection approach
  - What is the running time?
    - **"Fast enough" (0.5 sec. per step on average)**
  - What is the memory usage?
    - **Reasonable (laptop memory sufficient)**

Threats to Validity

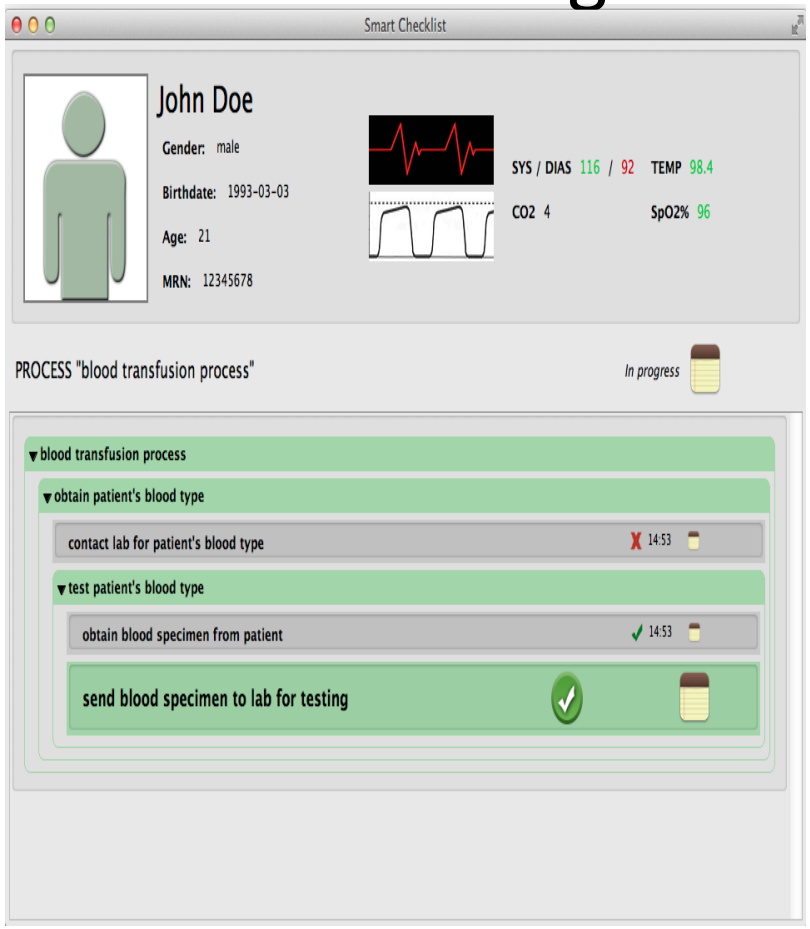
- Synthetic experimental evaluation
- Only two medical processes
- Limited set of errors

Limitations of the Deviation Detection Approach

- Need to be able to accurately monitor process execution
- Need an adequate process model

Future Work

- Explore analytic approaches for determining deviation detection delays
- Investigate approaches for deviation explanation
- Investigate approaches for proactive guidance
  - smart checklist



Conclusion

- **Investigated an approach for online deviation detection—*catch errors before harm is done***
- **Identified important issues and evaluated approach on medical processes**
- **Approach was effective on our examples**
  - Observed deviation detection delays were short, infrequent, not harmful
  - Reasonable computation time and memory usage
- **Need a more thorough evaluation**